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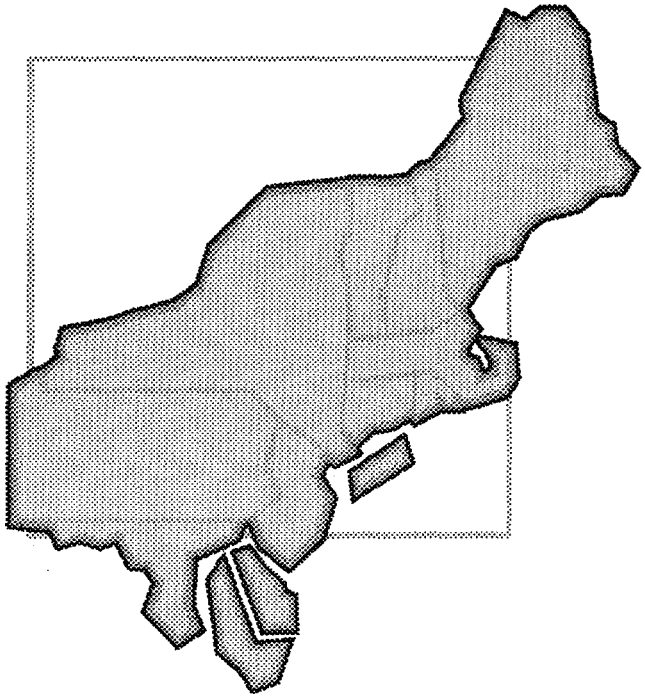
# NORTHEAST REGIONAL BIOMASS PROGRAM







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Coalition of Northeastern Governors Policy Research Center, Inc.

## RETROSPECTIVE: 1983-1993

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# PREFACE

This report provides a comprehensive account of the work of the Northeast Regional Biomass Program (NRBP) over its first ten years. The decade of NRBP activity covered by this report, 1983 to 1993, also corresponds to the period during which the Department of Energy grant funding which supports the NRBP was administered through the DOE's Oak Ridge Operations Office. Since the eleventh program year began in October 1993, funding for the Program is administered through the DOE's New York Regional Support Office. This report, then, serves to provide a detailed account of all activities and accomplishments funded by the Oak Ridge grant. (Note: a few of the projects initiated in this period ran over into 1994.)

In addition to describing the NRBP's mission, goals, and strategies, this report describes the work of the individual states which make up the Northeast region, and describes each of the technical studies carried out during the first ten years. As in past reports, an index of current publications as well as a map and index of wood-burning electric generating facilities in the region are provided.

Since its inception in 1983, the NRBP has undertaken over 60 applied research and technology transfer projects and supported the work of its eleven participating states, bringing together public and private sector organizations to promote the use of biomass energy resources and technologies. To guide these efforts, the Program developed an initial long-range plan. This plan was reviewed and updated in 1989. As this report is being prepared, the NRBP is completing its third planning effort, which will carry the Program into its second decade.

The Northeast has abundant biomass resources and markets for their use as energy. The Governors' Biomass Policy Roundtable, conducted under the auspices of the Coalition of Northeastern Governors with support from the NRBP, reflects a growing recognition that — now as never before — biomass has a key role to play in the region's economic development, energy independence and environmental management strategies.

# Contents

# THE BIOMASS ENERGY CHALLENGE

Ten years ago, when Congress initiated the Regional Biomass Energy Program, biomass fuel use in the Northeast was limited primarily to the forest products industry and residential wood stoves. An enduring form of energy as old as settlement in the region, residential wood-burning now takes its place beside modern biomass combustion systems in schools and other institutions, industrial cogeneration facilities, and utility-scale power plants which contribute electricity to regional grids. Biomass today represents more than 95 percent of all renewable energy consumed in the Northeast: a little more than one-half quadrillion BTUs yearly, or five percent of the region's total energy demand. Yet given the region's abundance of overstocked forests, municipal solid waste and processed wood residues, this represents just a fraction of the energy potential the biomass resource has to offer.

The Northeast Regional Biomass Program (NRBP) has contributed to the developments of the past decade by identifying and working to overcome gaps and barriers to the adoption of commercial or near-commercial biomass technologies. The wood stove is a case in point; once a contributor to local air pollution problems, the wood stove of today is a markedly cleaner, more efficient energy system. The NRBP was instrumental in initiating a collaborative research effort which made this possible, and has amplified the results of this work with a far-reaching public education campaign.

As a small program on a large playing field, the NRBP has achieved success by focusing its attention on well-defined targets. Yet despite this progress, the Northeast continues to have the nation's highest dependence on imported oil, and a limited renewables infrastructure. Misperceptions persist about the biomass resource and its energy utilization characteristics. Biomass development must proceed thoughtfully, to minimize or avoid any negative impacts while maximizing the energy, economic and environmental benefits. This is the biomass challenge.

## Biomass in Context

Development of the biomass energy resource takes place in the context of other developments, including:

- the larger energy supply and demand picture;
- the economic climate;
- technology and infrastructural developments; and
- environmental concerns.

When the NRBP undertook its first strategic planning process in 1983, the region's dependence on imported oil was the dominant concern. High fossil fuel prices represented a source of instability as well as a drain on the regional economy. With almost 73 million acres of forest land and a dense urban population generating large quantities of municipal solid waste, the region's biomass resource promised substantial fuel cost savings, a stable, indigenous energy base, and job retention and creation. Chief among the factors hindering development of the biomass resource were: the perception of uncertain wood supplies and an underdeveloped supply infrastructure; the high capital cost of conversion and unfamiliarity with the resource outside the forest products industry; and safety and air quality problems associated with residential wood stoves.

By the end of the decade, the energy picture had changed dramatically. Oil prices had fallen, and imports which had dropped

began to rise again. Electric utilities, which had responded to the energy crisis and energy policies of the late 1970s both by increasing their own capacity and entering into contracts with independent power producers (IPPs), now found themselves with excess capacity. The demand for energy, which had increased during the economic boom period of the 1980s, was beginning to fall. Emerging environmental concerns included global climate change and the energy sector's contribution to greenhouse gas emissions, and (particularly in the densely populated Northeast) a looming solid waste disposal crisis.

In 1993, the context for biomass energy development in the Northeast is characterized by:

- relatively low prices for fossil fuels;
- excess capacity in the electric utility sector;
- relatively flat economic conditions (unfavorable for new project development, but resulting in greater emphasis on the job creation / retention benefits of biomass development);
- continued concern about greenhouse gas emissions, notably carbon dioxide (but also methane);
- continued interest in solid waste disposal alternatives (coupled with lack of support or active opposition to direct combustion);
- far-reaching new air regulations, which limit ambient concentrations of nitrous oxides, sulphur dioxide, particulates and dozens of toxic compounds; and
- increasing federal interest in developing liquid fuels from biomass feedstocks.

## Emerging Key Issues

As the NRBP enters its second decade, key issues include some familiar topics, such as the ongoing debate over whether the combustion of wood for energy constitutes a "re-use" of wood waste otherwise destined for landfills, as opposed to being classified as "incineration" — with very different (and less favorable) regulatory and incentive implications.

Other aspects of the regulatory "playing field" have emerged more recently. These include new penalties and incentives associated with the Clean Air Act Amendments, as well as the development of "externalities" and other models for assigning value to the environmental impacts of different fuels used to generate electricity. While the impact of these models has so far been limited by the current excess of electric generating capacity in the region, it is clear that most of these models place wood at an unfair disadvantage because they do not assess and compare fuels on a full life-cycle basis. Such models confer an unfair disadvantage on wood by accounting only for the carbon emitted during combustion. Wood, unlike fossil fuels such as coal, is carbon-neutral when considered on a life-cycle basis.

Another set of issues concern land-use and choices about the management of the region's biomass resources. There persists a perception on the part of the general public and some environmental activists that the region's forest resource may be threatened by biomass energy development. This suggests an ongoing need to publicize the results of studies which show that a market for biomass fuel can lead to improved management of existing forest stands. At the same time, the NRBP needs to explore the potential for more intensively managed energy "plantations" of short-rotation woody or herbaceous crops, which are suitable to parts of the region.

In the area of conversion technologies, two well-established technologies, co-firing wood with coal and landfill gas recovery, are both experiencing new interest, partly as a result of new environmental regulations and incentives. Other technologies — such as the large-scale manufacture of liquid fuels (ethanol in particular), the highly efficient combustion/gasification system (BIG/STIG) pending full-scale testing in Vermont, or the use of biogas as a fuel cell feedstock — have not yet established themselves commercially, but offer much promise to the region. Another potential end-use for biomass is in the production of chemical feedstocks, both as direct substitutes for petroleum-based chemicals, and as components of other environmentally-benign chemical conversion processes. Although not an energy use per se, the development of biomass feedstocks and chemical conversion processes offer the potential to support a wide range of "Green Technologies".

## The Challenge Ahead

To a considerable degree the potential of biomass is intimately tied to the region's treatment of waste. Near-term opportunities for economic dispatch of biomass technologies are driven by the society's need to dispose of organic materials. The increasing costs associated with waste management create niche markets for bioenergy applications. As this publication goes to press, there are no major corporations whose primary mission is biomass energy. There are thousands of firms which can profit by its prudent utilization.

Under these conditions, the NRBP's challenge is threefold:

- to focus on market niches and technologies which promise to be competitive;
- to emphasize the economic development potential of biomass resource development; and
- to assess and promote policies and biomass technology applications which promote environmental objectives while mitigating any negative impacts.

# OVERVIEW OF THE REGIONAL BIOMASS PROGRAM

The Regional Biomass Energy Program was established at the national level by Congress in 1983. Because both the potential and the requirements for biofuels development vary with climate and geography, the enabling legislation instructed the Department of Energy (DOE) to support regional biomass energy programs, similar to one originally managed by the Bonneville Power Administration in the Northwest since 1979. Today there are five regional programs, each organized to identify and assess regional opportunities and barriers and to respond with regional solutions. Typical activities include:

- assessing the types, quantity, and availability of regional biomass resources;
- comparing the costs and benefits of biomass fuels to those of competing energy sources;
- assessing the potential for local biomass fuels to meet varied local requirements for energy from residences, commerce and industry;
- working to identify and meet the needs of biomass energy suppliers, distributors and users.

## Program Structure

The U.S. Department of Energy administers the regional programs. The Northeast Regional Biomass Program (NRBP) was initiated in August 1983 with a grant to CONEG Policy Research Center, Inc. from the U.S. DOE's Oak Ridge Operations Office. Beginning in the eleventh program year (October 1993), the CONEG NRBP grant has been administered by DOE through its New York Regional Support Office.

**NRBP MEMBER STATES**

| | |
|---|---|
| Connecticut | New Jersey |
| Delaware | New York |
| Maine | Pennsylvania |
| Maryland | Rhode Island |
| Massachusetts | Vermont |
| New Hampshire | |

In addition to reporting to DOE through its New York Support Office, the NRBP Program Manager communicates regularly with the Boston and Philadelphia Support Offices, which also serve the Northeast Region. The Program Manager works closely with a **Steering Committee**, made up of representatives from each state in the region, as well as the three DOE Support Offices. The Steering Committee provides a forum for the exchange of information and consideration of regional biomass and related issues. Steering Committee members advise the CONEG Policy Research Center on the focus of both the State Grant Program and the regional projects effort. The work of the Program Manager and the Steering Committee is supported by the Program's **Technical Support Contractor**, whose work includes: helping to develop project ideas for consideration by the NRBP; staffing long range planning efforts; helping to develop project work statements, advisory committees, and requests for proposals for regional projects; producing reports on the activities of the NRBP; and otherwise assisting with planning and technology transfer activities.

## NRBP Goals & Objectives

The goal of the NRBP is to increase acceptance and application of biomass energy technologies by the private sector and local governments. To achieve this goal, the Program seeks to identify barriers to increased biomass energy use and to remove those barriers by providing information and technical assistance to private and public decision-makers.

**NRBP OBJECTIVES:**

- Establish the availability of biomass resources in the Northeast.
- Identify and remove barriers to biomass energy development.
- Encourage private investment in commercial or nearly commercial biomass fuels harvesting, processing and energy conversion technologies and applications.
- Contribute to solid waste management solutions and biomass energy utilization goals.
- Contribute to understanding environmental impacts of biomass utilization for energy, to mitigating negative impacts and promoting positive impacts.
- Improve capabilities of state agencies with biomass-related responsibilities.
- Help member states coordinate efforts among the wide range of agencies involved in the various aspects of resource management, energy production, energy utilization, and environmental and public health protection.

Specific strategies, activities, and accomplishments are described in the following section; detailed accounts of the state and regional program components are presented in subsequent sections of this report.

# PROGRAM STRATEGIES AND ACCOMPLISHMENTS

Overcoming the barriers to increased biomass energy use requires that specific problems be clearly identified and carefully assessed; that the results of such analyses be communicated clearly to key decision-makers and other interested parties; and that communication be fostered among the diverse constituencies and agencies which influence the production, regulation and consumption of biomass energy.

## Program Components

The NRBP has two basic components, the State Grant Program and the Regional Program.

- **The State Grant Program** component provides funds with a 50 percent matching requirement to each of the region's eleven participating states to strengthen and integrate the work of state agencies involved in biomass energy. The NRBP's state grant program has been critical to the continuity of a biomass presence throughout the region, ensuring that the biomass energy resource is included in considerations of energy, waste management, and environmental policies.
- The **Regional Program** component produces a series of technical reports and policy studies addressing specific opportunities and barriers critical to biomass energy development in the region. Technical advisory committees, including representatives from private industry, academic research, regulatory and other state and local government agencies, as well as the NRBP Steering Committee, are convened to guide the work of private contractors who compete to perform these projects.

## Types of Activities

The NRBP and its member states undertake a wide range of state-specific as well as regional activities in support of the Program's goals and objectives. General categories of activity include: planning; resource assessments; applied research; demonstration projects and case studies; and technology transfer activities.

### PLANNING

The NRBP's first step in 1983 was to convene committees of industry, government and academic leaders to identify problems with regard to biomass energy demand, supply and technologies in the Northeast. Using the committees' assessments and recommendations, the NRBP developed a long-range plan for its state programs and technical studies. In 1989-1990, Program activities and accomplishments were reviewed against the recommendations and goals set forth in the original long-range plan, which was then updated. This valuable exercise was repeated in 1993-94, incorporating as appropriate the goals and recommendations of two parallel planning efforts, a strategic roadmap developed for the entire Regional Biomass Energy Program, and the Northeast Governors' Biomass Policy Roundtable.

The Steering Committee, which meets three to four times a year, performs as interim planning function for the Program. In addition, forums on topics such as utility cofiring or liquid fuels development provide an opportunity for the NRBP to bring together key stakeholders and identify issue-specific barriers and opportunities for constructive Program intervention.

### RESOURCE ASSESSMENTS

Establishing the size, location, availability and energy conversion characteristics of the region's biomass resource has been central to the NRBP's mission from the beginning. Early assessment efforts focused primarily on the forest resource base, including research into the availability of harvesting and mill residues. Increasingly, both state and regional assessment efforts have expanded to include urban wood waste and other processed biomass waste products with high potential for use as energy feedstocks.

### APPLIED RESEARCH

In a number of areas, the NRBP has identified areas of research which cut across more than one discipline, raising pivotal issues not previously explored by other agencies or programs. Many of the NRBP's most widely recognized projects have involved some combination of primary and secondary research into, and analysis of, the environmental, economic and energy impacts of biomass technology applications. Examples include the Program's groundbreaking work in the areas of residential wood stove testing and wood waste characteristics -- work for which the NRPB has leveraged significant outside funding and generated interest and impacts at the national level as well as within the region.

### CASE STUDIES AND DEMONSTRATION PROJECTS

The NRBP focuses heavily on "commercial" or nearly commercial biomass energy technologies, including but not limited to those generated under the auspices of the DOE laboratories. Often, the most effective development tool is to document and publish the successful application of these technologies in the region. In other instances, often through the state grant programs, the NRBP has sponsored or contributed to the support of pilot applications of technologies not yet commercialized.

### TECHNOLOGY TRANSFER

All of the NRBP's projects incorporate a strategy for disseminating results, but some projects are designed specifically for the purpose of getting existing biomass technology and applications information into the hands of private developers, regulators, policy-makers, and the general public. A particuarly successful example of this is the video, *Heating Schools With Wood Chips*, which effectively makes the case for wood energy by presenting Vermont's successful conversion of electrically-heated schools to wood-fired systems.

## Strategic Advantages

The structure of the Regional Biomass Program, and its administration through the CONEG Policy Research Center, has achieved several advantages to serving the biomass industry. These advantages, outlined below, reflect the virtues of managing a renewable energy technology program through a regional non-profit agency with a mission to serve state governments.

- ***Seeking out, listening to, and engaging key markets.*** Through the organization of technical committees, topical conferences, regular meetings of state representatives, and the long-range planning process, the NRBP continuously solicits the ideas, interests, and concerns of key constitutencies: regulators, harvesters, developers, landfill operators, equipment manufacturers and dealers, researchers, boiler operators, and others.
- ***Capacity-building and coordinating state government activities.*** The State Grant Program requires an agency contact, offers to pay a portion of a salary, and provides professional development opportunities for a biomass specialist, usually within the state energy, environmental or forestry agency, and in some cases within the state's policy or planning office. The State Grant Program contract requires the review and signature of the Governor's office, which serves to facilitate the coordination of energy, forestry, solid waste and air regulation offices. NRBP Steering Committee members work closely with their counterparts on other CONEG environmental and energy committees. CONEG's work with the Governors and their top staff helps ensure that biomass issues receive high visibility in state government. This is exemplified by the Governors Biomass Policy Roundtable, initiated through CONEG by Governor Dean of Vermont, with the aim of identifying opportunities and setting specific goals for the development of biomass in the Northeast.
- ***Acting locally, impacting nationally and internationally.*** A number of the issues and challenges associated with an emerging biomass industry in the Northeast are similar to those facing other regions and other countries. Several of our technical studies have received co-funding from other state, regional, federal and Canadian agencies. Wood stove emissions, wood ash markets, wood waste characterization, and equity adjustments in resource recovery facility siting are four prominent examples of projects which have received national and international interest and attention.
- ***Flexibility, responsiveness, and speed in addressing problems.*** When agreement is reached on the nature of a technical or policy problem, the NRBP can work very quickly to draft a statement of work, access additional funding or obtain co-funding commitments if needed, and solicit bids from contractors. In a period of two to three months, the NRBP can move from problem identification to problem-solving action. The NRBP's speed and flexibility in responding to

emerging issues have contributed to the Program's success in leveraging funding from other private and public agencies.

- ***Emphasis on technology transfer.*** NRBP projects focus on technologies already available in the marketplace. Therefore special attention is paid to dissemination of project results or findings to all appropriate constituencies. Project reports, handbooks, videos and brochures are made available through the CONEG Policy Research Center (a current list of publications is included in this report). In addition, contractors often are required to write articles for *Biologue* and appropriate trade publications. Other important strategies for disseminating information and engaging productive discussion on key biomass development issues include conferences, special meetings with manufacturers, technical advisory committee meetings and targeted forums.
- ***State-by-state constituency building.*** The NRBP's support for biomass specialists in each of the eleven Northeast states has helped to build and maintain an active biomass constituency in every state. The state biomass programs, each of whose activities and accomplishments of the past decade are detailed in the State Biomass Programs section of this report, ensure that the Program's research and technology transfer activities reflect the region's diversity.

## Accomplishments

Given the broad range of factors affecting biomass development, it is difficult to attribute major trends in the use of regional biomass exclusively to the NRBP's research, workshops, feedstock assessments, and public information campaigns. However, the NRBP can point to specific program accomplishments which have played a significant role in several sectors.

- ***Utility-Scale Boilers.*** With respect to the past half dozen years' rapid growth in wood-fueled utility-sized boilers, for example, the NRBP's early research studies documenting industrial emissions helped convince state air regulators that particulates from 1,000 ton-per-day boilers were not the threat to the environment that pre-certified woodstoves were to ambient air in certain locations. Some of the barriers to siting these independent power plants were lowered. Similarly, our technical assistance to biomass developers and state energy offices about the regulatory requirements of the Public Utilities Regulatory Policies Act (PURPA) brought more developers and investors into the regulatory process more informed and capable of meeting governmental requirements for licensure.
- ***Institutional Conversions.*** In the mid-eighties our workshops for schools, hospitals, and other institutional buildings convinced some facility managers to convert from oil or electricity to wood. NRBP-supported biomass specialists in Pennsylvania and Vermont state energy offices are using NRBP-sponsored case studies, ash disposal guidebooks and other assistance to convince electrically-heated schools to convert to wood. Our facilities directory of larger wood-burning facilities was of assistance to equipment vendors, ash recyclers, and prospective conversion candidates seeking relevant information.
- ***The Waste Wood Resource.*** Beginning in the mid-eighties, our work to identify and quantify sources of both clean and processed wood in the waste stream led to the construction of at least two stand-alone wood-burning plants fueled with wood wastes. It has also prompted several waste haulers to separate their wood wastes from other materials in their waste streams, thereby facilitating an emerging market for wood wastes as a fuel. In New Jersey, NRBP-supported conversion assistance has helped encourage industries to invest a collective total of over $3 million in system equipment — and to realize waste wood disposal savings of over $2 million per year as a result of conversion. This has helped these firms to remain competitive in a difficult economy. Moreover, in addition to generating lower cost energy, these conversions have diverted over 30,000 tons of wood waste annually away from landfills and to productive use.
- ***Residential Wood Stoves.*** NRBP research efforts to measure the particulate emissions from woodstoves directly contributed to the New Source Performance Standard enacted by EPA in 1988. Our research methodology has been accepted by industry, which now utilizes similar tests to improve stove designs. Moreover, our success in attracting the collaboration of other regional programs, the Canadian Combustion Research Laboratory, the woodstove trade association and EPA has created a network for the exchange of technical information and effective technology transfer.

  Having demonstrated that certified stoves are cleaner burning in the field as well as the laboratory, NRBP has collaborated with industry to promote consumer changeouts of old, dirty stoves for cleaner, new ones. More than 500 were changed out last winter. Hundreds of thousands of stove owners were either reminded or told for the first time how much cleaner and more efficient are today's woodburning appliance.
- ***Harvesting Impacts.*** Through our research addressing residual forestry impacts of wood energy harvesting, we have made the case to regulators that harvesting need not have significant environmental impacts. By providing forums for the Burlington Electric plant's procurement forester, we were able to help convince regulators in New York and other states in New England that responsible forest management practices can yield a benign impact on the resource base.

# RESEARCH AND TECHNOLOGY TRANSFER: CASE STUDIES

The four "case studies" which make up this section illustrate the genesis, development, dissemination and impact of the NRBP's applied research and technology transfer activities. Although regional in scope, these projects were initiated, designed and carried out with input from the state biomass representatives as well as from industry and other stakeholders, and much of the dissemination of findings and follow-on work takes place at the state level.

Two of the case studies focus on areas of research – wood stoves and wood waste – where work has been ongoing for several years, encompassing a series of related projects, with far-reaching impacts. The other two case studies focus on more recently initiated efforts – involving mid-sized boiler applications and landfill gas recovery projects, respectively – the impacts of which are still being shaped.

*Case Study 1*

# FIELD-TESTING RESIDENTIAL WOOD STOVES

## The Problem: Wood Stove Emissions

The use of wood for residential heating – along with the potential for even greater use and the corresponding concern about emissions -- was highlighted in the Northeast Regional Biomass Program's first Long Range Plan. The wood stove industry had grown rapidly since the late 1970s, with stove sales peaking in 1981-82 at approximately two million stoves nationwide.

The increase in wood stove use generated a corresponding increase in particulate emissions. In the Northeast, the Pacific Northwest, and in Colorado, air inversions compounded the problem of wood stove emissions. In early 1984, the state of Oregon, through its Department of Environmental Quality, promulgated the first wood stove particulate emissions regulations in the country. A few localities had passed ordinances restricting the use of wood stoves; many more were considering them. Growing concern that conventional wood stove emissions were significant contributors to unhealthy concentrations of respirable particulates in many airsheds prompted air pollution agencies, environmentalists, and researchers to look for ways to lower particulate emissions.

## The NRBP Response: A Multi-Phase Collaborative Research Agenda

Joined by its counterpart in the Northwest, the NRBP assembled a technical advisory committee of research, government, and industry professionals and initiated a research agenda which succeeded in:

- leveraging financial and institutional support from other state and federal agencies, the Canadian government and private industry;
- supporting the development of a testing protocol which was adopted by the industry, and of testing equipment which has since been utilized in other air pollution research settings;
- fundamentally affecting the New Source Performance Standard for wood stoves promulgated by the United States Environmental Protection Agency, and
- improving the product designs of many stove manufacturers.

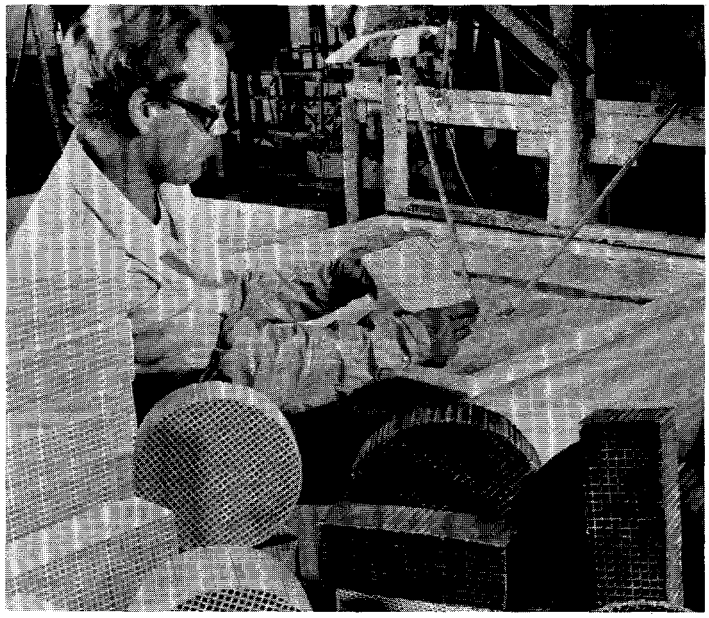
In addition, the NRBP implemented a highly successful consumer education campaign. Credit for the eight-year research effort is shared with several collaborating agencies (including the Northwest RBEP, the New York State Research & Development Authority, U.S. EPA, Canadian Combustion Research Lab, the Wood Heating Alliance), a number of whose financial contributions to the research far exceeded those of the Northeast Regional Biomass Program. Nevertheless — and indeed in part *because* of its collaborative nature — the NRBP's work in the area of residential wood stoves illustrates how the Program's applied research and technology transfer activities influence as well as respond to the needs and decisions of policymakers, industry, and consumers.

### THE INITIAL INVESTIGATION: EXISTING RESEARCH, REGULATIONS, AND STRATEGIES

In its first year (1983-84), the Northeast Regional Biomass Energy Program undertook an investigation of published wood stove emissions studies, prevailing airshed regulations by state and local governments, and strategies for mitigating emissions. Among the strategies evaluated by the researchers was the substitution of newly emerging "clean burning high technology" (catalytic and non-catalytic) stoves for conventional airtight stoves. Oregon's DEQ separated catalytic and non-catalytic technologies for different emissions requirements.

### FIRST ROUND OF FIELD TESTING (1985-87)

Oregon's required emissions levels were known to be achievable in laboratory testing, but there were questions about actual field use of wood stoves and whether these results could be maintained over time. In spring 1985, with co- sponsorship from NYSERDA and the US EPA, the NRBP initiated the Northeast Cooperative Wood Stove Study (NCWS), a field study involving 68 homes in Waterbury, Vermont and Glens Falls, New York over two heating seasons. During the second season (1986-87), the Canadian Department of Energy, Mines, and Resources conducted a one-year study at Whitehorse, Canada, and the Northwest RPEB conducted its own complementary research to test the field performance of six stove models in the Portland,



*A technician dips catalysts to coat them for installation in wood-burning stoves.*

Oregon area. These two parallel field research efforts used the same equipment developed by OMNI for the NCWS. The studies were timed and structured so that the research complemented the ongoing NRBP-led research, rather than duplicating efforts. Initial research findings indicated that field use of wood stoves did not meet the EPA levels, and suggested that operator practices, as well as design issues, contributed to both efficiency and reduced emissions. A major finding of this round of research was that the degradation of catalytic and other equipment was a crucial issue in stove design.

### SECOND ROUND OF TESTING (1988-89)

The second round of research focused on equipment degradation and operator practices, and it also increased the statistical reliability of the field testing. Efforts were made to isolate the particular stove operation practices that affected performance. These were found to include wood moisture, burn rate, and draft. These findings indicated that it might be possible to identify stove designs that were best geographically suited to various climatic areas. Testing continued to determine if laboratory equipment stress testing could accurately predict field performance of stoves.

### RECENT AND ONGOING TESTING

In 1990 the Canadian government sponsored two more studies: 1) a second season follow-up study on the Glens Falls, New York stoves that were part of the 1988 study; and 2) a study of three EPA Phase II Canadian-manufactured stoves in Klamath Falls, Oregon.

The Glens Falls study was conducted to measure the degree of equipment degradation after two seasons in the field. As in the previous studies, the OMNI testing procedures were used to measure field performance; additionally, the study conducted a laboratory analysis of two failed catalysts. An important highlight of this study was the reliability of the "simulated real world emissions test." The laboratory test was able to simulate and predict actual field performance by reproducing a number of variables, such as wood type, wood moisture, diameter, weight, loading pattern, stack draft, and some operator procedures.

The Klamath Falls study identified a non-catalytic technology with emissions values of 70 percent below conventional levels, but emissions were still 1.8 times higher than the stoves' laboratory-certified levels of 3.4 g/h. Operational differences were found to account for as much or more variance in emissions as stove design, pointing to as great a need for consumer education and training as for design improvements.

In addition to these Canadian-sponsored tests, the Northeast Stove study group continued to sponsor further laboratory testing to simulate over a period of days the field experience of wood stoves over an entire season. Jointly sponsored by NRBP, NYSERDA, EPA, the Canadian Combustion Research Laboratory, the Wood Heating Alliance, and the Oregon Department of Environmental Quality, this ongoing research is focusing on the causes of catalyst degradation and the design changes that can be made to improve long-term operation.

### DISSEMINATION AND IMPACTS

The involvement of key players (e.g., US EPA, wood stove manufacturers) in the design and implementation of the research ensured the dissemination and acceptance of NCWS methodologies and findings. Moreover, by attracting federal, state, and industry co-sponsors, the Biomass Program was able to leverage project financing at a ratio of 1:5. The Program's contracting flexibility, decision-making structure, program management expertise and planning horizon all contributed to the success of this collaborative effort.

### SUPPORTING DEVELOPMENT OF TESTING PROTOCOL AND EQUIPMENT

The testing methodology developed by OMNI Environmental Services for the Northeast Cooperative Wood Stove Study greatly influenced both the regulatory development process and all future field testing. Utilizing the Automated Wood Stove Emissions Sampler (AWES) and computerized Data LOG'r to sample emissions and measure operational and climatic variables, the OMNI protocol set the standard for all but one of the wood stove research studies conducted over the past ten years.*

With an entire series of research activities using the same methodology and testing technology, the EPA made several tests of the OMNI equipment for quality assurance and correlation with its own Methods 5G and 5H. This monitoring led to improvements in the AWES and Data LOG'r technology, resulting in more reliable test results.

As a result of its widespread effectiveness and accepted authority in this area, the OMNI technology continues to be used in more recent stress testing (sponsored jointly by the Canadian Combustion Laboratory, NRBP, the EPA, and the Oregon DEQ). It has also attracted the attention of the Bonneville Power Administration in Portland, Oregon, in researching the emissions for advanced technology small-scale biomass combustors relative to wood stoves. As a direct result of its experience with burn cycles gained from wood stove research, OMNI has assisted the California Air Resources Board and the Denver Brown Cloud Study in chemical balance modelling. Finally, OMNI's adaptation of its equipment to provide data for pellet stove and masonry fireplace research continues to set the standard for wider use of emissions testing technology.

### INFLUENCING REGULATIONS

Concurrently with the first Northeast (NCWS) Study, the U.S. Environmental Protection Agency (EPA) initiated an unprecedented Regulatory/Negotiation ("reg/neg") process prior to its promulgation of national regulatory standards for wood stove

*The studies conducted in Crested Butte, Colorado, relied on a different sampling technique developed by the Virginia Polytechnic Institute (VIP).

emissions in February, 1987. While the published findings from the NCWS were not available at the time the EPA regulations were promulgated, enough raw data was available for the EPA to take into account. Accompanied by the Northeast and Northwest research efforts, the EPA "reg/neg" process opened the wood stove emissions dialogue to a broad sector of government, regional, industry, and research representatives, culminating in a broad-based *pre-regulatory* input period.

According to one participant in the "reg/neg" process, the EPA initially intended to set a tough standard that only catalytic stoves could meet. Improved technologies were just emerging in response to the need for cleaner- burning stoves, and the EPA was interested in the results from catalytic add-ons, retrofits, and new stoves. While the Oregon DEQ regulations had set separate standards for catalytic and non-catalytic technology, there was little field data available regarding the emissions performance of the two stove types, and the findings had not been statistically validated to predict reliable field performance at the time of the regulation development. It became apparent to representatives from the Oregon DEQ that the Oregon standard would not be sufficient to reduce emissions to levels preferred by the EPA.

Preliminary indications from the NRBP study had a major influence on at least three aspects of the final New Source Performance Standards:

1) the setting of different standards for catalytic and non-catalytic stoves;
2) the requirement that quality assurance testing be conducted; and
3) the consideration of burn rate and fuel cycle conditions for the testing methodology, as well as the field testing protocol.

The NRBP study was the first to indicate that there were problems in the field with catalytic technology, particularly with regard to equipment degradation. Additionally, the NRBP testing indicated that catalytic add-ons and retrofits were not performing in the field as had been expected from the laboratory tests, and were in fact performing at levels comparable to conventional stove technology. The NRBP study also indicated for the first time that low emission non-catalytic technology had the potential to perform well in the field, prompting the EPA to agree to the separate and more lenient emissions standards for the non-catalytic equipment.

Second, the NRBP study raised questions about the durability of catalyst equipment. Problems were being identified with poor workmanship (gasket leaks, poor welds, bypass gaps, etc.) by the NRBP study that were of concern to both Oregon and EPA regulators. The NRBP preliminary findings, confirmed by the early findings of the Whitehorse, Canada, study, had a direct influence on the EPA's decision to set strong manufacturing quality control requirements and broaden its in-factory inspection protocol.

The third direct impact of the NRBP testing on the EPA regulations was the burn-rate testing methodology. As previous testing had been conducted in Oregon, where relatively mild winters were the norm, no data was available on the impact of weather on burn rates. The NRBP study was the first to be conducted under colder weather conditions, and subsequently was the first to indicate that emissions are burn-rate specific, and that temperature is highly correlated with burn rates. This preliminary data convinced the EPA to incorporate weighted burn-rate averages into its testing protocol.

## INFLUENCING TECHNOLOGY TRANSFER

One of the major impacts of the regional wood stove research activities has been a widespread transfer of "best" result technology. The independent findings of Northeast, Pacific West, and Canadian studies have led to better corroborated research findings and a higher degree of statistical validity about emissions data from wood stoves. At the same time, the regional collaboration and Canadian interest were coordinated to avoid duplication of effort.

The joint involvement of the NBRP, Canada, and Oregon in continued stress testing is an important outcome of the various research findings. Durability of wood stove equipment has become a major issue for more recent research, and, as laboratory activities have become more closely correlated with field results, continued durability testing has become a "proactive" means of local environmental action. Many local health departments have set standards on the basis of the regional testing, and some have instituted wood stove equipment replacement programs. The state of Oregon used Oil Overcharge funds to help low-income residents replace their old wood stoves. The Wood Heating Alliance (now the Hearth Products Association) has stressed to regulators the significance of replacing old stoves with newer, much cleaner-burning equipment, based on the Crested Butte, Colorado study.

Also, the Pacific Northwest findings regarding wood moisture have been used by the Hearth Products Association to convince regulators that wood moisture contributes to high emissions and can be affected by using dry wood. The Oregon DOE and the EPA are currently sponsoring a study to determine if commercially available densified logs can provide pollution reduction in certain airsheds without more expensive changeout of existing appliances.

## IMPROVING PRODUCT DESIGNS

A reluctant wood stove industry was brought into the process early. Primarily populated by small business entrepreneurs with little experience in testing and research, the wood stove industry was skeptical what bearing testing might have on their manufacturing efforts. As the field results began to focus on design and raised durability questions, industry interest increased. By involving the industry's trade alliance in helping to plan the research, the Northeast and Northwest Regional Biomass Programs engaged the wood stove manufacturers in a constructive, rather than adversarial role. Jason Perry, former Editor of

*Wood N' Energy* magazine, noted that the regional research "awakened the wood stove industry to the probability that testing had something to offer to the design of better stoves."*

In August, 1989, the Wood Heating Alliance and NRBP sponsored a stove research forum in Chicago to present the preliminary findings to stove manufacturers. Timed early enough to enable manufacturers in some cases to make changes to their stoves before the 1989-90 season, this meeting marked a turning point in the collaboration between industry and researchers in producing design changes and manufacturing better products. Attendees praised the quality and relevance of the research. Several manufacturers of non-catalytic stoves improved their baffle construction in response to the observations on the two non-catalytic stoves in the field study. A second manufacturers' meeting was held in 1993.

The first two rounds of research (through the time of the Wood Heating Alliance 1989 forum), provided the wood stove industry with sustained and valid technological data to support design and quality control efforts. While there has been mixed reaction to the stress testing, industry feedback regarding the support provided by testing for the field performance of new equipment has been positive. At a March 1992 trade show, incoming Chairman of the Hearth Products Association Jim Hermann remarked that "we now have the technical data to support the performance of new technologies in the field." The research efforts have brought the wood stove manufacturing industry into a more constructive relationship with government and other consumer groups.

## Next Steps: Educating Consumers

The NRBP's field monitoring of residential wood stoves revealed that wood stove retailers, installers and users need information on proper installation and operation of the new high-efficiency, low-emission wood stoves to meet fuel savings and air quality objectives. To address this need, the NRBP initiated several projects aimed at getting the information gleaned from seven years of field research out to the people who sell, install, and use wood stoves.

### VIDEOS

In 1987, NRBP produced three videos with the Wood Heating Alliance and Wood Energy Institute-West. The first consisted of a series of 10- and 30-second public service announcements. The second was a seven-minute presentation designed for use in wood stove retail outlets. The third was a 20-minute documentary distributed to cable and public television stations.

### WORKSHOPS

An initial workshop, held in October 1988 in Massachusetts, was attended by over 160 wood stove retailers, chimney sweeps, housing and weatherization specialists and state energy staff from throughout the Northeast. A workshop "notebook" published by NRBP includes:

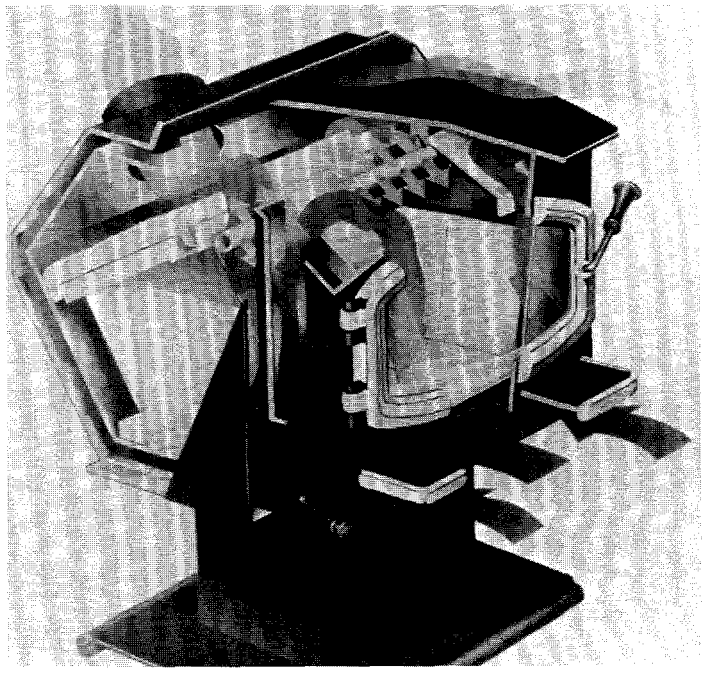
- "Shoppers Guide to the New Wood Stove Law";
- questions and answers about indoor wood smoke;
- review of certified wood stoves and a description of low-emission catalytic and non-catalytic stoves;
- guides to stove installation and safety and to chimney construction and maintenance; and
- a resource list for further information.

Additional workshops were held in 1989 in Vermont, and in 1990 in Pennsylvania.

### LESSONS LEARNED (I)

Lessons Learned (I) consisted of a five-pronged communications strategy to educate existing and prospective wood-stove owners about catalytic and non-catalytic stoves. The objective of this project was to increase awareness among consumers of improved safety and performance of the new generation of wood stoves, and to enhance consumer purchases of clean-burning wood stoves — including both first-time stove purchases and change-outs of dirtier, less efficient stoves. Elements of the strategy included:

- the dissemination of public service announcements;
- the distribution of an instructional videotape on stove pur-



*Schematic of a non-catalytic stove*

*Jason Perry cited in *The Impact of Regional Biomass Energy Program-Sponsored Wood Stove Research on Public Policy and Technology*, report prepared by Citizens Conservation Corporation for the National Renewable Energy Laboratory, February 1993, p. 39.

chase, maintenance and operation;

- the development and dissemination of a comprehensive brochure on the same subject;
- the writing and placement of feature newspaper articles and placement of radio talk show guests; and
- the development of a print advertising strategy based on the theme of changing out stoves for the environment.

As a result of these efforts in 1992, 119 video public service announcements were distributed to television stations. Sixteen stations utilized the PSAs in 312 telecasts, reaching an estimated audience of 30 million viewers. Another 80 instructional videos were distributed to 27 cable systems, which telecast them to an estimated audience of 833,000 viewers. Another 170 instructional videos were mailed to public libraries in the region. The states distributed 8,000 copies of the woodstove brochure, which features special sections on purchasing, operating and maintaining certified stoves.

**LESSONS LEARNED (II)**

Developed with retailer input and in collaboration with the Northeast Regional Hearth Products Association, the second phase of Lessons Learned (June 1993 - March 1994) consisted of a retail promotional campaign based on the theme of a "Clean Heat" Woodstove Exchange. Targeting the New York-New England region during the winter of 1994, the campaign's objective was to promote the replacement of older (pre-1989), dirtier, less efficient wood stoves with cleaner, more efficient new stoves.

Materials developed for the campaign included: a name, logo, two print advertisements, camera-ready headlines and copy points, a store banner design, a product hang tag and press release materials. Print, radio, and TV media targets established in the seven-state region; a spokesperson was designated and a radio tour organized.

Articles appeared in 85 newspapers, reaching an estimated audience of 4.5 million readers. Additionally, 16 radio stations broadcast live interviews on the wood stove exchange campaign, reaching an estimated 138,000 listeners. The publicity generated 2,100 inquiries from consumers to the "800" number established in New York state to field energy-related telephone calls. Retailers reported 550 stove changeouts during the six-week promotional period. Many retailers observed that the biggest benefit of the campaign was increased awareness among consumers about the difference in emissions and efficiency between old and new stoves.

*Case Study 2*

# DEVELOPING THE WASTE WOOD RESOURCE

## The Problem: Retrieving an Untapped Resource

In 1987, the NRBP began investigating a largely untapped and unresearched resource, the woody portion of the waste stream. Approximately 20-25 percent of the almost 150 million tons of solid waste disposed of in the United States in 1987 were estimated to be woody materials. Dwindling landfill capacity and high tipping fees prompted interest in recycling waste materials for a variety of purposes; the NRBP sought to learn more about what portion of the Northeast's waste stream was composed of woody materials potentially suitable for fuel. In addition to addressing a looming solid waste disposal crisis, the diversion of woody materials from the region's landfills offered the possibility of supplying biomass fuel at zero or negative acquisition cost.

The NRBP's applied research has confirmed the estimation that here is a vast potential resource, most heavily concentrated in urban areas where the demand for energy is greatest. Obstacles to the development of this resource include:

- the need to distinguish which wood wastes are suitable for use as fuel, under what conditions, at what costs, and in what quantities;
- concerns on the part of air quality, solid waste, and public health regulators, arising in part from lack of information about the resource and its characteristics, particularly for treated wood wastes;
- conflicting regulations governing solid waste disposal and waste-to-energy conversion, partly resulting from the above-mentioned lack of information and corresponding concerns; and
- general opposition to combustion (or "incineration") as a waste-to-energy conversion technology.

## The NBRP Response: Assessing the Resource and its Potential

The Program's research agenda has evolved to address each of these issues, from a simple inventory of wood's contribution to three metropolitan area waste streams to a more ambitious characterization of treated wood products and their combustion characteristics, and relevant regulations. Current efforts are focused on investigating and pursuing the potential for utilizing waste wood to produce liquid fuel (ethanol) on a large scale in the Northeast.

### WASTE WOOD SURVEY

In 1987, the NRBP commissioned an inventory of the wood wastes landfilled in three urban markets: Boston, New York, and Philadelphia. The objective of the study was to estimate the availability of wood and woody materials in the solid waste stream and to determine the economic and technical viability of separating and recycling these materials for use in energy applications. Information on air emissions and ash disposal regulations for facilities which might burn recycled wood was also collected as part of this study.

The study estimated that more than 3.5 million tons of woody wastes entered the waste stream from demolished buildings, land clearing, pallets, railroad ties, wood products manufacturers, and other sources. A single 43-megawatt wood-fired plant on Staten Island was found to purchase recycled wood waste from six of the nine wood recycling plants identified by the study, which provided detailed assessments of market opportunities for wood recycling operations in the three metropolitan areas inventoried. The supply of recycled wood was found to exceed demand in 1987, yet opportunities were found to exist for landfill operators, transfer stations, and waste haulers, as well as stand-alone recycling businesses. In addition to fuel, competing uses for recycled wood include landscaping mulch, soil amendment, sludge stabilizer, and farm bedding.

The 1988 wood wastes inventory stimulated the creation of an industry to separate, process and convert the clean waste wood to energy. Four wood waste-to-energy electricity facilities had been sited; another was planned. Independent power producers relied upon the 1988 research to convince permitting agencies that adequate waste is available. Site-specific studies commissioned by developers have further refined these estimates. The contractor hired by NRBP has also been asked to testify before at least one agency concerning the adequacy and suitability of wood wastes for utility-sized wood combustion boilers.

### WOOD PRODUCTS IN THE WASTE STREAM: COMBUSTION CHARACTERISTICS

Among the candidates for diversion from landfills are a variety of wood waste products, chiefly distinguished as either "clean" or "treated" wood. The former includes bark, sawdust, wood shavings, and wood chips from urban land clearings and tree prunings. The latter includes plywood, particleboard, painted, creosoted, stained and laminated wood. "Clean" wood wastes have long been obvious candidates for wood energy boilers; which of the remaining treated wood wastes are capable of meeting air quality and ash disposal tests in the states was a major unanswered question.

What makes burning wood wastes a more intriguing opportunity is the emergence of a second issue — the declining costs in acquisition of new electricity sources by utilities. A slow economy, increasing capacity margins, the absence of large new nuclear or fossil fuel generating stations on utility planning hori-

zons, and the availability of cheap hydroelectric power from Canada have all hampered independent power producers in their quest to win competitively priced utility contracts. Wood-fired power plants which commanded long-term utility contracts of 7-10 cents/kWh in the late 1980s would receive offers of 4 cents/kWh if they were sited today. At $15-25 per ton, chips harvested in forestry thinnings and integrated logging operations can provide power at 8 cents/kWh; at today's power prices, they cannot compete. Indeed in New Hampshire the major electric utility is trying to cancel the contracts of wood-fired plants commissioned 4-7 years ago.

Yet wood wastes which are otherwise destined for landfills may be available as a fuel for zero or negative cost. The challenge facing power producers, waste haulers, and regulators was to determine:

- which treated wood wastes may be recycled;
- at what cost; and
- what volumes these represent.

Since the NRBP's initial study, regulators' increasing concerns about the emissions and ash toxicity from combusted wood wastes have led to significant regulatory constraints being placed on waste haulers, wood processing facilities, and combustion boiler operators. By 1990 the source and type of wood fuel had a major bearing on the environmental permitting of facilities burning it. To complicate matters, the regulatory handling of treated wood varied considerably from state to state. Regulators were relying upon an almost nonexistent data base to make their judgments on acceptable versus unacceptable waste products as fuel.

In 1990 the NRBP sought to respond to regulators' concerns and capitalize on the findings of the earlier resource survey by undertaking another, more ambitious, piece of research. The goal of this study was to understand toxicity hazards associated with specific treated wood products. The research effort focused on two major tasks:

1) the surveying of existing air and ash disposal regulations governing wood-burning in several states and Canadian provinces; and
2) the characterization of specific compounds commonly found in treated woods for their toxicity levels.

The NRBP contributed a total of $80,000 to this $331,542 project. Other funders included the New York State Energy Research and Development Authority, the Canadian Department of Energy, Mines and Resources, the Tennessee Valley Authority, and the Virginia Department of Mines, Minerals and Energy.

The characterization of wood products in the wood stream has been a significant effort to assist industry, utilities, and regulators understand how treated wastes are now handled from state to state (and a Canadian province) and which wood treatments are associated with what toxic compounds in what amounts. The major findings of the study are summarized below.

1) State and provincial governments do not define the processing and combustion of wood waste as "recycling". Since many states require waste wood to be recycled, these policies can restrict the utilization of these feed stocks as fuel.
2) State and provincial agencies are increasingly demonstrating preferences for the combustion of certain biomass feedstocks over others: for example, the net favorable impacts of burning clean wood over municipal solid waste have resulted in permitting processes and control technologies less onerous for wood; on the other hand, many jurisdictions still fail to distinguish waste wood from MSW in their permitting and pollution controls requirements.
3) Several states require testing of wood ash for toxicity levels before facility permitting is approved.
4) States have adopted hazardous air pollutant regulatory programs which are more comprehensive than that of the federal government. Acceptable ambient concentrations of these pollutants have been established; of these, benzene, formaldehyde, acetaldehyde, and trace metals are commonly found in various treated wood wastes. Other regulated compounds, including polynuclear aromatic hydrocarbons, dioxins, and furans are regulated, but they are not found in signficant amounts in treated wood.
5) Only 17 percent of all wood waste used for fuel during the study was derived from urban wood waste and secondary mill residue; the remaining 83 percent came from clean sources: harvesting operations and wastes from primary wood products industries.
6) Operators of facilities which burn waste wood are more careful in specifying fuel than other wood fuel operators. Most are confident they can meet air standards through a combination of adjustments in combustion unit parameters and careful monitoring of fuel quality rather than making significant equipment changes.

A second stage of the study analyzed the composition of common treated wood products, including plywood, chromated copper arsenate (CCA) pressure treated-wood, particle board, creosote-treated wood, furniture scraps, and laminated wood. Data from this analysis led to a modeling of emissions of heavy metals, sulfur and chloride from the combustion of wood waste. Concentrations in the wood and wood ash assisted this modeling exercise. Actual emissions data from secondary sources supplemented and supported this analysis, in which emissions data from more than 100 combustors are summarized into consistent units for the first time, enabling more reliable comparisons. Key findings included:

1) Organic emissions are not significantly greater from treated than from clean wood; metals emission data indicates only slightly higher levels.
2) Organic compounds subjected to combustion systems and operations yielding lower efficiencies are elevated in emissions levels; efficient combustion reduces these levels quite significantly.

3) Electrostatic precipitators and baghouses are more effective in reducing particulate emissions than are wet scrubbers and mechanical cyclones; metals control follows a similar pattern.

4) Chlorinated compounds are detected at extremely low concentrations.

5) State arsenic and chromium guidelines may be exceeded in waste streams with sizable amounts of chromated copper arsenate treatments (railroad ties, utility poles, exterior grade lumber); this category of treated wood may be tolerated only in reduced quantities to meet the minimum standards.

## Dissemination and Impacts

By attracting co-sponsors from agencies across the continent, *Wood Products in the Waste Stream* rolled off the presses to a broad and interested audience. Disseminating the results of this survey to regulators should help to stimulate a more consistent set of regulations from state to state — or at a minimum, agency commitments to utilize the shared data base in their formulations of policy and specific standards. To date, results have been disseminated through the publication of an article in *Waste Age* and through the Waste Wood Conference which was held in conjunction with the 1992 National Biofuels Conference. In addition, several other states have followed up on the initial survey by sponsoring state-specific waste wood surveys. The New York State Energy Research and Development Authority subsequently designed a workshop to bring together the New York State regulatory community, utilities, independent power producers, environmental advocacy groups and energy planners to discuss the results of the study and to identify additional questions and concerns.

The categorization and quantification of toxic compounds in the ash and emissions of specific wood treatments aids regulators in their consideration of specific facility permitting applications and assists facility operators in their fuel specification process. The data suggests that most treated woods produce emissions which meet current standards; only CCA-treated wood in large quantities sparked immediate concern. Given the pressure on reducing landfill pressures and the costs associated with waste wood materials, this information should be a major stimulus to the acceptance of treated waste woods in monitored combustion situations. (See sidebar, *Managing Chemically Treated Wood Scrap through Incineration and Energy Recovery.*)

The study also emphasizes the site-specific variability in emissions characteristics from identical waste wood products. Combustion system parameters, pollution controls and operator skills contribute enormously to the particular emissions level at a particular facility. To gain a better understanding of the actual variability and the relative importance of each contributing factor, the researchers recommend boiler emissions testing of treated woods in existing full-scale installations. This will be the next major challenge faced by the NRBP in this area.

### Managing Chemically Treated Wood Scrap through Incineration and Energy Recovery

In December, 1993, the Acting Commissioner for the State of New Jersey's Department of Environmental Protection (DEP) issued a Decision on Request for Interpretation of the applicability of solid waste regulations to chemically- treated wood scrap such as utility poles, railroad ties and pier wood. The request, posed by Public Service Electric & Gas, Conrail, Bell Atlantic and New Jersey Bell, specifically sought to determine whether the incineration of such materials for purposes of energy recovery exempts the generator from otherwise applicable solid waste regulations.

The total amount of chemically treated wood generated by New Jersey's utilities and transit systems is estimated to range from 35,000 to 50,000 tons annually. Historically directed to specific solid waste management facilities for disposal, treated wood wastes are increasingly unwelcome in the state's transfer stations, landfills, and solid waste incinerators, and offer few if any options for recycling into other products. Noting that "chemically treated wood provides a very good fuel source with a high BTU value," the Decision goes on to determine that

...the incineration and energy recovery of chemically treated wood at facilities with proper air pollution control and monitoring equipment can represent a particularly sound approach to the management of creosote, PCP and CCA-treated wood because of the destruction of the chemicals in the incineration process, as well as the recovery of the wood's energy value.*

Based on these findings, the DEP interpreted that chemically treated wood is an exception to the waste flow regulations, and as such may be shipped for utilization as fuel to dedicated power generating incinerators which employ energy recovery systems that have been authorized by NJDEP. (This interpretation is consistent with an earlier decision that a dedicated power plant could incinerate processed non-chemically treated wood produced at a wood recycling center without a solid waste permit and without violating the solid waste flow rules.) The DEP expects to promulgate amendments to the state's solid waste flow rules to codify this interpretation before it expires at the end of 1994.

*State of New Jersey Dept. of Environmental Protection and Energy, Jeanne M. Fox, Acting Commissioner. Decision on Request for interpretation, Dec. 29, 1993.

## Next Steps: Promoting Large-Scale Liquid Fuel Conversion from Biomass

With the decline in demand for expanded electric capacity and local opposition to combustion-based energy conversion processes, attention has turned to the utilization of wood wastes as feedstocks for liquid fuels.

The nation's environmental, national security and energy policy priorities on cleaner air and less dependence on foreign oil also point to a greater emphasis on the favorable economics of ethanol production from biomass feedstocks in the Northeast. Several corporations have indicated to governmental agencies their interest in siting one or more ethanol production facilities in the region. Biomass waste feedstocks are of primary interest due to their low or negative costs. From a total fuel-cycle perspective, ethanol produced from waste wood feedstocks is more environmentally benign than ethanol produced from corn, which requires significant petro-chemical inputs to produce the feedstock material.

### RESOURCE SURVEY: LIQUID FUEL FEEDSTOCKS FROM BIOMASS WASTES

In 1993, the NRBP commissioned a resource survey to examine the potential for utilizing a number of woody and agricultural wastes in the manufacture of liquid fuels. Preliminary analysis indicated that ethanol is the most cost effective product from these feedstocks. Ethanol could substitute for gasoline as a transportation fuel. Both clean and treated wood wastes received attention. The objectives of the survey were to:

- examine the characteristics of these feedstocks favorable to ethanol production;
- estimate the volumes of these feedstocks in the region;
- identify factors which may affect future availability;
- identify potential locations favorable for a production facility; and
- recommend logical next steps towards implementation of an ethanol production facility in the region.

The resource survey found that the total amount of biomass materials currently being discarded in the region exceeds the nationwide production of the ethanol industry, which is approximately 1 billion gallons annually. Since transportation fuel analysts predict a national market of 3 billion gallons could be utilized today, there is ample latent demand for the resource.

Taking into account the amount of feedstock available, its cost, the potential ethanol yield, the conversion process complexity and the maximum ethanol production possible, the study ranks urban wood waste, paper sludge, waste paper, and cheese whey respectively as the near-term feedstock winners in the region. Over the longer term short rotation woody crops could add 240 million gallons and herbaceous crops 291 million gallons to the ethanol reservoir potential. Because urban wood waste, paper sludge, and waste paper are available at negative cost, these feedstocks offer immediate promise for conversion to ethanol.

The assessment also examined key incentives which would affect the production of ethanol as a biofuel. The Clean Air Act Amendments offer a half dozen incentives, ranging from requirements for reformulated gasoline and clean fuel vehicles to fuel credits. Critical issues influencing the siting of ethanol production facilities include storage capacity, environmental impacts on land, truck traffic, noise, air, solid waste and other regulations.

More detailed state surveys of pulp and paper mills to determine paper sludge inventories, waste paper volumes, cheese whey, and food processing waste are recommended. The potential of agricultural crop residues and energy crops production also merit future attention.

### FACILITATING DEVELOPMENT OF BIOMASS-TO-ETHANOL PRODUCTION

In May 1994, based on the NRBP Resource Survey's preliminary findings that the region has numerous biomass feedstocks suitable for the production of ethanol, the NRBP sought opportunities to accelerate the siting of a biomass-to-ethanol plant in the Northeast. With the goal of facilitating the development and implementation of a site-specific business plan by the end of 1995, the NRBP planned a forum to initiate this effort. Held in October, 1994, the forum brought together potential developers, NREL's biofuels program managers, representatives of each state's biomass programs and relevant permitting agencies, as well as major waste generators who constitute the potential resource base for ethanol production.

The purpose of the forum was to get developers to take a serious look at the Northeast as a locale where waste biomass provides a low-cost transitional ethanol feedstock and the densely settled population provides a strong market for a clean, renewable transportation fuel. The forum provided an opportunity to get the Resource Survey findings into the hands of developers, to emphasize the amplitude and suitability of the waste biomass feedstock (both in the short and long terms), and to put developers in touch with the people who are generating these feedstocks. The objective of the forum was to identify what barriers, if any, stand in the way of a commercial-scale biomass-to-ethanol conversion plant being developed in the Northeast, and what specific steps the NRBP can take to remove those barriers. One outcome of the forum was the possibility that production of high-value industrial chemical feedstocks may be a more cost-effective use of wood wastes than ethanol production.

*Case Study 3*

# PROMOTING SMALL AND MID-SIZED WOOD-FIRED BOILERS

## The Problem: Lack of Reliable Information about Wood-Energy Systems

While the forest products industry has been utilizing wood energy boilers successfully to provide steam and electricity to sawmills, paper mills and furniture manufacturers for more than two decades, a lack of reliable information and skepticism about system efficiency and overall performance have been significant barriers to the adoption of wood energy systems by schools, municipal buildings, and small and medium-sized commercial facilities.

## The NRBP Response: Making the Case for Wood-Energy Systems to Different Audiences

To address these barriers, the NRBP set about to:

1) educate architects, engineers, energy professionals and facility managers about the system efficiencies, overall performance, and economic paybacks of conversions from oil to wood systems;
2) provide facility managers with a comprehensive guide to all the issues associated with evaluating, selecting and installing wood chip heating systems; and to
3) produce a videotape aimed at making wood-energy systems and their benefits comprehensible to a more general audience, such as a school board or other institutional decision-making body.

### EVALUATING THE EFFICIENCY OF INSTITUTIONAL AND COMMERCIAL WOOD BOILERS

In 1992, the NRBP contracted with Commercial Testing & Engineering (CT&E) to evaluate seven representative wood energy boilers operation at sizes between 500,000 and 12.5 million BTUh.

Seven facilities, including three public schools, a college building, an abbey, a prison and a housing development, were selected in five Northeastern states from Pennsylvania to Maine. Four of the facilities had converted from electricity to wood for their space heating load; three had converted from oil. Most used virgin wood chips as the feedstock; for a few of the facilities the chips are supplemented with saw mill residues.

As the table on page 23 illustrates, the combustion and thermal efficiencies at the seven facilities are very similar to, or slightly below, that typical of fossil fuel systems. Combustion efficiencies, a measure of how much of the fuel's theoretical energy content is released when the fuel is burned, ranged from 62-69 percent. An alternative combustion efficiency methodology which systematically accounts for the fuel moisture content would raise the combustion efficiency numbers to a range of 68-77 percent. Thermal efficiencies, a measure of how well the steam or hot water generator converted the chemical energy from the fuel into steam or hot water, ranged from 72-87 percent.

The testing methodology generally followed the American Society of Mechanical Engineers (ASME) Power Test Code PTC 4.1. Calculations were based on ultimate and proximate analysis of the wood chip fuel and a test for Loss on Ignition (LOI) for the ash. This data was integrated into the standard heat loss method recommended by ASME. The thermal efficiency testing used the results of the combustion efficiency analysis and also included the assumed unaccounted for losses due to radiation and other non-combustion factors. The combustion efficiency calculations were based upon the certified chemical analysis of the fuel, flue gas analysis, combustion air temperatures and flue gas temperatures.

Incomplete pre-retrofit fuel records at several of the sites precluded generalizations about system paybacks after conversions to wood. Total installed costs for systems ranged from $105,000 for a 2.2 million BTU system to $750,000 for a rated 12.5 million BTU system. Annual fuel savings ranged from $8,500 to an estimated $50,000.

***Instrumentation Lacking.*** The lack of instrumentation caused problems in the calculation of energy output. Pump motor amperage and name plate data provided assumptions for several sites. Isolation of the feedwater system and calculation of the differential head of feedwater over time in a cylindrical, horizontal tank provided an index of steam flow, which led to an output calculation in one case. Combustion controls were fully automated at only one site; the others relied upon on/off settings.

***Fuel Storage Varied.*** Wood energy systems require a sizable fuel storage capacity, prompting a variety of solutions at converted facilities. One site utilized a parked trailer visited by a "skip" loader to offload the chips and deposit them in a "live" feed hopper. More typical was an enclosed fuel storage area with an automatic, mechanical conveyance system which delivered fuel to the live feed hopper before being fed to the furnace on demand from the boiler. Ash removal varied from daily, manual removal to an automated, continuous ash removal conveyor system.

***Systems Oversized.*** At six of the seven sites, oversized furnaces led to difficulty in tuning the systems to operate efficiently at both low and full loads. Oversizing resulted from a very conservative engineering design approach, geared to the most severe winter weather, and perhaps the industry's relative inexperience with small and medium-sized systems. CT&E's report recommended sizing the units such that an efficient, automatic control over a 3:1 turndown (high fire to low fire) could handle the entire load. The contractor also recommended sizing the wood systems smaller to handle the typical range of cold temperatures and to provide a small supplemental fuel backup to handle the few coldest days. So doing would improve the efficiency of the wood systems and lower overall fuel costs, even taking into account the supplemental fossil fuel usage.

The study suggests that proper attention to boiler sizing, tuning and modulating fuel feed and combustion air with microprocessor controls should generate significant increases in efficiencies in the next generation of heating system installations.

**WOOD-CHIP HEATING SYSTEMS: A GUIDE FOR DECISION-MAKERS**

To complement the work of the boiler efficiency testing report, NRBP commissioned a guide for institutional and commercial facility managers considering the conversion of their heating systems from electricity or oil to wood. While also useful for managers planning a new facility, the guidebook is directed at schools, public facilities, and small to medium commercial facilities with expensive heating systems, especially those fueled by electricity. The guide offers a detailed discussion of every major step associated with investigating the feasibility of burning biomass, considering its cost-effectiveness, and installing a biomass heating system.

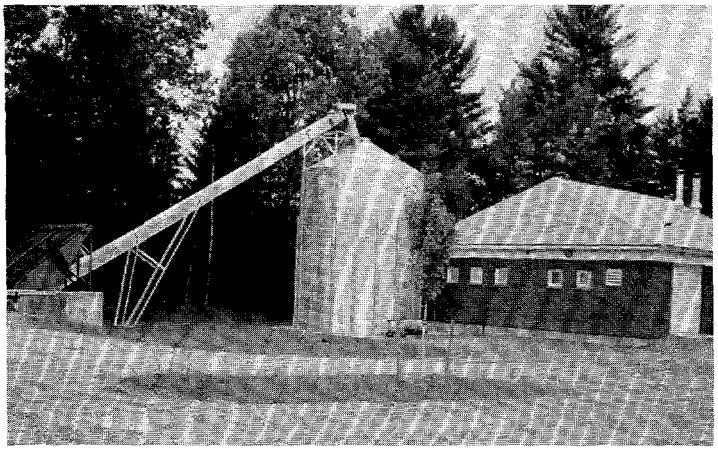
***System Components.*** The guidebook begins with a description of a wood-burning system and its physical requirements at a school, factory, hospital or other location requiring a heating load of 1-10 milion BTUh. The availability of a back-up system, often oil-fired, makes it possible to size the system to maximize seasonal efficiency, a recommendation of the CT&E boiler efficiency evaluation. Because biomass heating systems require more storage space and may require a more elaborate fuel handling system, the capital costs of the entire system tend to be greater than for a conventional fossil fuel-fired system.

***Feedstocks.*** The guide next considers the various biomass feedstocks suitable for off-the-shelf direct combustion systems: mill residues, sawdust, bark, municipal solid waste, and wood chips from logging or wood wastes processing. Consistent quality fuel, meeting specified size and moisture requirements, is the biggest challenge presented in the fuel procurement process. In some areas of the region an associated challenge is the availability of a stable fuel supply network. The northern reaches of the region already have such a network; part of the southern tier do not. The occasional inconsistency in feedstock size, moisture content, and impurities can mean higher maintenance costs for biomass systems.

***Fuel Savings.*** Lower fuel cost is the largest attraction of converting from an electric or fossil fuel heating system to biomass. In most of the northeast, wood fuel is available for $15-25 per ton. In BTU equivalence, both coal and #2 oil cost twice and natural gas two-and-a-half times as much. Most dramatically, electricity costs ten times as much. Therefore, facilities which currently heat with electricity are the most obvious candidates for biomass conversions. Since wood systems have higher capital and maintenance costs than conventional systems, it is the significant fuel cost savings which prompt most facility managers to select a biomass system. Several case studies in the book illustrate the net benefit to those schools, hospitals, resorts, factories, and prisons which have converted to biomass. Other factors cited

*Facility Boiler Summaries*

| | Mount. View | Camp Gabr. | Green Acres | Calais | L&G | U of M | St. Jo. |
|---|---|---|---|---|---|---|---|
| Facility | School | Prison | Housing | School | School | College | Abbey |
| Installed Cost | $385 k | $750 k | $105 k | $162 k | $465 k | $118 k | $174 k |
| Combustion Efficiency | 62% | 65.5% | 67% | 69% | 69% | 66% | 64% |
| Thermal Efficiency | 81% | 75% | 75% | 87% | 82% | 72% | 75% |
| Rated Capacity BTU | 10.8 Mil | 12.5 Mil | 2.2 Mil | .52 Mil | 45 HP | 2.1 Mil | .84 M 6 k st |
| Fuel Type | Chips | Chips | Chips | Chips Mill Res | Chips | Mill Residue | Annual |
| Consumption Tons | 1,278 | 2,583 | 450 | 140 | 180 | 653 | 358 |
| Cost/Ton | $23 | $23 | $25 | $25 | $29 | $22.40 | $17.50 |
| Fuel Savings | $8,536 | NA | $33,470 | $19,375 | $50,000 | $4,466 | NA |
| Combustion Process | Recip. Grate | Step Grate | Stoker Feed | Direct Burn | Gasification | AfterbrTube | Step Grate |
| Conversion FromOil/Elec. | Oil/Elec. | Elec. | Elec. | Elec. | Oil | Oil | |



*Wood storage bin for a small institutional building.*

by facility managers as contributing to their decision to select biomass include: local economic development gains, the reduction in $CO_2$ emissions associated with the full cycle of growth, harvesting and combustion, and biomass' status as a renewable feedstock.

***Performance Factors.*** Drawing upon lessons learned from the CT&E study and site visits to a dozen facilities in the region, the guide cites several critical factors associated with optimal system performanance. To improve the steady state efficiency of a direct combustion heating system, the operator should reduce excess air and stack temperatures, especially when excess air is greater than 100 percent. Reducing moisture content below 40 percent and reducing carbon monoxide emissions will also generate efficiency dividends.

***Financing Options.*** The guide explores financing options for biomass systems, ranging from state energy grants to the issuance of tax-exempt bonds to performance contracts. The latter refers to a relationship between a lender and a facility in which the former agrees to finance the system and guarantees that the annual savings will be sufficient to retire the debt service and associated expenses of the installation. The higher capital costs required of a biomass installation can be offset by the fuel savings when the installation is financed under a long-term (10-15 years) contract.

Site-specific considerations can dictate large variations in cost. For example, a facility which can accommodate a tractor-based system — one which uses a tractor or front-end loader to move the fuel from the storage bin to a day bin — may be able to eliminate one-half to two-thirds of the storage and handling equipment costs typically associated with an automatically-fed system. The level of control sophistication also has significant cost ramifications; simple on/off controls and no exhaust gas cleaning equipment is much cheaper to install than a system with microprocessor controls and features such as automatic ash removal or moving grates. On the other hand, additional capital costs may be recouped in reduced operation and maintenance costs.

***Project Team.*** Beyond a boiler engineer and possibly an architect, the guide suggests that the facility manager may rely upon a business manager, maintenance staff, and other specialized personnel or consultants to plan and execute a conversion. It is particularly important to define clearly the relationship between the project architect and mechanical engineer during the project's planning stages. Finally, the guide stresses the importance of utilizing a plant manager who is firmly committed to the success of the project.

## Dissemination and Impacts

The facilities which participated in the Boiler Efficiency Study responded very positively to what they learned. A mailing list of 5,000 small- to medium-sized commercial and institutional facilities has been developed to get the study report out to a wide audience. In addition to receiving a copy of the study's executive summary with a cover letter from the NRBP, this mailing list will receive notification of the Wood Chip Heating Guide's availability and the results of the Air Emissions Testing project scheduled to get underway later this year.

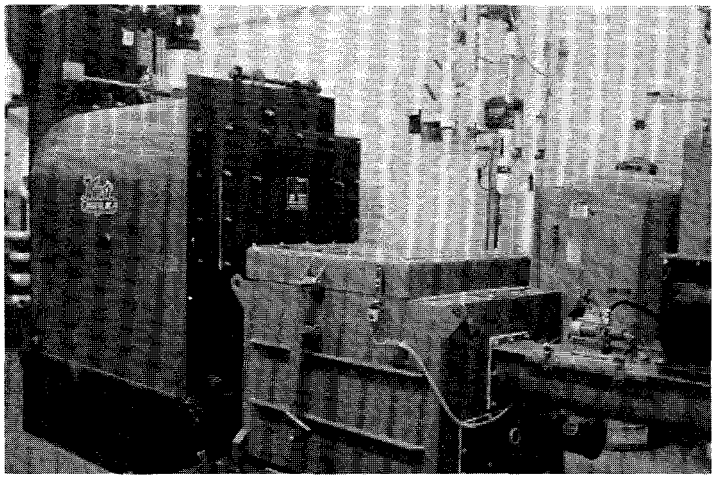
## Next Steps: Air Emissions Testing of Two Wood-Chip Fired Furnaces

Although the prospects for commercial-scale wood-chip heating are not massive in this period of relatively low fossil fuel prices and limited economic growth, this application continues to represent a significant niche market for biomass in the Northeast. The success of Vermont's NRBP-supported conversion assistance to electrically-heated public schools (see Vermont State Program Profile) has led to interest from school districts in New York, Maryland, and Pennsylvania.

In May 1994, the NRBP Steering Committee approved a project introduced by the Vermont Department of Public Service (DPS, Energy Efficiency Division). Intended to complement the CT&E efficiency testing, the Wood Chip Heating Guide and a video on heating schools with wood chips, the testing project will be designed to determine the air emissions produced by small (0.5 to 3.0 MMBTUh) wood-chip fired combustion systems and to determine the associated health risks, if any. Concentrations and emissions rates will be determined for metals, poly-aromatic hydrocarbons, and dioxins/furans. The Department of Health will conduct an environmental health risk assessment. Every effort will be made to ensure that data collected is representative of such systems throughout the eleven Northeast states.

The testing program will be coordinated by the Vermont DPS, with Vermont's Department of Environmental Conservation (Air

Pollution Control Division - VAPCD) and Department of Health (Environmental Health Division) contributing in-house staff time to monitor and assist the testing consultant and provide quality control and project management/oversight. This cooperative approach will serve both to augment NRBP project funds and to establish the credibility of the findings with the region's air quality and public health regulators who will be one audience for the final report.



*Medium sized wood-fired boiler*

*Case Study 4*

# NEW OPPORTUNITIES FOR LANDFILL GAS RECOVERY PROJECTS

## The Problem: An Underdeveloped Resource

Landfills produce a gas, comprised of approximately 50 percent methane and 50 percent carbon dioxide (and other trace gases) when organic materials decompose under anaerobic conditions. This gas can be a hazardous liability to a landfill owner when subsurface migration of the gas reaches the basement of a neighboring house; when harnessed as a gas it can be an energy feedstock with a typical heating value of 400 to 600 Btus per standard cubic foot — approximately one-half the heating value of natural gas. The technology of converting landfill gas (LFG) to energy has been known for several years and today there are 120-150 landfill projects in the United States, producing an estimated 344 megawatts of electrical power. Many of these projects are in the Western United States; development of LFG recovery projects has been slow in the Northeast.

In the mid-1970s, developers began to contract with landfill owners for the rights to capture landfill gas and to convert the methane portion to useful energy for sale. Energy conservation measures, rising fuel prices, governmental incentives, and fuel shortages created a climate receptive to the LFG-to-energy industry through the mid-1980s. Landfill owners received royalties ranging from 12-30 percent of energy revenues.

By the early 1990s, low energy prices, fuel-price competition, and the phasing out of tax incentives were making it more difficult for developers to earn an attractive net return on investment in LFG recovery projects. Yet other factors have combined to give LFG recovery a new boost. LFG generation potential was expected to peak in the 1990s, with many landfills approaching capacity and fewer new landfills being sited. Stricter regulations promulgated by the Environmental Protection Agency and by state and local regulators have prompted the closing of hundreds of landfills and mandated pollution controls on thousands more. There are two alternatives for landfill operators complying with the stricter environmental regulations: flaring the landfill gas (LFG) or harnessing it for energy. The former option involves lower upfront capital costs and fewer regulatory hurdles. The latter requires a greater investment, a willing buyer, and a lengthier approval process — but also may generate a significant revenue stream.

## The NRBP Response: Rediscovering an Existing Resource Conversion Technology

In 1992, with the results of its recently-completed *Greenhouse Gas Mitigation* report stressing the importance of recovering methane as well as implementing carbon-neutral energy strategies, and with new federal regulations improving the relative economics of LFG recovery for large landfills, the NRBP Steering Committee saw an opportunity to "rediscover" landfill gas-to-energy facilities.

Not all landfills are worthy candidates for LFG energy recovery. Attributes such as the size, depth, age and composition of the landfil must be considered. Once determined that it is feasible to harvest gas from a landfill site, a gas buyer or electric utility purchaser must be identified, and a host of additional institutional and technical issues investigated. A conversion technology and collection system must be selected. The developer must understand utility purchasing regulations and master the environmental permitting process for power projects in order to proceed. Federal tax credits and production incentives must also be factored into any detailed feasibility study of a particular landfill site.

To assist landfill owners, municipalities, and independent power producers, NRBP engaged a contractor to examine the technical, economic, institutional, and environmental issues associated with successful LFG recovery. The contractor identified project criteria and barriers to siting of energy recovery facilities. In a second phase, specific landfills in the region which demonstrate positive characteristics for most of these criteria were also identified, and a software spreadsheet program developed to help energy and solid waste officials perform a preliminary economic feasibility assessment on a given site or sites. The concept of public/private partnership was also investigated.

### BARRIERS AND CRITERIA FOR SUCCESS

The first phase of the project was to survey current LFG-to-energy experience in the Northeast to make conclusions about what makes a project successful, to identify what the impediments to a successful project are, and to make recommendations on how barriers can be surmounted.

### IDENTIFYING CANDIDATE SITES

The second phase, completed earlier this year, applied the Phase I findings to identify feasible landfill sites for LFG-to-energy projects. The objective of Phase II was to inform government policy makers of the total current energy potential in the Northeast from LFG, and to make a list of candidate landfill sites available to potential public and private developers of LFG-to-energy projects in the eleven NRBP states.

### PROJECT FINDINGS AND RESULTS TO DATE

There are 41 operating LFG projects in the Northeast, generating 92.5 megawatts of power. Energy applications include direct use as a boiler fuel in an adjacent facility; electrical generation via an internal combustion engine, gas or steam turbines; and upgrade to pipeline-quality natural gas. The vast majority of facilities in operation today are electrical generators, most with internal combustion engines.

Landfills successfully supporting LFG recovery facilities range in area from 20 to 3,000 acres, with a mean of 207 acres. Typically, the minimum acreage devoted to recovery is 100 acres. The mean depth of an LFG recovery landfill is 84 feet; typical tonnage is 7,000,000; the number of collection wells averages about 70 wells. Construction costs for well-drilling vary between $30 and over $100 per foot. A complete collection system, including wells, headers and condensate traps typically costs $10,000 per acre to install.

The major economic variable associated with electrical generation from LFG recovery is the power purchase rate available from the local utility. Rates of 6 cents per kWh were prevailing for typical generators associated with LFG recovery facilities built in the past decade. Today, most utilities are experiencing declining avoided costs, generally below 6 cents per kWh. Yet Congress has sweetened the incentive by enacting a $3.00 per million Btu tax credit for this fuel and other "unconventional" fuels sold to unrelated parties. Congress also enacted a production credit for renewable technologies with dedicated feedstocks. To date Congress has not appropriated funding to implement the credits, nor has DOE yet determined that landfill gas is a "dedicated" resource.

The NRBP contractor interviewed LFG operators and regulators to identify the key elements associated with successful energy projects. Beyond the characteristics associated with landfill tonnage, acreage, and age described above, most or all of the following elements have been present:

- a landfill owner experienced with LFG issues;
- a landfill owner responsible for the supply of LFG;
- utilities with high avoided electricity prices, entrepreneurial in their solicitation of renewable supplies;
- early planning meetings with state regulators; and
- condensate managed with landfill leachate.

The contractor identified 92 of the region's 530 landfill sites as good potential candidates for LFG recovery projects. A computer-assisted LFG recovery model has been developed to assist municipalities and developers in determining the viability of a particular site. The model features a LFG Utilization Pro-Forma which uses acreage, estimated methane content, and first year energy sales rate to determine the economic feasibility of a project. O&M costs, capital costs, interest rates, amortization periods, inflation rates, royalties to landfill owners, tax credit values, rewewable energy production incentives and other variables are projected. Operating income, expenses, and project cash flows are estimated for a fifteen year-period. The NRBP is working with the EPA's Methane Outreach Program and planning workshops to get these findings and the computer model into the hands of municipal planners and developers.

The NRBP's studies of landfill gas technologies and of impediments to extraction have stimulated interest in several of the region's states. The Maryland Energy Administration is using the candidate landfill survey and feasibility assessment model as a starting point for an assessment of potential end-users located near sites which have been identified as candidates for LFG recovery. Massachusetts conducted a one-day forum for members of state and federal government agencies to explore best methods for follow-on work and to evaluate future directions for this work.

## Next Steps: Determining the Most Economic Technologies

In 1993, the NRBP initiated a new line of inquiry, to determine the most economic technologies for harnessing landfill gas. The standard internal combustion engine will be compared for its economic and performance characteristics against gas turbines, the Organic Rankine Cycle, the Stirling Engine, and perhaps fuel cells. Prevailing utility rates in the Northeast for independent power production and the rate boosts provided by environmental externalities will also receive attention to provide states with a stronger focus on subregions and technologies with the strongest potentials.

The project will include an examination of existing and pending regulations in the 11-state region and at the federal level to ascertain whether reduction of emissions due to LFG energy projects qualify for any economic incentives, including off-site emissions reduction credits. Part of the analysis will be to determine the types of project partnerships that are necessary to maximize federal economic incentives (e.g., the Production Tax Credit or the Renewable Energy Production Incentive) for each technology considered.

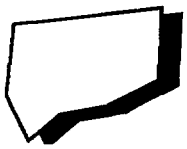
The final report will be geared towards potential public and private developers of LFG energy projects. The report should aim to demonstrate the availabily of low cost conversion technologies, appropriate to landfill sites of different sizes and other conditions, which when combined with existing economic incentives and pressing LFG control regulations will accelerate the development of LFG energy projects. The report shall also be directed to key constituencies, air, water, and solid waste regulators, environmental consultants, municipalities, landfill operators, and utilities.

# STATE BIOMASS PROGRAMS

Through the State Grant Program, the NRBP provides money for its eleven member states to pursue a variety of information dissemination and networking activities designed to foster the use of biomass energy at specific project sites and generally throughout each state. Typical state activities include: resource assessments, surveys of facilities that use biomass energy; technical assistance to facilities considering a conversion to biofuels; dissemination of consumer information on subjects such as the safe installation and operation of wood stoves; and consultation and coordination with the various state agencies with responsibilty for forestry/resource management, energy, environmental quality, economic development, and public health.

Most importantly, the State Grant Program, which requires a matching grant from each state government, requires that participating states maintain a designated biomass energy contact person. In addition to representing his or her state on the NRBP Steering Committee, the biomass contact person represents a base of knowledge accumulated over the lifetime of the Regional Biomass Energy Program, including research conducted by the NRBP and other regional programs as well as state-specific biomass energy issues.

The importance of this presence cannot be overstated. In the several states where energy office budgets have been cut back or eliminated, the NRBP state biomass contact is the only person in state government with a base of knowledge and a mandate to promote the development of biomass energy. In addition to working directly with local constituencies (forest products industry, residential wood stove dealers and users, independent power producers, commercial/industrial and institutional users and potential users of wood energy, to name a few), the NRBP state biomass contact person ensures that biomass resource potential and technologies are taken into consideration in the formulation of the state's energy, resource, and environmental policies and programs.



# CONNECTICUT

***Forest Acreage:*** 1.8 million acres
***Industrial/Commercial Wood Fuel Use:*** 27,200 tons/yr (1990)
***Residential Wood Fuel Use:*** 800,000 tons/yr (1988)
***Wood-Fired Electricity Generation:*** Existing: <1 megawatt (1994)
***MSW Resource Recovery Facilities:***
In operation: 5 facilities with a design capacity of 6,010 tons/day and generating 159.7 megawatts
Under construction: none
Planned: 1 facility expected to generate 13.5 megawatts
***Landfill Gas Recovery Projects:***
Active recovery projects: 1
Candidate landfill sites: 14
Planned recovery projects: 1
(scheduled to open by Sept.1994)

## Overview

The use of wood for energy increased significantly during the 1970s in Connecticut, in response to the increasing cost of oil and other fuels during that period. Generally, the demand for cordwood has been inversely correlated with the health of the economy over the past 20 years. Fuelwood use by industry in Connecticut increased at a much slower rate in the 1980s, in part because of the relatively low price of fossil fuels. A number of the firms which were burning wood for energy in 1984 have since closed their doors, left the state, or are not currently using their wood-fuel capacity.

Connecticut has 1.8 million acres of forested land, of which 86 percent is privately held. Allowing for accessibility and the preferences of these landowners, it has been estimated that 57 percent of the state's forest is potentially available for fuel harvesting, with the growing stock on these lands experiencing a total net increase of 328,000 tons per year. In addition, lack of active management over a number of decades has created a backlog of 2.6 million tons of culled trees and salvable dead wood available for fuel.

A serious shortage of landfill space has spurred the development of trash-to-energy facilities and turned municipal solid waste (MSW) into a resource of considerable importance. The state now has a total of five operating MSW facilities with a design capacity of 6,010 tons/day.

## NRBP Supported Activities

### RESOURCE ASSESSMENTS

Emphasis during the first program year was placed on gathering basic data on Connecticut's forest resource and on the level of use of various types of forest products. The objective was to get a measure of the potential for expanded wood fuel utilization. This effort, a joint undertaking of the Department of Environmental Protection's Bureau of Forestry and the Office of Policy & Management (OPM)'s Energy Division, resulted in three surveys:

- Primary Wood Processors by County;
- Industrial Biomass Users; and
- Residential Wood Energy Users.

The surveys found that Connecticut's 95 sawmills produced nearly 220,000 tons of residues (bark, coarse, fine) in 1984, while nine firms used a total of 27,200 tons of wood or wood residues to meet all or part of their energy needs. Approximately 30 percent of residences in the state used a total of 1,320,000 tons of wood for energy. From these findings it was estimated that only about 12 percent of the residue resulting from the Connecticut wood products industry was being used for energy production. The survey findings, along with a 1983 USDA study on Connecticut residential fuelwood use, were brought together in a publication entitled *Timber and Fuelwood Use in Connecticut: A Status Report* (University of Connecticut Cooperative Extension Service Bulletin 86-9).

***Availability of Wood Biomass in Connecticut.*** In 1987, OPM once again contracted with the Cooperative Extension Service to determine how much of Connecticut biomass residues could be used for energy purposes without jeopardizing the State's forest resource, a perception tending to inhibit wood- energy conversions. Analyzing the residues available from two major sources — forest operations and sawmills — the study concluded that the Connecticut forest had the potential to provide a "significant amount of fuelwood beyond that which is currently used," and that removing the backlog of cull trees and dead wood would promote forest growth. The resulting publication (CES Bulletin 87-42) indicated that the availability of wood fuel is highly dependent on wood being harvested or cleared for other, non-energy related purposes.

***Opportunities and Constraints for Using Waste Wood.*** Questions raised during the siting and environmental review of proposed wood-fired power plants prompted OPM to contract with C.T. Donovan Associates (CTD) to determine the actual volume of wood waste available for "recycling" in Connecticut, to compile data on air emissions and ash at facilities using "recycled" wood, and to compile information on the contents of construction and demolition wastes.

Atlantis, Inc. prepared the technical report on urban wood waste and Environmental Risk Limited prepared the technical report on air emissions. Their reports and the material developed by CTD were brought together in a publication entitled *Opportunities and Constraints Associated with Using Wood Waste for Fuel in Connecticut, June 1990.* A smaller document entitled *Concise Guide: The Use of Processed Wood Waste for*

*Fuel in Connecticut* was also issued for use by citizen groups, legislators, and others interested in an overview.

## END-USE SURVEYS

***Residential and Industrial User Surveys.*** Surveys of Industrial and Residential wood fuel use were conducted in 1984 (see above). Approximately 30 percent of residences in the state use wood for energy, burning a total of about 660,000 cords (1,320,000 tons) of wood. A 1989 telephone survey indicated that three percent of Connecticut residents were using wood as their primary heating fuel, nine to ten percent were using wood as a supplemental source of heat and five to six percent were using it as an occasional heat source.

***Revisiting Residential Wood Use.*** Falling oil prices prompted a new survey of residential wood use. While the 1990 study did not sample all woodburners, it did provide demographic information about Connecticut's woodburning households. Woodburners tended to be homeowners as opposed to renters, between 31 and 50 years of age and earning between $15,000 and $70,000 annually. A majority reported having used wood for heat from 5 to 20 years. An airtight wood stove was the equipment most frequently used by both primary and secondary users. Non-wood burners perceived wood heat as being "inexpensive" and "provid[ing] a cozy atmosphere," but also tended to view it as "inconvenient" and "bad for the environment."

## CONVERSION ASSISTANCE

In the fourth program year the emphasis shifted to identifying and working with small- to mid-sized industrial firms which might be appropriate for conversion to wood for heat or cogeneration. OPM contracted with the University of Connecticut's Renewable Natural Resources Department to develop a workshop designed to answer potential wood energy users' questions about the supply and cost of wood fuel, the types and costs of woodburning systems, and about regulations pertaining to the use of wood. Additionally, each participant was given a detailed financial analysis, derived from input supplied confidentially by the firm prior to the workshop, of the economics of converting the participant's facility to wood energy. A total of 52 individuals attended the initial workshop, which was conducted by East-West Forestry Associates. East-West developed a personalized computer program to perform the detailed financial analysis for 12 firms which expressed further interest.

## INTERAGENCY ACTIVITIES

From the outset, OPM has worked closely with the Department of Environmental Protection (DEP) and the University of Connecticut's Cooperative Extension Service — as well as UConn's Departments of Renewable Natural Resources, Agricultural Engineering, and Agricultural Economics and Rural Sociology, and representatives from Connecticut's Bureau of Forestry — to carry out biomass projects.

In 1990, OPM established an Ad Hoc Interagency Committee to assist in the investigation of biomass fuels defined as "clean alternative fuels" under Clean Air Act lesgislation, and to help ensure that the various state agencies concerned with implementation of Title II of the Act would proceed from a common core of information (see sidebar). State funding has enabled the Ad Hoc Committee to continue well after the end of this subgrant, gaining familiarity with most of the other clean/alternative fuels cited in the CAAA or EPAct.

## CONFERENCES/WORKSHOPS/FORUMS

***Forest Management for Fuelwood.*** Although highly urbanized, over half of Connecticut is wooded, with 86 percent of forested lands under private ownership. Working with the University of Connecticut's Cooperative Extension Service and others, OPM developed and produced 4,000 copies of a handbook entitled *Managing Oak Forests for Fuelwood*, issued by the Extension Service as Bulletin 86-71. These were distributed through workshops for woodland owners, one-on-one contacts between county agents, state foresters and woodland owners, and direct mailings.

***Targeting Small to Mid-Sized Firms.*** In the fourth program year (March 1988), a two-part workshop was conducted for small to mid-sized greenhouse/nursery and wood-products firms to investigate their potential for conversion to wood energy. (See above.)

## OTHER

***Economics of Producing Woodchips.*** To help develop markets for forest and sawmill residues, and to take advantage of interest in renewable energy and cogeneration spurred by the Public Utilities Regulatory Policies Act (PURPA), OPM investigated the economics of producing wood chips for fuel at facilities expected to have an ongoing need for wood fuel. The study identified types of equipment and harvesting methods used by logging companies in New England area to produce chips, and surveyed available information on the economics of converting urban wood wastes and sawmill residues to chips.

The study concluded that most timber harvests in Connecticut would be too small to accumulate the necessary volume to justify moving and setting up a chipper, and suggested a method which involves chipping at the end-user facility rather than at the residue-generating site as an alternative which might be suitable for Connecticut, depending on the delivered price for roundwood. These findings and several appendices were brought together in a publication entitled *Biomass Harvesting Costs in Connecticut*, issued by OPM in March, 1989. East-West Forestry Associates served as contractors for this project, for which DEP's Bureau of Forestry also provided assistance.

***Looking at Biomass Fuels for the Transportation Sector.*** With continuing organized opposition to the state's proposed wood-fired generating facilities and the anticipated enactment of the 1990 Clean Air Act Amendments, Connecticut's biomass program focus shifted in 1990 to a consideration of biomass fuels

### Addressing the Barriers to Alternative Transportation Fuels

In 1990, OPM established an Ad Hoc Interagency Committee to ensure that the various state agencies concerned with implementation of Title II of the Clean Air Act — the Departments of Environmental Protection (DEP), of Transportation (DOT), and of Administrative Services (DAS), which manages the state vehicle fleet — would proceed from a common core of information. The Committee began with ethanol, instituting a two-month pilot program using a 10 percent blend in a limited number of state vehicles. Approximately 75 percent of the drivers responding to a survey following the pilot reported "no difference" in driveability. Emissions testing, though limited, appeared to indicate a reduction in hydrocarbon (HC) and carbon monoxide (CO). Concerns about possible contamination of ethanol with water in the tank used for the blended fuel were not realized. DAS elected to issue an alternate bid allowing two of the state's stations to use an "oxygenated blend" in 1991, a year earlier than it would otherwise have been required. This option was not acted upon because of the increased cost it would have entailed.

In 1992, the Committee began examining where alternative fuels, including ethanol and methanol, could make a significant impact on the fuel mix of Connecticut's transportation sector. The objective was to identify specific statutory, regulatory, or other barriers which would limit the introduction or use of these fuels. It was concluded that displacement of petroleum by alternative fuels would take place first in the State's fleet vehicles. Buses used approximately 12.5 million gallons of diesel fuel in 1990, while other fleet vehicles used about 55.6 million gallons of gasoline. At this time, the natural gas industry appears to be the most aggressive of several possible contenders.

In the tenth program year, OPM continued working in the transportation sector by: identifying and addressing regulatory and other barriers to the introduction of biomass and other alternative fuels; seeking clarification regarding their emissions (i.e., NOx, Volatile Organic Compounds, or VOCs); supporting efforts of the DOT's Bureau of Public Transportation to become familiar with biodiesel; and by seeking sources of funding to assist Connecticut agencies in purchasing alternatively fueled vehicles or conversion equipment. OPM also hoped to continue investigating the possibility of producing ethanol within this region from indigenous biomass wastes, contingent upon joint participation with Connecticut's DEP or with the other NRBP states.

defined as "clean alternative fuels" under sec. 241 of part C of that legislation. OPM proposed to identify the environmental impacts associated with use of these fuels in the transportation sector, as well as other factors which might affect their suitability for vehicular use, and to determine the extent to which these fuels could reduce Connecticut's dependence on petroleum-based transportation fuels. (See sidebar.)

An amendment to Connecticut's subgrant allowing the reprogramming of carryover funds in the amount of $17,000 has allowed the Ad Hoc Committee to initiate work in support of developing a turbine which can use landfill gas or gas derived from other biomass sources. The project has a completion date of August 31, 1994.

## Future Trends

Connecticut's MSW facilities currently generate 159.7 megawatts of power. The recent drop in economic activity has contributed to a decrease in MSW. Although the reduction in locally-generated waste has been partially offset by MSW from other states, pressures to reduce packaging and to expand recycling programs have added to doubts about the need for a planned sixth facility.

The recovery of methane from landfills is expected to make a small contribution to Connecticut's energy supply while mitigating the state's greenhouse gas emissions. One LFG recovery facility began operating in 1991 and a second is expected to begin operations in 1994. Work initiated this year to develop a turbine which can operate on landfill gas or gas derived from other biomass sources has the potential to open a new and sizeable market to biomass interests.

With the termination of contracts for Connecticut's proposed wood-fired power plants, projects involving the direct combustion of wood appear unlikely to win the necessary approvals in this state in the foreseeable future. However, the use of biomass wastes, including wood, for conversion into ethanol remains under active consideration. An ethanol facility using biomass as a feedstock could provide a needed market for these wastes (or reduce the costs of disposing them) and create new job opportunities.

While use of wood in the residential sector remains limited, the pellet stove, if it gains a foothold in Connecticut, could make this a more appealing option.

## NRBP Contact


| | |
|---|---|
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# DELAWARE

***Forest Acreage:*** 376,400 acres
***Industrial/Commercial Wood Fuel Use:*** 212 tons/yr (1991)
***Residential Wood Use:*** 78,713 tons/yr (1988)
***Wood-Fired Electricity Generation:***
Existing: None
Proposed: None
***MSW Resource Recovery Facilities:***
Existing: 1,000 tons/day
***Landfill Gas Recovery Projects:***
Active recovery projects: 2
Candidate landfill sites: 5
Planned recovery projects: 1

## Overview

Delaware is only 31 percent forested which limits the role which biomass can fill as an energy source. Additionally, nearly all of the state's timber is processed out of state, eliminating the potential for utilizing processing residues. However, there are many heavy industries, particularly in northern Delaware, which produce a substantial amount of waste woods. There is also a large poultry industry in the southern half of the state which generates large amounts of waste biomass. Due to increased awareness of waste biomass' energy potential, the future holds much promise.

In 1983, the only notable biomass for energy production in Delaware was the use of cordwood for residential heating. There were a few small industrial firms using wood for heating, but most of these were small secondary wood processing firms which used their waste wood for heat. An NRBP-sponsored survey conducted by the Delaware Forest Service and Delaware Energy Office found that approximately 162,000 cords were used by the residential sector in 1984. Approximately 30 percent of the state's households were burning wood, with nine percent using wood as their primary heat. There were no large institutions using biomass energy, nor were there any landfill gas recovery sites. There were no whole-tree chipping operations to produce wood chips. There was also little interest in studying potential uses of biomass for energy.

Currently, biomass energy's role is at approximately the same level as in 1983, with some forms of biomass exhibiting increased utilization while other forms' utilization has decreased. Two landfills now utilize their gas for energy and a third landfill gas recovery system is planned. Two whole-tree chipping operations now operate in Delaware and the surrounding states, providing a supply source for wood chips and a silvicultural tool for forest landowners.

It is estimated that wood for residential wood heating has decreased since 1983. A 1988 residential fuelwood survey showed that the number of households using wood heat had fallen to nine percent, down from 30 percent in 1984. Also, biomass energy is virtually nonexistent in the industrial and commercial industries.

While the use of biomass energy in Delaware has not dramatically increased in the past ten years, NRBP funding has generated new opportunities. A biomass working group has been assembled involving representatives from both the private and public sectors to investigate the opportunities for biomass within Delaware. One project which the group approved is a statewide survey to estimate the types, amounts, and the availability of various waste biomass resources within Delaware, thus providing valuable information to utilities and other firms

### Biomass Working Group

The Delaware Forest Service is very proud of the Biomass Working Group which it formed in 1992. Functioning as a steering committee to help decide the best course of action to promote biomass energy in Delaware, the Working Group helps the Forest Service review potential projects for NRBP funds and provides guidance on chosen projects.

Perhaps the Group's greatest achievement is that it has brought the major players in the biomass energy field to the same table. There are representatives from Delmarva Power & Light (the state's major utility), the Delaware Solid Waste Authority, the Delaware Department of Natural Resources and Environmental Control, the Delmarva poultry industry, the University of Delaware Cooperative Extension Service, and the Delaware Energy Office. The Delaware Forest Service's NRBP representative chairs the Working Group, which has provided valuable comments and suggestions for the state's biomass program. One example is the state's waste biomass resource survey currently contracted with C.T. Donovan Associates. The Working Group provided valuable comments and suggestions for the project and "real world" insights.

Additionally, the Working Group has allowed our NRBP representative to establish contacts with these individuals which we believe will lead to even greater future accomplishments. The utility company is now discussing with the Forest Service the possibility for biomass-for-energy plantation test plots within Delaware. This Group also has allowed the state's NRBP representative to work with leaders from the poultry industry which in turn has led to contacts with individuals considering building pellet mills within Delaware.

The Delaware Forest Service believes this committee is the best step we have taken to advance our state's biomass industry. We recommend this for other states considering how to promote their state's biomass industry.

which may be considering biomass energy. The local utility in Delaware, which is a member of the working group, has expressed an interest in using biomass for energy production. This includes not only waste biomass but also biomass-for-energy plantations. Furthermore, two separate businesses are investigating installing pellet mills in southern Delaware to utilize sawdust and poultry industry wastes. These are promising developments for biomass energy in Delaware, and the Delaware Forest Service continues to help foster these ideas with the assistance of NRBP funding.

## NRBP Supported Activities

### RESOURCE ASSESSMENTS

Currently, Delaware has contracted with C.T. Donovan Associates, Inc. in Burlington, Vermont to conduct a statewide assessment of the amount of waste biomass available in Delaware. The study includes waste woods, waste paper and cardboard, and poultry industry wastes. Scheduled for completion in August 1, 1994, this project already has generated much interest. Delmarva Power & Light, the state's major utility, is interested in the survey to see if there is a sufficient supply of biomass to consider using in their systems. Also, two individuals are interested in the findings to help determine the feasibility of pellet mills.

### END-USE SURVEYS

NRBP funds were used to conduct two statewide residential wood heating surveys in 1984 and 1988 and two statewide industrial wood use surveys in 1984 and 1991. The residential surveys found that residential wood use for heat declined from 446,000 tons in 1984 to 78,700 tons in 1988. This large decline was largely based on a corresponding decrease in fossil fuel prices. The industrial wood use surveys found that virtually no firms were utilizing wood for energy, except some primary and secondary wood products firms. Only an estimated 212 tons of wood are used by industry to produce energy. These surveys have indicated a clear need to promote wood and other biomass for energy within Delaware, which has led in turn to the biomass resource assessment currently underway to further quantify how much biomass is available for fuel. Once this assessment is finished, the Delaware Forest Service hopes to locate potential sites, such as schools, prisons, and other institutions, which may be suitable for wood energy.

### CONVERSION ASSISTANCE

Very little conversion assistance has been accomplished with NRBP funds. The Delaware Forest Service attempted to help a local Shiitake mushroom farm convert from LP gas heating system to a system fired by wood chips in 1993. However, the cost of installation was too great for the company. The Delaware Forest Service continues to pursue other possibilities for converting energy systems to wood and other biomass.

One project just finished in the winter of 1994 was the installation of a wood-fired furnace in a house located on the Blackbird State Forest. This system was installed with an oil back-up and is in a home occupied by one of the state forest's employees. It is hoped that the use of a wood-fired furnace on the state forest will demonstrate to the public the opportunities for wood heat in their homes. An open house is planned for the forest in 1995 where the furnace will be on display.

### INTERAGENCY ACTIVITIES

A biomass working group was formed in 1992 with the assistance of NRBP funding to determine the best opportunities for biomass in Delaware. This group consists of individuals from both the private and public sectors, including representatives from the local utility, the solid waste authority, the state regulatory branch, the State Energy Office, the Cooperative Extension Service, the poultry industry, and the State Department of Agriculture. Not only has this group provided valuable information and insights to the state's biomass program but it has also provided a means to establish contacts with the individuals who are most involved with biomass. One example is the Delaware Forest Service's relationship with the state's major utility. Not only has the utility expressed interest in the resource survey but they have also talked to the Forest Service about researching biomass-for-energy plantations. This group has and continues to provide excellent support for the conception and execution of the biomass resource survey, and it is hoped that it will continue to exist and provide support in the future to Delaware's biomass program.

### CONFERENCES, WORKSHOPS, FORUMS

The Delaware Forest Service organized annual workshops from 1986 to 1991 to cover all aspects of using wood for fuel. These workshops were designed for private landowners and homeowners burning wood for fuel to inform them how to burn wood correctly. They also demonstrated to landowners how to manage their woodlots for fuel production while improving their woodlots for sawtimber production. These workshops led to a demonstration area on the Blackbird State Forest where a woodlot is managed for fuel and hardwood sawtimber.

### OTHER

The Delaware Forest Service used NRBP funds to produce Primary Wood Processors' Directories in 1991 and 1993. These directories include lists of loggers, sawmills, and timber buyers and concentration yards within Delaware as well as companies from surrounding states which operate in Delaware. The directories indicate which raw products each firm purchases and the finished products they sell. The Forest Service receives on average at least one call every two weeks for this directory.

Funds were also used to produce a secondary wood processors directory in 1991. This directory lists the manufacturers within Delaware such as cabinet and furniture makers. The directory also includes how much waste biomass, typically sawdust, shavings, and trimmings, is produced by these firms. This information was used in the 1991 Industrial Wood Use Survey.

The Delaware Forest Service also produced a brochure describing the benefits of wood energy. This brochure was distributed at the wood fuel seminars and at state fairs and other events which the Delaware Forest Service attended.

### FUTURE TRENDS

The future for biomass energy is promising in Delaware. With the completion of the resource survey, there will be an accurate estimate of how much and what types of biomass are available for potential industries in Delaware. It is believed that this survey will find that there is an ample supply of available biomass for energy projects.

There will not likely be enough biomass to support an independent power plant, but it is hoped that the resource assessment will show sufficient supplies to consider co-firing at one or more of the power plants within Delaware. The utility has helped provide guidance for the resource assessment and expressed interest in a biomass for energy plantation research project. There are two whole-tree chipping companies operating in Delaware and the surrounding states and these two producers are interested in developing additional markets. Thus, the state's biomass program continues to investigate not only large scale co-firing, but also the possibility of installing a wood chip boiler in a school or other state facility to demonstrate the viability of wood for energy on a smaller scale.

Additionally, the popularity of pellet stoves is increasing in Delaware, and it is hoped that the biomass resource survey will indicate that there is a sufficient supply of raw feedstocks for a pellet mill in Delaware. Southern Delaware is a prime candidate for the presence of the large poultry and wood processing industries within Delaware and the surrounding states.

## NRBP Contact


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# MAINE

***Forest Acreage:*** 16.9 million acres
***Industrial/Commercial Wood Fuel Use:*** 1.7 million tons/yr
***Qualifying Facilities Feeding the Electric Grid:*** 4.8 million tons/yr (includes industrial cogenerators and stand-alone power plants)
***Residential Wood Use:*** 1.5 million tons/yr
***Wood-Fired Electricity Generation:***
Existing: 490 megawatts 1994
***MSW Resource Recovery Facilities:***
In operation: 1,350 tons/day
***Landfill Gas Recovery Projects:***
Candidate landfill sites: 4

## Overview

Since 1983, woody biomass has re-emerged as a significant part of Maine's energy resource mix. While residential fuelwood use has declined over this period, the development and growth of a wood-fired electricity-generating industry has dramatically increased the use of wood for energy. Taking wood-fired power production into account along with the modest use of municipal solid waste for energy and the widespread use of wood for energy in the wood products industry, Maine relied on biomass-fired power generation to meet 25 percent of its electricity needs in 1990.

## NRBP Supported Activities

The NRBP has been an important source of support for biomass energy developments in the state. Program funding has supported a variety of resource assessment surveys and studies, end use surveys, conversion analysis, interagency cooperation in program planning and working committees, workshops and demonstrations, and information gathering and sharing activities. As a result of severe State budget cutbacks, NRBP funding currently provides the critical support for an active biomass energy program in Maine.

### RESOURCE ASSESSMENTS

***Regional Forest Resource Data.*** NRBP funds supported the development of computer programming needed to re-aggregate USFS forest resource data into specifically defined geographic regions/areas in support of biomass power project planning and development. This program is used extensively in both public and private development activities.

***Harvesting-Related Research.*** NRBP funds supported an analysis of biomass harvesting-related research needs, including the publication of a bibliography of existing research and a study of the feasibility of establishing a biomass research center within the Cooperative Forest Research Unit of the College of Forest Resources at the University of Maine. Although the research center was not feasible, this work served to provide useful guidance for the existing research programs.

***Whole Tree Harvesting.*** Conducted by the Maine Forest Service, NRBP funds supported annual surveys of whole tree

### THE IMPORTANCE OF DOCUMENTING BIOMASS ENERGY'S DEVELOPMENT

NRBP support enabled the State Planning Office to prepare a comprehensive report on the wood-fired electric generating industry in Maine. This report details the development of the biomass energy industry over the past ten years. It documents the status of biomass in the state's energy supply; the impacts of biomass harvesting and combustion on the state's forest, air, and soil resources; and its positive influence on the State's economy. This report has played a significant role in recent energy planning and political decisions in Maine.

The report provides a solid foundation for State policies supporting the continued use of indigenous energy resources. The Legislative Commission on Comprehensive Energy Planning in its report recognized the positive value biomass energy development contributes to the State, and re-affirmed the State's policy toward indigenous energy resources.

The report played a critical role as a comprehensive independent source of information about the biomass power industry in recent Legislative and PUC deliberations. Severe economic recession, low-cost electricity alternatives, surplus generating capacity, and relatively more costly power generation by non-utility generators operating under PURPA agreements, have contributed to significant increases in customer electricity rates. Responses to rate-payer shock and demands for action to control costs have raised serious questions that could adversely affect the current and future use of woody biomass as an energy resource.

The data collected for the report on the wood energy industry have been cited extensively in other reports (*Energy Choices Revisited: An Examination of the Cost and Benefits of Maine's Energy Policy, Mainewatch Institute, Feb. 1994*), and in public presentations and Legislative discussions. The report has been useful and influential in the current round of political debate and decision-making. It was the NRBP annual state grant that made it possible for the Maine State Planning Office to undertake this study, prepare the report, and disseminate its findings.

(biomass) harvesting activities in Maine from 1985 through 1989. This data is instrumental in providing a thorough understanding of harvesting practices and impacts. The published results have been shared with legislative and policy makers.

***Forest Impact Study.*** In addition to a regional NRBP stand damage study project, State grant funds supported a forest impact study conducted jointly by the Maine Forest Service and the Cooperative Forest Research Unit (CFRU). This study of residual stand damage, regeneration, and forest management objectives, published as a CFRU research report, provides additional information about the impacts of biomass harvesting activities on Maine's forest lands.

## END-USE SURVEYS

***Residential Fuelwood.*** NRBP funds were first used to supplement State funds, then to wholly support the annual residential fuelwood use surveys. Almost ten years of survey data were analyzed and published in a 1989 summary report. Results of the last survey conducted (covering the winter of 1990-91) were summarized and released to the public. This survey is not currently being conducted.

***Potential Conversion Candidates.*** A survey of oil-fired licensed boilers was conducted early in the program (1984) to identify potential candidates for conversion to biomass fuels. The results of this survey provided a list of potential candidates for use in ongoing conversion efforts.

## CONVERSION ASSISTANCE

***Cogeneration Feasibility Audits.*** In 1983-84, NRBP funds were used to cost-share cogeneration feasiblity audits for ten likely candidates identified in the licensed boiler survey. Technical questions, declining oil prices, lack of capital, and other factors discouraged further work on these projects.

***Pineland Center.*** Also in 1983-84, preliminary assessments of the potential to convert existing State facility power plants to burn wood led to an active project at the Pineland Center. This was the first project undertaken with NRBP funds and involved multiple agencies and Legislative action to authorize third-party financing of a public facility. In the end, however, these efforts were undermined by falling oil prices and financial difficulties.

## INTERAGENCY ACTIVITIES

***Cooperative Agreements.*** The interagency working committee organized to work on the Pineland project provided early experience in cooperative relationships that have carried through the State's NRBP efforts. In particular, the State's biomass program has entered into several cooperative agreements over the years with the Maine Department of Conservation /Maine Forest Service to support task forces, demonstration projects, surveys and the development of educational materials:

- The Biomass Harvesting Strategy Task Force was organized by the Commissioner of Conservation to address and make recommendations for proper biomass harvesting practices. A report with recommendations was issued in April 1985.
- A Biomass Research Committee was organized by the Commissioner and charged with identifying biomass harvesting related research needs. Their report in 1985 led to two follow-up activities also supported by NRBP funds, a literature search and a feasibility study (see Resource Assessments, above).
- NRBP funds have been used to support biomass harvesting demonstration projects organized by the Department of Conservation and the Maine Forest Service. One project, involving vegetation management and harvesting in the I-95 median, required close cooperation with the State Department of Transportation and Public Safety.
- Biomass harvesting demonstrations on several pieces of public forest lands are available, as self-guided tours, to the public. A biomass harvesting guideline brochure is also available from the Maine Forest Service.

Strong interagency ties contributed materially to the preparation of the recent study of the growth and impacts of the wood-fired electric generating industry in Maine. Agency contacts provided access to data and information, as well as invaluable advice and reviews of report drafts.

***Waste Wood Working Group.*** A multi-agency working group was convened to discuss waste wood issues and potential interagency cooperation. The result was a Waste Wood Seminar designed to address pertinent issues confronting waste managers. This effort forged new working relationships with other state agencies, municipal representatives, and private sector interests on issues related to proper waste wood use.

## CONFERENCES, WORKSHOPS, FORUMS

***Cogeneration.*** In 1986 the Maine Office of Energy Resources provided funding from the NRBP grant to the Northeast Solar Energy Association to support a conference on cogeneration, *Cogeneration: Making the Right Decisions.*

***Waste Wood Processing and Use.*** Working with an ad hoc committee of state agency representatives, a waste wood processing and use seminar was organized, with the support of the Maine Resource Recovery Association. Over 90 municipal officials, waste management authorities, and recycling companies attended the one-day program.

## OTHER

***Biomass Harvesting Demonstrations.*** In the early years of the program, NRBP funds were used to support biomass harvesting demonstration projects, organized by the MFS. In one organized program, "public" biomass harvesting demonstrations were held at three locations across the state. These two-day events, built around an ongoing commercial operation, fea-

tured a half-day session for foresters and a half-day session for the press. In-the-field biomass harvesting demonstrations helped land-owners, foresters, and the public see and understand the specialized equipment involved, the harvesting planning and control required, and the effect of this new type of harvesting on a forest area.

***The Wood-fired Electric Generating Industry in Maine.*** In 1990, the NRBP grant enabled the State Planning Office to undertake a comprehensive study of the State's wood-based power production. A subsequent report documents the role of biomass in the State's regulated utility energy supply, the impacts of biomass harvesting and combustion on the State's forest, air and soil, and the industry's impact on the local economy. The results of the biomass energy industry study have been instrumental in formulating policies in the State's energy planning process. (See sidebar, page 35.)

## Future Trends

Biomass energy will continue to play a vital role in the state energy mix. The desirable consequences of biomass energy development are recognized in the recent Final Report of the Commission on Comprehensive Energy Planning. The Commission adopted a recommendation that includes a statement of support for "the continued utilization and further development, where appropriate, of the State's renewable, indigenous hydro and biomass energy resources." The Commission further recognized "that any significant increase in the harvesting of Maine's forests for biomass must be sustainable over the long term," and called for additional research on soil nutrients, wildlife and land use impacts.

Meanwhile, public attention has focused on the relatively rapid rise in electricity rates, due in part to power purchases from independent power producers, including wood-fired facilities. The combination of low oil prices, the potential for large new supplies of natural gas, and the relatively high cost of wood-fired power challenge the biomass energy industry's ability to compete. One area that shows promise of growth in the near future is the market for compressed wood fuel pellets.

In Maine, the State Planning Office, Energy Division, will continue to support and manage the State's biomass energy planning and development program.

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# MARYLAND

***Forest Acreage:*** 2.7 million acres

***Industrial/Commercial Wood Fuel Use:***

Heating: 70,038 tons/yr

Process: 4,450 tons/yr

***Residential Wood Fuel Use:*** 88,269 tons/yr

***Wood-Fired Electricity Generation:***

Existing: 3 megawatts/yr (1993)

***MSW Resource Recovery Facilities:***

In operation: 3,400 tons/day (March 1992)

***Landfill Gas Recovery Projects:***

Active recovery projects: 3

Candidate landfill sites: 22

Planned recovery projects: 1

## Overview

A variety of residences, businesses, and industries use wood for energy in Maryland. However, due primarily to the warmer climate, relatively low oil, gas, and coal prices, and a less prominent forest products sector, wood energy use is less widespread in Maryland than in many other Northeast states.

Maryland's NRBP state program grant was administered initially by the Maryland Energy Administration (MEA). This responsibility was transferred to the Department of Natural Resources (DNR) in 1985, and returned to MEA in 1992.

## NRBP Supported Activities

### RESOURCE ASSESSMENTS

***Woodfuel Availability Survey.*** In 1984-85, the Department of Natural Resources conducted studies of woodfuel suppliers and woodfuel availability in the state as part of the development of a wood-fired energy system for the Eastern Shore Correctional Facility.

***Waste Wood Survey.*** In 1993, the first project undertaken under MEA auspices was a survey of waste wood materials. Findings were documented in a report, the *Maryland Waste Wood Survey.* Of 400 firms believed to be producing waste wood, a total of 123 firms responded to the survey questionnaire; complete information was obtained on 81 of these companies. Gross waste wood production figures were calculated by weight, adjusted to eliminate moisture content. Subtracting the amount of waste wood consumed, the survey identified a total of 422,408,054 tons of wood waste potentially available as energy feedstock. (See sidebar.)

### END-USE SURVEYS

As part of the follow-up to the Waste Wood Survey, MEA anticipates conducting a statewide assessment of commercial, industrial, and residential woodfuel use. The goal is to match resources identified in the waste wood survey to businesses and residential markets that can use this material.

### CONVERSION ASSISTANCE

***Public School Conversion.*** Faced with increasingly rigorous federal emissions standards, coal-burning schools in Western Maryland are looking for alternatives that can compete with low-cost but high sulfur-emitting coal. Conversion to wood is one option currently being investigated by the Garrett County Public School System, with assistance from MEA. Program staff are also looking into the feasibility of co-firing in existing school facility boilers, an option which would enable schools to continue using local coal, with local wood waste added to the fuel mix to mitigate emissions.

***Guide and Sourcebooks.*** In 1985, Maryland wood energy staff researched and published a guidebook to industrial wood energy equipment. In 1987, MEA produced and published a *Sourcebook for Industrial and Commercial Wood Energy Use in Maryland,* which is still available.

***A Study of Industrial Wood Energy in Maryland.*** NRBP funds have also supported several feasibility assessments in the state, and provided technical assistance to several potential com-

### SURVEY OF WASTE WOOD IN MARYLAND

The largest percentage of Maryland's wood waste is produced on the Eastern Shore. Surprisingly little was found in the western part of the state, while the central counties of Howard, Frederick and Baltimore were found to produce — and consume — a more significant than expected amount of wood waste. Most of the firms currently consuming wood waste in large quantities use it to make mulch or other products with agricultural uses. Small companies report little or no cost disposing of wood waste; it is hypothesized that firms with small amounts of wood waste are able to dispose of it a little at a time in landfills.

A number of county landfills have set aside space for wood waste recovery. The MEA's next survey will attempt to measure the extent of wood waste being landfilled, and also will focus more explicitly on identifying transportation costs associated with waste wood disposal.

Perhaps the most important benefit of this survey was the interest it has created among wood industry businesses, concerning the potential energy benefits of wood waste. The survey project has generated an increasing number of phone calls, putting MEA in the position to act as a broker between companies paying to have wood waste hauled away and companies seeking waste wood materials.

mercial and industrial conversion candidates. In 1984-85, wood energy staff provided an assessment of five industrial energy facilities' potential to convert to wood heating systems.

***Mount St. Mary's Feasibility Study.*** In late 1985, DNR received a two-year grant ($60,000) to perform a study for a boiler conversion at Mount St. Mary's College in Emmitsburg, Maryland. Two reports were produced:

- *Technical and Economic Feasibility Analysis for the Potential Conversion of Coal Boilers to Burn Wood at Mount St. Mary's College (1987);* and
- *Addendum to Wood Burning Feasibility Analysis for Mount St. Mary's College, Emmitsburg, Maryland (1987).*

The first report considered a number of scenarios for burning wood, but a retrofit of the college's coal-burning boiler was ruled out of consideration because the boiler lacked the capacity needed to supply peak loads in cold weather. Replacement of the coal-fired system with a wood-fired system was determined technically feasible; however, the cost of installing a new system proved prohibitive.

***Eastern Shore Correctional Facility.*** Maryland NRBP staff participated in the development of the wood-fired energy plant at the Eastern Shore Correctional Facility. Program staff also helped to publicize the plant once it was built.

#### INTERAGENCY ACTIVITIES

In the mid-1980s, NRBP staff worked closely with the Maryland's Departments of Corrections and General Services in all phases of developing a wood-fired energy plant at the Eastern Shore Correctional Facility, from planning and design through construction and operation. NRBP-supported staff also participated with representatives of over three dozen state agencies in the compilation of a guide to policies and regulations governing Maryland's forest products industry, including the use of wood for energy. (See below.)

Currently, Program staff are working directly with a number of Maryland cities and counties to develop existing or potential conversion and waste water treatment (methane recovery) projects. Other agencies the Maryland's biomass program has worked with include the Department of Environment, with which MEA has a good ongoing working relationship, and the Department of Licensing and Regulations, from which MEA obtained a list of the state's seven licensed wood-fired boiler systems.

#### CONFERENCES, WORKSHOPS, FORUMS

MEA will host a statewide meeting on methane recovery from waste water treatment systems in the fall of 1994. This meeting will build on opportunities identified under the Oak Ridge grant.

#### OTHER

In June, 1990, the State of Maryland released *A Guide to Maryland's Regulation of Forest Products Industries: Energy Conservation, Energy Production and Environmental Protection Through Production and Utilization of a Renewable Resource.* The document covers all the laws, rules, regulations, and policies to which forest products-based enterprises — including wood-fired energy systems — must adhere. It is hoped that this comprehensive guide will encourage and facilitate private sector development of wood energy projects, particularly on the part of the state's forest products industry.

MEA provided funding to the City of Cumberland to investigate the feasibility of cogeneration using methane from the city's anaerobic sludge digester. MEA staff hope to pursue cogeneration at the city's waste water treatment plant, pending the results of a city study to determine how much additional waste water treatment capacity will be required to accommodate new industry. If a second anaerobic digester is required, it will be more cost-effective to build in cogeneration as part of the new construction.

## Future Trends

The development of waste wood markets, co-firing (wood with coal), and methane recovery from landfills and waste water treatment plants offer the most promising opportunities for biomass energy in Maryland.

Co-firing affords a possible means of meeting Clean Air Act requirements without abandoning coal, an inexpensive and local resource. If feasible, this may prove a particularly attractive solution for schools and other small- to mid-sized facilities which cannot afford scrubbers or other pollution-mitigation technologies.

The SCS Engineers' survey of landfills has provided a starting point for an assessment of potential end-users located near sites which have been identified as candidates for LFG recovery. MEA will also continue to pursue methane recovery/cogeneration projects at waste water treatment plants throughout the state.

## NRBP Contact


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# MASSACHUSETTS

***Forest Acreage:*** 3,225,000 acres (64 percent of land area)
***Industrial/Commercial Wood Fuel Use:*** 64,000 tons/yr(1988)
***Residential Wood Fuel Use:*** 220,000 tons/yr
***Wood-Fired Electricity Generation:***
Existing: 18 MW
***MSW Recovery Facilities:***
8 facilities producing 228 MW
***Landfill Gas Recovery Projects:***
Active recovery projects: 1
Planned recovery projects: 9

## Overview

The use of biomass-derived energy has had a mixed history in Massachusetts in the ten-year period since the NRBP's inception. After increasing in the late 1970s and early 1980s, wood-fueled energy has declined in Massachusetts, in all areas of usage: commercial, industrial and residential. Price competition against oil has been a problem, compounded by a "Not-in-My-Backyard" reaction against combustion facilities generally. The one noteworthy exception is KES-Fitchburg's 18-MW plant in Westminster.

By contrast, MSW-fueled energy grew rapidly during the 1980s, peaking at about three million tons per year, or 45 percent of the total tonnage of solid waste generated in the state. This is among the highest percentages of energy recovery from solid waste in the nation. In the 1990s, however, attention has turned to recycling, both as an alternative and as a complement to incineration.

Recovery of biogas from waste water treatment and from landfills has had a spotty history, with moisture in sludge and low prices for the electricity produced proving formidable barriers. This situation is expected to improve for landfills now that new, stricter requirements on control of fugitive emissions are being put in place.

Because of rising opposition to solid fuels in general, the future of biomass-derived energy in Massachusetts lies in extraction and utilization of energy in liquid or in gaseous form.

## NRBP Supported Activities

The Northeast Regional Biomass Program, administered in Massachusetts by the Division of Energy Resources (DOER), has played a significant role in maintaining progress in biomass-derived energy in Massachusetts. NRBP funds half of the program management costs at DOER, leveraging state funds that go directly to grants to municipalities and to feasibility studies of biomass energy concepts. Communicating closely with environmental and forestry groups, DOER has been able to explore ways of ensuring that the extraction of the energy resource from biomass is fully compatible with environmental constraints.

### RESOURCE ASSESSMENTS

***State Energy Plan.*** DOER's recently published State Energy Plan addressed the role of renewables, including biomass, as part of the state's energy resource base.

### END-USE SURVEYS

***Wood Energy Development Program*** (1983-1984). In the first year of the program, NRBP funds supported a survey of 40 conversions to wood energy in Massachusetts.

### CONVERSION ASSISTANCE

***Wood Energy Development Program*** (1983-84). In addition to the survey, activities carried out as part of this program included producing a directory of wood energy information sources and providing technical assistance to 45 firms.

***Wood-fired Furnace at the Massachusetts Correction Institution in Warwick*** (1984-1986). A grant was obtained from the Alternative Energy Property Program (AEPP) to install a hand-fired wood-burning furnace at the institution, serviced by trained prison labor.

***The Fall River Incinerator Retrofit Project*** (1986-1987). This project established the economic and technical feasibility of converting the incinerator to resource recovery.

***Cogeneration at the University of Massachusetts at Amherst*** (1989-1992). DOER succeeded in passing legislation enabling private ownership and financing of a cogeneration pilot project at a state facility. A second bill (not yet passed) would enable the retail sale of electricity from a cogeneration to a host site. DOER completed a feasibility study to quantify the short- and long-term economic and environmental costs and benefits of siting a cogeneration facility on the UMass campus. DOER also funded the services of a legal/financial consultant to develop procedures for contracting within the context of a public/private partnership for cogeneration at a state facility. The project is currently in procurement.

### INTERAGENCY ACTIVITIES

DOER works closely with the Executive Office of Environmental Affairs, its Divisions of Solid Waste Management, Air Quality Control, and Forests and Parks. These close working relationships produced the wood stove test program (in partnership with EPA) and the wood stove public outreach program (with funding and initiative from the Massachusetts Division of Forests and Parks).

***Burn It Clean, Burn It Right*** (1993). This cooperative effort with NYSERDA, CONEG and the Massachusetts Division of Forests and Parks produced a brochure and video in support of new-technology wood stoves.

***Alternative Transportation Fuels Program*** (1989 - present). Working with the Executive Office of Environmental Affairs, the Department of Environmental Protection, and the Department of Procurement and General Services, DOER has carried out a program to convert the Massachusetts fleet of automobiles to alternative fuels. Propane and natural gas were evaluated for their economic and environmental impacts, safety, and "wear and tear". The demonstration program is expected to yield recommendations for converting and replacing portions of the state's fleet of 3,500 motor vehicles.

**CONFERENCES, WORKSHOPS, FORUMS**

***Wood Energy Development Program*** (1983-84). NRBP funds supported a wood energy conversion workshop for forest product firms in Massachusetts.

***Woodstove Workshop*** (1988) in Northampton, MA. This cooperative workshop with CONEG and the Biomass Energy Systems Team (BEST) was directed at purchasers and manufacturers of wood stoves.

***Landfill Gas Recovery Potential in the Northeast*** (1994). NRBP-funded studies of landfill gas technologies and of impediments to extraction have stimulated interest in more advanced and environmentally-beneficial technologies. DOER conducted a one-day forum for members of state and federal government agencies to explore best methods for follow-on work and to evaluate future directions for this work.

## Methane Recovery from Anaerobic Digestion of Sewer Sludge

The Alternative Energy Properties Program (AEPP), funded by a special state bond issue, was established to provide capital construction funds for innovative renewable energy projects. Grants were awarded to projects submitted by the Cities of Springfield ($610,000) and Northampton ($260,000), in 1986 and 1987, respectively. With NRBP providing the funds for grant management, these grants were to be used to design and build cogeneration systems using biogas recovered from anaerobic digestion of sewer sludge.

The Springfield program involved the recovery of methane by one of three newly developed techniques: the "HYAN" process, employed in Toronto's Secondary Waste Water Treatment Plant; a lagoon system developed by ADI Industries of Fredericton, NB; and a fluidized bed combustion process developed by Envirex, a Wisconsin firm. The methane when recovered was expected to provide fuel for cogeneration producing approximately 1,000 kW of electricity. The City of Northampton waste water treatment plant already produced biogas from its anaerobic digestion process, enough to generate 100 kW of electricity for on-site power displacement as well as thermal energy for drying loads.

The two programs were regarded as complementary: one large and one small, thereby affording a comparison of the economics of scale.

Springfield's consultant performed an economic analysis and determined that gas production and utilization in on-site electricity and thermal application would produce a four-year investment payback. In 1988, however, the waste water treatment plant hit an urgent obstacle: the landfill into which they had deposited their sludge could no longer accept it because a new adjacent solid waste incinerator had begun operation. In an effort to preserve the biogas project, Springfield considered the possibility of composting the sludge, but the bids received were unacceptably high. The anaerobic digestion process and the grant were terminated in 1989.

The analysis performed for the Northampton Waste Water Treatment Plant yielded similarly favorable results:

1. Digester gas production was between 40 - 70 SCFM.
2. Digester gas heating value was between 540 - 590 BTU/SCF.
3. With consistent digester operation there would be digester gas produced to fuel a 150 - 200 kW engine.
4. The waste heat from a gas engine generator of this would be adequate to maintain the digesters at the optimum digesting temperature, 95-105 deg-F, and to heat the digester building.
5. Annual savings would run over $90,000 in electricity over $5,000 in digester heating costs.
6. The facility would cost $275,000 for equipment, tions, and installations. Estimated simple pay back was 3.2 years.

Although these results confirmed the economic benefits of putting the anaerobically-produced biogas to constructive use through cogeneration, the Division of Water Pollution Control determined that the landfill was overloaded to the extent that dewatering was insufficient to permit the sludge residuals to be deposited in a landfill (maximum allowable moisture content, 18 percent). As a consequence, the City of Northampton reluctantly terminated the project. After extensive review of dewatering options, the treatment plant reluctantly abandoned its anaerobic digestion process and turned, instead, to the drier sludge process inherent in aerobic digestion.

OTHER

***Potential for Commercial Waste Resource Recovery on State Lands*** (1987). This study identified barriers, potential locations and possible developers, and included case studies of three institutions.

***Methane Recovery of Anaerobic Digestion of Sewer Sludge at the Municipal Waste Water Treatment Plants in Springfield and Northampton*** (1988-1989). These studies, funded under a special state bond issue with NRBP funds used to provide for grant management, confirmed the feasibility and economic viability of methane recovery and on-site utilization. Environmental regulations on maximum allowable sludge moisture content for land filling remain a barrier, however. (See Sidebar, page 41.)

***Feasibility Study Of Waste Heat Utilization*** (1988). This study was undertaken to determine the feasibility of self-fueling with sludge. The analysis concluded that the sludge was too wet for self-fueling unless intermediate drying steps were undertaken.

***Wood Energy Outreach Program*** (1987- present). Opportunities pursued in the course of this ongoing effort have included:

- modifying the prohibition by Department of Environmental Protection against hand-fired wood furnaces;
- examining the potential for co-combustion of wood and coal in the small power production market;
- investigating the potential for using wood energy at the University of Massachusetts, Amherst; and
- assisting the Kenetech 18-MW waste-wood-fired plant development by expediting an easement process.

***Resource Recovery from Municipal Solid Waste in Hull*** (1989). This program confirmed the growing "NIMBY" sentiment in Massachusetts, a major obstacle to new resource recovery (and other combustion-based) projects.

## Future Trends

Both the Springfield and Northampton programs described above serve to illustrate the point that energy recovery from waste products cannot proceed successfully without better understanding and proper accounting for the environmentally and beneficial disposal of liquid and solid, and, indeed, wood wastes. DOER believes that accounting for the environmental fallout of any of NRBP's waste recovery projects must accompany future projects sponsored by the NRBP.

Given rising opposition to the direct combustion of solid fuels in general, the future of biomass-derived energy in Massachusetts appears to lie principally in extraction and utilization of energy in liquid or in gaseous form.

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# NEW HAMPSHIRE

***Forest Acreage (acres):*** 5,021,000
***Industrial/Commercial Wood Fuel Use:***
1,519,600 (green chip) tons/yr*
***Residential Wood Fuel Use:*** approximately 600,000 tons/yr
***Wood-Fired Electricity Generation****
Existing: 129 megawatts
***MSW Resource Recovery Facilities****
In operation: 3 facilities generating 18.7 MW
***Landfill Gas Recovery Projects***
Active recovery projects: 2
Candidate landfill sites: 6 *1992

## Overview

New Hampshire's land and climate encourages forest growth. The state is over 87 percent forested today, up from the estimated 60 percent forest cover of the late 19th and early 20th centuries, when farming (especially sheep farming) resulted in a much more open landscape. During the intervening years the forest has grown back, but without benefit of good forest management the economic value of the timber has been limited.

In the late 1970s and early 1980s, public policy decisions at the state and federal level, along with economic opportunities, encouraged the biomass industry in New Hampshire. As a result, low-quality wood is now harvested and converted into more than a million tons of marketable chips annually, used to produce 10.4 percent of the state's electricity. Substantial benefits accrue to the forest products industry, the third largest industry in the state. The market for the low quality wood provides an incentive for good forest management practices that directly increase the value of the timber. Studies conducted in 1991 and 1993 found that the established biomass energy industry contributes over $282 million to the New Hampshire economy, in addition to reducing dependence on imported fuel.

## NRBP Supported Activities

In New Hampshire, the Regional Biomass Program is carried out by the Governor's Office of Energy and Community Services (ECS). The ECS staff responsible for the NRBP state program is a visible and accessible liaison, able to forge direct links within state government, and between the state and the Regional Biomass Program, to the benefit of biomass energy development.

### RESOURCE ASSESSMENTS

The New Hampshire Timberland Owners Association (NHTOA) received NRBP funding through ECS to determine the source of wood chips used in the wood-fired power industry. NHTOA now tracks this data on a quarterly basis.

### END-USE SURVEYS

Since the inception of the NRBP, ECS has tracked residential wood use trends through a random survey of households from around the state. Conducted annually, the Fuel Use Survey data showed that 30 percent of those surveyed used wood as a primary source of heat in 1984. The 1993 Survey found that only 13 percent of households were using wood as a primary heating fuel. Declining oil prices are considered to be a determining factor accounting for this trend.

### CONVERSION ASSISTANCE

NRBP funding has made possible the presence of a knowledgeable and accessible staff person available to respond to inquiries and requests for information from industry as well as from ECS and other public agencies. During the 1980s, when numerous companies were filing applications to build energy plants in New Hampshire, biomass program staff played a key role in responding to industry inquiries and processing applications.

ECS has established strong working relationships with industry. The New Hampshire Independent Power Producers Association co-funded with ECS the 1991 study, *The Wood-Fired Electricity Industry in New Hampshire*, and a 1993 update of this study. The Independent Power Producers Association also co-funded another study, the *Re-assessment of Biomass Harvesting on Small Woodlots in New Hampshire and Evaluation of Whole Tree Harvest Operator Economics.*

### INTERAGENCY ACTIVITES

Over the course of the years, the biomass program manager has participated in a variety of interagency committees, including the Forest Data Committee, the Forest Energy Advisory Board, and the Energy Facility Siting Committee. The ECS also utilizes the data and expertise of the biomass program manager to respond to inquiries from the press and the Legislature, as well as to provide information to the executive branch as needed.

### CONFERENCES, WORKSHOPS, FORUMS

NRBP funding has made possible a wide range of workshops and public information activities and events. Workshops have targeted specific industries (e.g., Wood Conversion for Motels and Inns) and conversion technologies (Cogeneration and Wood-fired Conversion). The New Hampshire Association of Chimney Professionals works with the ECS to offer such educational opportunities for the public as its statewide series of Chimney and Woodstove Safety Workshops.

In addition, the ECS has provided public exhibits for state agricultural fairs and the Made In New Hampshire Expo, and made lecture presentations to schools and professional groups. ECS has also used NRBP funding to sponsor events such as Wood Energy Day and a Wood Energy Festival co-sponsored with the New Hampshire Independent Power Producers Association. State program (ECS) staff have participated in the First Biomass Conference of the Americas and in forums such as the Bedford Wood Pellet Forum, and in the advancement of regional projects such as the Burn Wood Right Campaign and Clean Heat Exchange program.

### OTHER

Tours of New Hampshire's biomass industry have been arranged for international visitors and others from North America as requested. For example, ECS accompanied the Associate Deputy Minister of Energy and Resources for the Government of Quebec on a tour of Bio Energy's nine-megawatt wood-fired power generating facility in West Hopkinton.

## Future Trends

The biomass industry has been and will continue to be greatly affected by the economics of energy. Since the inception of NRBP funding, oil prices have dropped, in contrast to the forecasters' expectations in the early 1980s that prices would continue to increase. As a consequence, interest in wood conversion has been low.

Wood-fired energy has come under close scrutiny due to the excess of electricity being produced at lower costs from conventional or nuclear fuel. The future role of biomass energy will be greatly determined by the outcome of state policy being formulated by the New Hampshire Legislature, the PUC, the industry itself and the Governor, who is committed to the viability of the industry.

## NRBP Contact


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### PUBLIC OUTREACH: AN EFFECTIVE TOOL IN NEW HAMPSHIRE

The New Hampshire Biomass Program in recent years has forged public and private sector links to inform and educate the public about the practical applications of biomass energy. The NRBP's state program grant, in combination with Petroleum Violation Escrow Account (Oil Overcharge) funds, has enabled the Governor's Office of Energy and Community Services (ECS) to support the efforts of the New Hampshire Independent Power Producers Association (NHIPPA) and the New Hampshire Association of Chimney Professionals in familiarizing the general public with wood energy applications that affect their lives — from residential wood stoves to wood-fired power plants.

Wood Energy Day and Wood Festival Day grew out of NHIPPA's efforts to better acquaint the public with wood-fired electricity production. Wood Energy Day was held during Energy Awareness Month in 1991 and 1992. Nine participating wood-fired power plants in different parts of the state were open to members of the public, giving people an opportunity to tour the sites and bringing home the fact that over 10 percent of the state's electrical energy is produced from trees. Each plant took a different approach to welcoming the more than a thousand visitors who turned out. ECS helped NHIPPA to coordinate these successful events.

The 1993 Wood Energy Festival grew out of the success of the Wood Energy Days. NHIPPA gathered sponsors, including ECS, to host a carnival-like open house at the Bridgewater Power Plant. Food, games, and amusements were available to visitors, while vendors were on hand to demonstrate products and services, from wood-cutting to pellet stoves. Special demonstrations included a lumberjack show and simulated chimney fires — the latter put on by the New Hampshire Association of Chimney Professionals, which aggressively pursues public education about proper chimney maintenance. The impressive array of activities took place against the backdrop of a wood-fired power plant.

In addition to these events, the Biomass Program in New Hampshire has leveraged Oil Overcharge monies to conduct regular outreach as part of coordinated Fall and Spring media campaigns. A special advertising rate set through a contract with the New Hampshire Association of Broadcasters provides ECS with access to airtime on over 30 radio and three television stations by means of 60-second radio and 30-second TV spots. The multi-week campaigns are used to provide messages to the public on a variety of topics, including biomass. TV and radio ads were developed, for example, to focus on wood stoves and chimney safety and awareness, a critical public safety issue.

Print media also have been used extensively to promote the Chimney and Woodstove Safety Awareness Workshops offered jointly by ECS and the New Hampshire Association of Chimney Professionals. The workshops provide a unique opportunity for novice stove users, home inspectors, and fire department officials to receive hands-on exposure to residential wood stoves and the proper use and maintenance of stoves and chimneys.

# NEW JERSEY

*Forest Acreage:* 2 million acres
*Industrial/Commercial Wood Fuel Use:* 65,000 tons/yr
*Residential Wood Fuel Use:* 1.5 million tons
*Wood-Fired Electricity Generation:* 0 megawatts
*MSW Resource Recovery Facilities:*
In operation: 6,600 tons/day
Under construction: 1,000 tons/day
*Landfill Gas Recovery Projects:*
Active recovery projects: 5
Candidate landfill sites: 20
Planned recovery projects: 5

## Overview

Although New Jersey has large areas of developed land, 42 percent of the land area remains as forests. The mix of developed areas and forest lands provides substantial opportunity for residential wood energy use. During the 1970s and early 1980s there was a substantial increase in the amount of fuelwood used by residences. Although these increases have waned due to relatively low fossil fuel costs, residential fuelwood use remains at approximately one million cords per year.

Industrial wood energy has found application primarily within the state's secondary wood processing industry. Existing industries that have already converted have collectively invested over $3 million in system equipment and realized disposal savings of over $2 million per year as a result of conversion. This has helped these firms to remain competitive in a difficult economy. Moreover, in addition to generating lower cost energy, these conversions have diverted over 30,000 tons of wood waste annually away from landfills and to productive use.

Commercial wood energy continues to hold great promise in New Jersey. Recent recycling initiatives and solid waste regulations have encouraged the diversion of woody biomass, which in the past had been landfilled, to recycling centers throughout the state. Stumps, tree parts, demolition wood and used pallets now finding their way to recycling centers are processed into ground wood products. Markets for these recycled materials however, fall far short of the approximately 6,000 tons/day production. Commercial wood power remains a great opportunity for productive use of these materials, but although several specific projects have been proposed, local approval remains a barrier to date.

## NRBP Supported Activities

### RESOURCE ASSESSMENTS

***Residential Fuelwood Assessment.*** This survey was conducted to develop statewide detail of residential fuelwood use, including statewide, regional and county statistics, combustion system information and fuelwood supply information. The survey has provided base statistics on fuelwood use, trends and market information for suppliers.

***Pitch Pine Fuelwood Evaluation Study.*** This analysis was conducted as a cooperative effort between the Northeast Regional Biomass Program, the New Jersey Bureau of Forest Management and Rutgers University. The project analyzed pitch pine, an abundant and common tree species in southern New Jersey, for its heating value, burning characteristics, processing and supply considerations in addition to its fuelwood characteristics as compared to red oak. The study helped encourage fuelwood market opportunities for this drastically underutilized species.

***Secondary Wood Residue Assessment.*** An assessment, completed in cooperation with New Jersey Department of Energy and NRBP, inventoried wood residue production within the state's secondary wood processing industry, which manufactures finished wood products. The study collected data on the production of cut offs, rippings, sawdust, hogged wood and chips produced as residues through processing. The study provided detail which has served as a guide for individual wood energy conversions and also as a collective feed stock raw material for large scale conversion.

***Wood Energy Feedstock Assessments.*** Continuing assessments and contact is made through program efforts with the state's wood recycling industries. Stump grinding facilities, pallet grinding companies, demolition wood, whole tree chips and other processed wood suppliers are in regular contact as potential commercial wood power feedstock sources. Production and supply data is maintained including equipment, company contact and delivery detail. This data will ultimately serve, through program efforts, as supply information to promote large scale wood energy conversion.

### END-USE SURVEYS

Since 1983 approximately 28 New Jersey businesses have installed equipment to convert wood to energy. To a large degree these businesses are secondary wood processors which have utilized wood energy technology in helping reduce wood disposal costs. Although no formal survey has been conducted we continue to maintain contact with many of these businesses in addition to out-of-state wood energy facilities utilizing wood fuel suppliers from New Jersey sources.

### CONVERSION ASSISTANCE

Many of the industrial wood energy applications in New Jersey have been brought about through the state's NRBP program information, guidance, consultant referral and support. New Jersey has approached the promotion of biomass energy

applications not only from an energy standpoint but also as a way to help wood products businesses develop productive uses for the wood residues they generate.

Businesses manufacturing finished wood products have shown interest in wood energy largely in response to wood waste disposal fees. Wood energy applications have helped companies defer these costs and productively utilize wood waste materials generated through processing their finished products.

Although assistance is still available to promote industrial scale conversions, the business climate has not been good for wood products manufacturers and business generally has not been willing to invest capital in wood energy systems. Larger industries with wood residue production sufficient to generate wood-to-energy interest have already converted. Additional industrial-scale conversion opportunities exist among borderline-sized facilities and for large non-wood industries; however, those industry groups require an increase in fossil fuel costs to trigger active interest in conversion to wood.

Commercial wood power production in New Jersey has had a difficult past but a brighter future. Six large scale commercial wood power proposals have been addressed through the state biomass program effort. Our work supplying feedstock source guidance has shown adequate quantities of biomass available in each instance, but low utility buy-back rates and local siting approval have proven major stumbling blocks which none of the independent power producers have overcome to date. This scenario has improved somewhat recently, and with biomass feedstock supplies continuing to be abundant, wood-fired power may yet become part of the state's electric supply mix.

### INTERAGENCY ACTIVITIES

The state biomass program contact has been selected to serve on the state's Emergency Debris Management Task Force, which includes representatives of seven state departments and two federal agencies. The purpose of the group's effort is to propose modifications to the state's Emergency Response Plan that provide for management and disposal of debris generated from catastrophic natural disaster. As a result of knowledge and expertise gained through biomass program work, contacts and wood processing/reduction capability information, the biomass program coordinator will aid in this task force effort to plan for the woody component of natural disaster debris. This assistance will include large-scale wood collection, transportation and processing capabilities guidance on both local and statewide levels.

The biomass program coordinator also participates on a Biofuels Development Working Group. An Alternate Fuels Demonstration Project is presently in progress. One demonstration involves the use of soy or biodiesel as a vehicular fuel. The New Jersey Department of Transportation is currently testing this soy-based diesel fuel additive with positive results in both emissions and mileage.

### CONFERENCES, WORKSHOPS, FORUMS

In addition to regularly participating in biomass conferences and workshops to learn about changing biomass issues and technologies, New Jersey's NRBP program coordinator served on the planning committee for the Wood Energy and Recycling Training Course for state and federal foresters, held in 1992. The four-day training course, funded jointly by the U.S. Forest Service and NRBP, provided forestry specialists from throughout the Northeast with in-depth training on wood energy systems, emissions, policy issues, processing equipment and wood fuel procurement. In addition to increasing participants' knowledge and capabilities, the conference helped to create a functional partnership between state forestry and energy personnel in the region.

## Future Trends

Biomass energy in New Jersey will likely show increased application across residential, industrial and commercial sectors. Wood feedstock supplies available to fuel large-scale industrial/commercial opportunities have never been greater in the state. Recycling initiatives now in place have diverted considerable quantities of clean wood waste from landfills to recy-

### PROMOTING CO-FIRING IN UTILITY POWER GENERATION

An effort has begun to develop the co-firing of wood and coal in one of New Jersey's utility power generating stations. NRBP staff have organized several meetings with utility personnel, the New Jersey Bureau of Forest Management, and private industry representatives. The state's biomass program manager has arranged site visits for utility officials at in-state wood recycling facilities and have developed feedstock supply sources sufficient to meet the needs of the co-firing project.

The intended application involves one 50 MW pulverized coal-fired station. Cofired with wood at a 20 percent wood/coal ratio, the station would require wood at the rate of 15 dry tons per hour. If successful, the project will improve emissions, lower fuel costs and create a large continuous market for recycled wood. This market will be a great benefit to wood recycling industries in New Jersey.

Collectively, New Jersey utilities utilize over 1,200 MW of coal fired power production. Although this coal use represents a small percentage of its over 17,300 MW total capacity, wood/coal co-firing still represents a significant opportunity, one which will generate a broad range of benefits to the environment, the utility, and to the state's wood recycling enterprises.

cling facilities around the state. These facilities, processing tree stumps, used pallets, clean demolition wood and other wood materials have produced marketable materials from these previously wasted resources. Production of chips, grindings and hogged wood from these raw materials, however, far exceeds existing outlets. Wood energy is a productive outlet for these materials that could generate a viable market.

The future of large-scale industrial and commercial biomass energy is bright, not only from the standpoint of available feedstocks but also from the anticipated turnover of existing plant capacity. By the year 2000 almost one-third of New Jersey's installed utility capacity will be approaching or exceeding its service life. As the utility sector plans for the future of these facilities, the great quantity of wood feedstock available for energy application may prove to be an alternative to existing fossil fuel use, either as a primary fuel or as a co-firing option.

The advantages of residential wood heat have long been realized by the citizens of New Jersey. Residential use of firewood throughout the state continues to exceed one million cords per year. Despite relatively mild winters and low fossil fuel costs, homeowners have maintained a steady interest in supplementing their home heat with the warmth of wood. At a minimum, this trend is likely to persist; any rise in fossil fuel costs is apt to generate an increase in homeowner firewood use.

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# NEW YORK

***Forest Acreage:*** 18.5 million acres
***Industrial/Commercial Wood Fuel Use:*** 3 million tons/yr (1988)
***Residential Wood Fuel Use:*** 2 million tons/yr (1989-90)
***Wood-Fired Electricity Generation:***
Existing: 39 megawatts (1994)
Proposed/in development: 61.5 megawatts
***MSW Resource Recovery Facilities (figures as of Sept. 1992):***
In operation: 7,897 tons/day
Under construction: 1,150 tons/day
Planned: 17,330 tons/day
***Landfill Gas Recovery Projects:***
Active recovery projects: 16
Candidate landfill sites: 45
Planned recovery projects: 2

## Overview

New York is a diverse state, ranging from urban New York City to the rural and wild Adirondack State Forest preserve. Wood energy use varies around the state. Overall, there are an estimated 700,000 residential wood stoves in use, three wood-energy independent power producers, numerous industrial-scale wood energy users and one utility that cofires wood and coal. With over 60 percent of the state forested and an enormous quantity of waste wood generated each year, New York State is only beginning to realize the opportunities wood energy provides. Some of the driving forces behind increasing the amount of renewable energy in New York include:

- New York must import almost all of its fossil fuel supplies to generate electricity. The State spends $16 billion annually on out-of-state energy sources, and forecasts show an increasing reliance on oil imports.
- New York has many old (45 years) fossil-fueled power plants. With the Clean Air Act Amendments going into effect and other uncertainties entailed in extending the useful life of these plants, a large number of these plants may need to be retired and replaced with "clean" supply in the relatively near-term.
- New York will see a decrease in the percentage of total electricity supplies provided by indigenous renewable resources over the next 20 years without actions to avert the present trend.

The New York Public Service Commission is considering a settlement reached between the electric power utilities and other stakeholders to acquire 387 megawatts of new capacity from renewable resources by 1998. Wood is proposed to be the feedstock for 96 megawatts. The Energy Authority's Biomass Office has been instrumental in securing this commitment, providing information, advocating at meetings, and aggressively promoting a role for biomass energy technologies.

Opportunities for biomass energy exist beyond the production of electricity or steam. Replacing petroleum derivatives with materials derived from indigenous biomass can result in tangible energy savings to the State. Also, the creation of a biomaterials industry would result in new jobs and regional economic development. In addition to the potential to reduce net contributions to atmospheric $CO_2$ through sustainable biomass use, some end biomaterial products, such as substitute road deicers and fuel additives, are specifically targeted to have a beneficial impact on the environment.

## NRBP Supported Activities

The Energy Authority directs NRBP activities in the state, in association with the State Energy Office (SEO) and the Department of Environmental Conservation (NYSDEC). The Energy Authority supports a wide range of research activities in the biomass area. Many of the projects are in cooperation with the Northeast Regional Biomass Program. The regional effort provides a communication link to similar activities in neighboring states and across the nation.

### RESOURCE ASSESSMENTS

***Geographic Information System Development.*** A computer-based geographic information system (GIS) was developed to estimate quantities of wood growing in any user-specified region of the State. The project involved the establishment of forest growth zones, or areas where given ecological conditions result in similar rates of growth; the development of a geographic reference system to allow for the location of the specific area of interest; and integration with the forest survey work of the U.S. Forest Service to provide estimates of growth for a point of interest. The geographic reference system allows for reliable, statistically valid estimates of biomass supply.

A model was developed and tested by staff of the NYSDEC forest resources group. One task of this unit at NYSDEC is to provide wood-using industries (including energy facilities) with estimates of the types and quantities of wood available. The conventional way of doing this involves evaluating reports prepared on a county-by-county basis into a reasonable woodshed for the industry. The GIS accomplishes this in a matter of minutes versus hours.

***Integrated Waste Management Computer Planning Model: WastePlan.*** The model provides a broad assessment of the energy implications of alternative integrated waste management systems, and estimating the energy used, saved or produced per ton of waste processed by the five major methods of managing solid waste: reduction, recycling, composting, incineration with ener-

gy recovery, and landfilling. The project compared energy savings for recycled and virgin materials processing, and determined the location where these savings actually occur. Three case studies were conducted to improve the energy efficiency associated with recycling processes. Finally, an analysis will be conducted of the energy implications due to cross media pollution generated by various waste management technologies.

***Impact of Whole-Tree Harvesting on Forest Soils in the State.*** Increasing demands on the forest resource base require careful management of harvesting practices. A literature survey and analysis was performed by the College of Environmental Science and Forestry in Syracuse to determine possible negative impacts of whole tree harvesting. Their conclusion was that with proper consideration of the soil conditions, whole tree harvesting techniques will have minimal negative impacts on the ecosystem. This information has been used by NYSDEC to prepare a generic environmental impact statement on whole-tree harvesting operations in the state.

***An Analysis of Energy-Intensive Materials from Wood.*** Wood can be used for more than the production of electric power and heat. An analysis was performed by Rensselaer Polytechnic Institute to evaluate the state of the art in wood materials and revisit many of the concepts developed over the past 10 years. A computer spreadsheet model was also developed to aid in the economic evaluation of some of the more promising systems.

## END-USE SURVEYS

***Residential Wood Stove Survey.*** Residential wood stoves account for a significant portion of the wood energy demand in New York. The College of Environmental Science and Forestry conducted a residential wood survey for 1989 to update the one from 1981. The results of the survey indicate that the use of wood for heating residential homes has declined. The primary growth area has been on Long Island, where stoves are being used for supplemental heating.

## CONVERSION ASSISTANCE

***Wood Energy Advisory Service to Industry.*** The State Energy Office manages an extensive industry outreach program. With the assistance of the NRBP, SEO advisors received specialized training in wood energy issues. Over a three year period, the advisors conducted surveys at 87 sites and prepared feasibility studies detailing energy options appropriate for each facility.

***Wood Products in the Waste Stream: Characterization and Emission Testing Protocol Development.*** The possible environmental impact of global warming has refocused attention on the generation of energy from renewable resources. Wood offers the potential to become a major feedstock for the production of base-load electric power. Old pallets, crates, and demolition debris represent a renewable resource currently being disposed of at a cost. Prompted by the findings of the NRBP's 1987 Waste Wood Survey, the Energy Authority organized a consortium of federal and state organizations, including the NRBP, to investigate the emission characteristics of burning waste wood. This research provides sound technical information for environmental regulatory agencies to use in evaluating wood combustion facilities.

## INTERAGENCY ACTIVITIES

A Renewable Resources Working Group was established by the State Energy Office in 1993 as a forum for the exchange of ideas and the identification of needs. Energy Authority participation offers the opportunity to educate various state agencies in the opportunities of renewable energy and to pass along the latest information from the NRBP and other USDOE programs.

## CONFERENCES, WORKSHOPS, FORUMS

***Residential Wood Stoves: Lessons Learned.*** This project was designed to provide the "front line" of the wood stove market with the fruits of several years' research co-sponsored by the Regional Biomass Programs, the Energy Authority and others. The New York State Energy Office operated an 800 "Hotline" number to field inquiries generated by the multi-pronged media campaign, and to distribute copies of brochures and instructional videos. (See"Applied Research" section for further details on the Residential Wood Stove research and consumer education projects.)

***Wood Combustion Emissions Workshop.*** Following completion of the NRBP/Energy Authority-led project on the combustion of waste wood, the Energy Authority designed a workshop to bring together the New York State regulatory community, utilities, independent power producers, environmental advocacy groups and energy planners to discuss the results of the study and to identify additional questions and concerns. A pre-workshop questionnaire was developed for workshop participants to identify and comment on key issues. The workshop provided a useful forum for participants to voice opinions in a non-adversarial manner.

***Targeted Scoping Sessions.*** The programs of the Energy Authority and the NRBP address some of the more complicated and pressing issues of the day. To generate better understanding of these issues and to open lines of communication among all stakeholding groups, the Energy Authority has held a number of interactive and facilitated workshops. Topics covered have included: wood combustion and emissions, the conversion of industrial waste streams into high-valued fuels and chemicals, and the environmental and energy pressures on the pulp and paper industry of New York. Each workshop has brought together representatives from the governmental agencies with regulatory and policy responsibilities; researchers who may have solutions to the issues at hand; and, most importantly, representatives from industry and the private sector.

### Wood Products in the Waste Stream

New York State contains a resource base of waste wood adequate to generate between 400 and 800 megawatts of competitive electric power. In an era of decreasing landfill space and an increasing demand for imported energy, waste wood offers a unique opportunity to generate renewable power.

The waste wood opportunity was first established through the efforts of the Northeast Regional Biomass Program. Following a region-wide resource assessment, New York conducted an intensive, state-specific survey. The results were surprising. With an adequate resource base identified, why was waste wood not being used as a feedstock?

Environmental regulators were concerned that, as a waste product, these materials could have undesirable environmental impacts due to contamination. Regulators were therefore reluctant to issue the necessary permits for power plant construction.

To fill in the missing information on the extent of contamination and possible environmental impacts, the Energy Authority designed a project which was expanded to include eight states and New Brunswick. Financial support was provided by the Energy Authority, the Regional Biomass Program, U.S. EPA, Canadian Department of Energy, Mines and Resources, and the State of Virginia. The results from the "Wood Products in the Waste Stream" project have been disseminated to over 700 companies and numerous others through conferences and journal articles. (See next section for detailed project description.)

## Future Trends

The relatively low price of oil and natural gas, coupled with an over supply of electric power in New York, has made it difficult to promote wood energy in recent years. Important new driving forces have become the environment and the economy. New York imports over 92 percent of its primary energy. Keeping those dollars in the state would have important economic implications. The public is also pushing for energy production on a renewable, sustainable basis. Wood is the only resource available to us that offers the potential to produce large, base-load quantities of power. With the utilities agreeing to procure an additional 96 megawatts of wood power, we have the unique opportunity to bring state-of-the-art technology into the state and demonstrate the positive role wood can play.

Biomass includes more than wood. Just as we focused on the use of waste wood, we will start to draw attention to the availability and potential of industrial organic waste streams.

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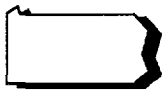

# PENNSYLVANIA

***Forest Acreage:*** 17 million acres
***Industrial/Commerical Fuel Use:*** 850,000 tons/yr
***Residential Wood Fuel Use:*** 3 million tons/yr
***Wood-Fired Electricity Generation:*** 75 megawatts
***MSW Resource Recovery Facilities:***
In operation: 4,658 tons/day
Under construction: 2,800 tons/day
Planned: 1,844 tons/day
***Landfill Gas Recovery Projects:***
Active recovery projects: 8
Candidate landfill sites: 52
Planned recovery projects: 1

## Overview

Pennsylvania's landscape is dominated by forests. A total of 17 million acres or about 59 percent of the State is covered by forests. Among the most popular and traditional benefits Commonwealth residents derive from the forest is wood for fuel.

Pennsylvania is also characterized by many large urban areas. Despite the heavy demands this large population places on the state's natural resources, the number of forested acres in Pennsylvania has increased since the NRBP program began in 1983. With the increase in timbered acres has come an increase in biomass volume, especially in the larger trees. Between 1978 and 1989, volumes of all species increased 19 percent. Pennsylvania has more hardwood growing-stock than any other State, with hardwood species accounting for 91 percent of timber volume.

While the use of firewood for home fuel has declined in recent years, it remains popular. Wood pellets have begun to gain in popularity as well. The "chicken-or-egg" situation which prevailed for many years — retailers couldn't sell pellets or other densified fuels until they were steadily manufactured, manufacturers couldn't establish pellet production until a market was established — recently has been overcome. Two wood pellet plants are now generating and distributing fuel pellets in 40-pound bags, and another plant manufacturers a waxed firelog and fire starter.

Industrial and commercial wood energy use increased during the last decade and continues to do so, especially among those industries producing wood residues. Perhaps the harsher winters experienced in Pennsylvania in recent years have influenced this trend. Initially, interest in wood energy was due to instability in foreign fuel markets and the lower cost of wood compared to oil, gas, and coal. Increasing costs of waste disposal and the threat of landfill closures have added to this interest in wood energy. As biomass technologies develop, wood energy conversion costs decrease, thereby attracting more industrial and commercial applications.

## NRBP Supported Activities

NRBP activities are co-directed by the Department of Environmental Resources-Bureau of Forestry and the Pennsylvania Energy Office. The Program is outreach-oriented, emphasizing the identification of opportunities for industrial and commercial wood energy uses, and providing technical assistance to biomass users.

### RESOURCE ASSESSMENTS

Sawmills and secondary wood processors have been surveyed to establish a directory of wood residue producers available to supply fuels for wood energy projects. A guide titled *Best Management Practices for Wood Residues* was published to address problems associated with handling and storing wood residue for energy use.

### END-USE SURVEYS

In 1981, approximately 1.2 million households in Pennsylvania burned wood. Although no more recent residential woodfuel use survey has been conducted, state energy staff believe that residential use has declined approximately in half since the early 1980s due to declining oil and gas prices.

### CONVERSION ASSISTANCE

In addition to offering industrial wood energy and boiler efficiency workshops, Pennsylvania's Wood Energy Specialist also performs feasibility studies and provides direct assistance to projects. Examples include the installation of the first wood-fired cogeneration project in the state, a wood-fired conversion at a state hospital, installation of a wood boiler at the largest commercial greenhouse in Pennsylvania, and the installation of a wood boiler in a new junior/senior high school. Fuel shortages during the severe winter of 1993-94 have prompted another greenhouse in northeastern Pennsylvania to consider wood as a primary heat source. Their successful conversion will preserve a $500,000 inventory of greenhouse orchids during the next mid-winter rolling blackout.

Other NRBP-supported activities have included a presentation on wood energy district heating opportunities for the Clarion Industrial Development Authority, and tours of Pennsylvania wood-burning installations.

Pennsylvania participated in the review of a *Wood-Chip Heating Guide*. Together, the Guide and video make an effective and powerful strategy to encourage decision-makers to invest capital and install new institutional and commercial biomass energy systems. For example, a non-profit organization in southern Pennsylvania anticipates using tree-trimming waste in a dis-

trict-heating system designed to heat a low-income housing project being planned for migrant workers employed to work in apple orchards.

### INTERAGENCY ACTIVITIES

Pennsylvania's Wood Energy Specialist, responsible for coordinating NRBP activities in the state, occupies an interagency position, working part-time for the Department of Environmental Resources-Bureau of Forestry and part-time for the Pennsylvania Energy Office.

The Program cooperates with other government programs. One of these is the Northeast Utilization & Marketing Council, which promotes efficient and environmentally sound conversion of forest products to desirable goods and services, including wood energy conversion projects. Sponsored by the U.S. Forest Service and supported by representatives from the twenty states in the Northeastern Area, the Council provides the NRBP opportunities to inform the public of the social and economic benefits derived from wood residue not as a waste product but as a co-product of our wood utilization industry.

### CONFERENCES, WORKSHOPS, FORUMS

Program staff have conducted presentations and workshops focusing on the safe storage, use, and marketing of wood residues.

The Program has offered industrial wood energy workshops and boiler efficiency workshops. Among the target audiences for the wood energy workshops have been energy engineering firms. They continue to play a big role in advising institutions such as schools and hospitals on whether and how to convert to wood-burning systems.

### OTHER

NRBP funds have been used to research opportunities for composting wood chips with manure and have produced and made available videotapes from a series of industrial wood energy slide shows prepared by the NRBP. Currently, work is underway to produce another video on wood-energy conversions and success stories not only in Pennsylvania but also other NRBP States. This product will be used by the North Region States to encourage other commercial, industrial, state facility, and school wood-energy successes.

The Program continues to expand as it investigates other forms of biomass. *The NRBP's Implementation Guide for Landfill Gas Recovery Projects in the Northeast* has sparked interest within Pennsylvania, resulting in inquiries and long-range planning by some landfill operators. Three recent proposals have been reviewed for the Pennsylvania Energy Development Authority. If selected, landfill operators would receive funding to develop their proposed landfill gas recovery project. There are 30 landfills in Pennsylvania that meet the criteria for potential gas recovery, and eight landfills that are successfully recovering their bio-gases.

## Future Trends

Industrial and commercial use of wood energy is expected to continue increasing in Pennsylvania. In the near future other biomass fuels will be used for clean energy production.

Co-firing wood with coal at utility plants may find renewed interest as these energy utilities strive to meet air quality standards and improve the Btu contents of their fuels. With landfill space at a premium, refuse-derived biomass pellets will become an integral part of that co-firing technology.

Wood pellet use should expand in Pennsylvania. Two plants successfully produce pellets and have improved the market for Pennsylvanians. If the Northeast experiences more "old fashioned" winters, and as Pennsylvanians continue to demand clean efficient home heat, wood pellet use should continue to increase as well. New pellet burners, low ash content, cleanliness, long burn, and the increased availability of pellets add to the attractiveness of this residential fuel.

Landfill Gas (LFG) recovery is a clean, alternative energy application expected to increase as air quality standards are enforced. There are currently eight landfills capturing methane and using it to generate electricity in Pennsylvania; however, 30 more landfills meet criteria to be considered candidates for LFG recovery facilities.

Pennsylvania will continue to reclaim its stripmines. Switchgrass, a warm-season grass, offers great potential for these reclamation sites. Its thick rootstock provides tremendous erosion control and humus buildup. More importantly, however, is the exciting opportunity Switchgrass has as a biomass fuel for hydrogen fuel cell technologies. Initial developments have begun to examine large plantings of the C-4 perennial on reclamation

### THE PENNSYLVANIA WOOD RESIDUE DIRECTORY

*The Pennsylvania Wood Residue Directory* was updated in 1993, listing the kinds and amounts of wood residue available from sawmills and secondary wood processors in Pennsylvania. This assessment assists companies or institutions and their energy consultants to procure a steady supply of sawdust, shavings, chips, or chunkwood for their wood-fired systems. It is funded by the NRBP through Pennsylvania's Wood Energy Program. Additional residue information comes from the Pennsylvania Marketing Bulletin and the Timber Drain Study co-sponsored by the Bureau of Forestry and the U.S. Forest Service, respectively. Here exists a strong network to provide updated information on Pennsylvania's forest products industry.

The Residue Directory continues to be the primary tool-of-choice in each wood-energy inquiry and promotional activity. It is an excellent example of government agencies leveraging funds to produce a multipurpose tool that reaches beyond initial program objectives.

sites, hoping eventually to use them as dedicated feedstocks to operate fuel cells.

Presently, there are fewer than a half dozen fuel cells in operation in Pennsylvania. These have been established in the last couple of years and are supplied by natural gas. Switchgrass provides an opportunity to utilize biomass in this rapidly developing technology. This promises to be not only a form of clean alternative energy, but also an opportunity for agricultural and rural economic development. There is a need to establish corridors of this biomass along river drainages to effectively mitigate nutrient overload and siltation, especially among the Pennsylvania farming communities along the drainages leading to the Chesapeake Bay.

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# RHODE ISLAND

***Forest Acreage:*** 371,700 acres
***Industrial/Commercial Wood Fuel Use:*** 236,370 tons/yr (1985)
***Residential Wood Fuel Use:*** 126,300 tons/yr (1991)
***Wood-Fired Electricity Generation:***
Existing: 0 megawatts
***MSW Resource Recovery Facilities:***
In operation: 0 tons/day
***Landfill Gas Recovery Projects:***
Active recovery projects: 1
Candidate landfill sites: 1
Planned recovery projects: 1

## Overview

Rhode Island is a small state that is 55 percent harvestable forests. Residential wood energy use grew during the late 1970s and early 1980s as oil prices increased. A residential survey completed in 1986 found 13 percent of all households burning wood. However, the 1990 census found that only 5,408 homes, or 1.3 percent of the total housing units in Rhode Island, used wood as their primary heating fuel. It is generally believed that still fewer households are burning wood today.

Due to the relatively low cost of fossil fuels, there are no major businesses or industries known to use wood as a primary fuel in Rhode Island. However, increasing disposal costs are encouraging wood waste producers to seek other ways to dispose of residues. In addition, there are an increasing number of wood recycling operations on-line or planned in Rhode Island and neighboring states. Recently, the State Energy Office (OHEIR) has been focusing its efforts on wood waste processing and recycling.

## NRBP Supported Activities

### RESOURCE ASSESSMENTS

In 1990, NRBP funds supported development of the report, *Wood Waste Available for Fuel in Rhode Island* by C.T. Donovan Associates (CTD). Intended for use by energy and solid waste planners, public policy makers, and environmental regulators, the report outlines the types and amounts of wood waste available in Rhode Island for use as fuel.

In 1992, CTD was hired to develop a report on *Recycling Construction and Demolition Waste in Rhode Island.* This report described the types and amounts of construction and demolition (C/D) waste generated in Rhode Island, and identified opportunities for increased re-use and recycling. The report is a key step in the process of developing economically viable and environmentally acceptable approaches to reducing the amount of C/D waste disposed of in the State.

NRBP funds were used to conduct a study of the potential for the recovery of methane gas from small landfills in Rhode Island. Results were distributed to solid waste planners and municipal officials. A more detailed analysis and hazard mitigation plan for a landfill in Bristol, RI followed this study.

### END-USE SURVEYS

In 1992, NRBP funds were used to support development of a study by the Tellus Institute investigating operating experience at selected new composting and anaerobic digestion facilities. The study report, *Study of Anaerobic Digestion and In-Vessel Composting Options for Rhode Island,* provided an overview of issues critical to facility development: facility siting, end-product quality, and capital and operational costs. Insights from this study are helping to formulate policy and regulations on MSW composting and anaerobic digestion for the State of Rhode Island. The study focused on both In-Vessel mixed solid waste (MSW) anaerobic digestion and In-Vessel MSW composting options. It provides information about various technological approaches existing today for the recovery of the organic fraction from mixed solid waste.

### CONVERSION ASSISTANCE

OHEIR has studied the feasibility of developing wood cogeneration facilities, and provided technical assistance to a potential project.

NRBP funds also supported research into small commercial and industrial cordwood boilers, and identified industrial parks with a high potential to use wood boilers.

### INTERAGENCY ACTIVITIES

A Technical Advisory Committee was formed to study anaerobic digestion options in the state. Consisting of members of the Solid Waste Management Corporation, the Departments of Environmental Management and Economic Development, OHEIR, municipal sludge management officials, recycling coordinators, and sewage authorities, the Committee's provided advice and direction to Tellus Institute, the consultant which performed the research and analysis.

A Technical Advisory Committee was also formed relative to the C.T. Donovan (CTD) project to study recycling opportunities for wood waste and C/D debris. The Committee was represented by wood energy, solid waste planning, environmental permitting and economic development officials in the state. A current project with CTD also requires the formation of a task force to discuss and prioritize strategies and assist in implementation of results of the Roundtable on Wood Waste Recycling.

### CONFERENCES, WORKSHOPS, FORUMS

In September 1993, the *Rhode Island Roundtable on Wood Waste Recycling: Technical, Regulatory, and Public Policy Issues Affecting Future Opportunities in Rhode Island* was held in Providence. Its purpose was to discuss and review policies, regulations and barriers to the processing and use of wood waste as fuel in Rhode Island. Participants included state regulators and policy makers, private developers, environmental advocates, and utilities. (See sidebar.)

#### RHODE ISLAND ROUNDTABLE ON WOOD WASTE RECYCLING

A major NRBP-supported initiative during the period 1983-93 was the Rhode Island Roundtable on Wood Waste Recycling held on September 23,1993 in Providence, Rhode Island. A variety of public and private sector officials involved in developing, operating, regulating, and permitting wood waste processing and recycling programs and facilities were invited to participate in this "roll-up-your-sleeves" workshop, the objectives of which were to:

- review and discuss recycling, solid waste, energy and environmental policies and regulations in effect in Rhode Island that apply to wood waste processing and recycling;
- identify inconsistencies among existing policies and regulations, and between those policies and regulations and the results of wood and C/D waste studies;
- identify and discuss barriers to wood waste processing and recycling created by these inconsistencies and other factors; and to
- develop specific strategies and an action plan for eliminating or reducing barriers to recycling wood waste.

During the Roundtable, a common concern expressed was the need for better understanding of the types of wood waste that can and should be recycled for certain end uses. An example is creosote-treated wood, which may be acceptable as fuel in utility-scale power plants but may not be acceptable for mulch markets. Participants in the Roundtable expressed concern about recycling wood waste as fuel, noting that certain types of wood waste could be supplied to this end-use market, but that this would not meet existing environmentally acceptable recycling end-use specifications.

The OHEIR could greatly affect the future ability to use wood waste recycled in Rhode Island for fuel (either in or out of state) by providing important background information that will assist other agencies in developing future regulatory and policy approaches and definitions. OHEIR intends to strengthen its efforts in this area by doing further analysis and research on these issues.

### OTHER

***Woodstove Workbook.*** The *Rhode Island Woodstove Book* was printed and distributed by OHEIR in 1985. In 1993, the workbook was revised and updated to comply with new standards and data made available through regional CONEG studies.

***Woodlot Management Videotape.*** To encourage private forest landowners to properly care for forestland, OHEIR produced a videotape on woodlot management.

## Future Trends

The cost of waste disposal and the closing of Rhode Island's landfills are likely to have a significant impact on industries and businesses that produce wood residues, demolition debris, and construction waste. While Rhode Island's General Assembly has placed the emphasis on recycling and composting, it is likely that prohibitive disposal costs will favor the use of wood for fuel, even if the price of other fuels remains relatively low. The results of the anaerobic digestion/in-vessel composting study, as well as continued efforts in the development of future regulatory initiatives, public policies, and agency definitions concerning wood waste recycling will also have a bearing on Rhode Island's biomass energy future.

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# VERMONT

***Forest Acreage:*** 4.5 million acres
***Industrial/Commercial Wood Fuel Use:*** 990,000 tons/yr (1993)
***Residential Wood Fuel Use:*** 605,500 tons/yr (1991-92)
***Wood-Fired Electricity Generation:***
Existing: 71 megawatts (1994)
Proposed: 20 megawatts
***MSW Resource Recovery Facilities as of February 1994:***
In operation: 0
***Landfill Gas Recovery Projects:***
Active recovery projects: 2
Candidate landfill sites: 8
(A farm-based methane generator and a sewage sludge facility are also in operation.)

## Overview

Vermont is primarily a rural state, with over 75 percent of the land area forested. Wood is commonly used as fuel by residences, businesses and industries. The largest municipally-owned wood-fired power plant in the country is located in Burlington, Vermont. It is estimated that over a third of all Vermont homes use wood for heat; at least 75 state buildings burn wood, and approximately 175 industries and businesses rely on wood energy.

State foresters and energy specialists are convinced woodfuel harvesting has positive impacts on the state's forests. The use of integrated forest management techniques includes harvesting low quality wood while simultaneously improving growing conditions for higher quality trees. An increased market for wood chips created by the Burlington Electric Department's 50-megawatt power plant has provided economic incentives for harvesting previously unmerchantable wood. The establishment of an 18-megawatt wood-fired plant at East Ryegate, which came on line in November 1992, enhances these incentives.

## NRBP Supported Activities

The Department of Public Service (DPS) and the Department of Forest, Parks and Recreation direct NRBP activities in Vermont. Within the DPS' Energy Efficiency Division (formerly the Conservation and Renewable Energy Unit), a state forester and demand-side management specialist work as a team on biomass initiatives. Emphasis is placed on researching and documenting successful wood installations and helping to develop new markets for wood fuel. Information and technical assistance are provided to current and potential wood energy users in Vermont.

### RESOURCE ASSESSMENTS

Vermont's wood energy team has been able to make use of two large-scale wood resource assessments, one conducted for the Burlington Electric Department in 1975, the other for a Governor's Task Force during the same period. Though neither of these studies was conducted under the auspices of the NRBP, the program continues to make use of their findings. Both studies concluded that the biomass resource is ample for Vermont energy needs.

### END-USE SURVEYS

Residential woodfuel surveys are completed on a biennial basis by the Energy Efficiency Division. The most recent survey was completed for 1991-92; a 1993-94 survey will be conducted this year. Overall, an estimated 39 percent of homes used wood as a fuel in 1991-92.

### CONVERSION ASSISTANCE

As it has over the past ten years, the Vermont Department of Public Service (DPS) aggressively promotes wood-chip fired heating systems as an option for state or publicly-funded buildings, particularly schools and state buildings. The Vermont DPS Energy Efficiency Division administers the Department of Energy Institutional Conservation Program (ICP), which provides grants to fund energy efficiency measures in existing schools and hospitals. The DPS requires ICP audits to evaluate wood heating systems under the program's renewable energy component. Of the 12 schools with wood-chip systems — eight conversions and four new construction projects — five were ICP grantees. Of the three schools currently planning to install wood-chip systems, both of the two existing schools participated in the ICP. (The third is a new facility.)

The Vermont DPS has also promoted the installation of wood-chip plants to existing central distribution systems. Two large state complexes have been retrofitted with wood-chip fired heating plants and provide steam heat through district heating to over 75 buildings. A state police academy has been converted to wood-chip heating, and several state corrections facilities burn chunk wood. Additionally, a 50-unit HUD housing complex was retrofitted to district heating and now burns wood-chips.

### INTERAGENCY ACTIVITIES

At the heart of Vermont's coordinated biomass energy effort is a strong working relationship between a Forester from the Department of Forest and Parks and an Energy Engineer (a Demand Side Management Specialist), from the Department of Public Service, both housed at the Vermont DPS.

The success of Vermont's wood-energy conversion efforts has resulted in part from a coordinated approach to accessing state and federal funding to install wood heating systems. The Energy Engineer serves as the DPS' technical reviewer of ICP audits, and remains in close contact both with his counterpart from the

Department of Forest and Parks and with the ICP Program Manager. This teaming-up of a Forester and Energy Engineer, under the auspices of the DPS, facilitates the identification of opportunities for wood energy use as well as follow-through in implementing such opportunities. As the public advocate on public utility matters, DPS personnel also work to ensure that proper forest management and harvesting practices are required as part of the permitting process for wood-fired electric generating stations.

### CONFERENCES, WORKSHOPS, FORUMS

In addition to hosting the First Biomass Conference of the Americas in September 1993, Vermont has used NRBP State Program funds to sponsor or co-sponsor the following:

- ***Commercial, Industrial and Residential Wood Heating Systems*** was held in Lake Morey, Vermont in October 1989, with over 100 in attendance. This workshop was targeted primarily at light commercial/industrial facilities, including farms and greenhouses. Afternoon break-out sessions were geared to accommodate different types of users, including residential users. The day-long session featured the "Doing it Right" video produced by DPS' Wood Energy Specialist.
- ***Wood Energy and Recycling.*** This training course, held in Vergennes, Vermont in 1992, was designed to familiarize state and federal foresters with the use of wood residues for energy. Approximately 50 foresters from throughout the Northeast attended the course, which was organized by C.T. Donovan Associates.

### OTHER

In 1989, NRBP funds were used to produce a 20-minute video on how wood is harvested for energy in Vermont. *Doing it Right* reviews the steps Vermont has taken to ensure that proper silvicultural practices are followed in harvesting wood for fuel, and illustrates how such harvesting operations take place.

In 1993, the Vermont DPS used NRBP funds to produce another 20-minute video, this one documenting the program's success with helping electrically-heated public schools convert to wood-burning systems. Designed to be shown to school boards and other local decision-makers, the video addresses such issues as capital cost and financing; operating requirements and costs; fuel availability, delivery and on-site handling; reliability of equipment; environmental impact and safety. (See sidebar.)

#### HEATING SCHOOLS WITH WOOD CHIPS

Vermont DPS' video *Heating Schools With Wood Chips* communicates the basic technical issues and other elements of the decision-making process as experienced by schools in Townsend and East Montpelier, Vermont, which converted from electric to wood-fired heating systems. Accessible to the layperson, the 20-minute tape makes a compelling case for the advantages of wood energy at the small- to mid-sized institutional level, addressing the concerns of the broad community of decision-makers, from the school board president to the chief financial officer to the head of custodial and maintenance operations, to local citizens concerned about traffic, safety, and smoke, and the impact on Vermont's forest resource.

Response to the videotape has been enthusiastic. Jeffrey W. Forward, Town Energy Coordinator for the Town of Richmond, Vermont, wrote:

> The video tape *Heating Schools with Wood Chips* really turned the tide for my school board in their consideration of using a wood chip system for fuel conversion. It alleviated many of their fears and dispelled many of the myths surrounding wood chip heating systems. This tool along with the recent CONEG study [*Conversion of Wood to Energy: Seven Case Studies*] were cited to me by members of the fuel conversion study committee as the primary reasons for convincing them that this was a viable technology...
>
> Thanks for providing me with the video and thanks for all of your help personally.

The Richmond School and another school in the same district received affirmative bond votes for wood chip systems which will be on line by September 1994, in time for the 1994-95 heating season. Nor has the impact of DPS' work with electrically-heated schools been confined to Vermont. A New York State forester showed the videotape to superintendents of two school districts in upstate New York, and they were sufficiently impressed to arrange with Vermont DPS for a tour of wood-heated schools in three Vermont communities.

## Future Trends

While wood energy use is higher in Vermont than in many Northeastern states, the percentage of residences and businesses burning wood declined during the late 1980s. This trend is largely in response to the relatively low prices of fossil fuels, and could reverse itself quite significantly if events cause other fuel prices to rise.

Two local developments have boosted the utilization of wood chips for fuel in Vermont. In 1988, the establishment of ChipTec, a fabricator of commercial and light industrial wood chip gasifiers in Bristol, Vermont, has lowered the cost of this technology. Previously, the only wood chip gasifiers on the market were imported from Canada or Europe, at an incremental cost. Domestic production of these systems has reduced the cost to consumers by two-thirds, bringing them within the reach of schools and businesses.

A second development, known as the "Bennington Project," may have an even more dramatic impact on the way Vermonters and others generate electricity. The 20-megawatt wood chip gasi-

fier jet engine generator design is expected to be 45 percent efficient, a significant improvement over the 33 percent efficiency levels achieved by current steam generators. The design underwent early testing by General Electric in October 1991. The Environmental Protection Agency performed a variety of further tests through the summer of 1993. Pending complete test results, a consortium of Vermont utilities will be developing a 20-megawatt experimental model in 1995.

Municipal waste management issues continue to pose a critical challenge for Vermont. The State Solid Waste Bill, passed in 1987, established a goal of recycling 40 percent of all solid wastes by 1990. In addition, landfills must have liners or face being closed. To help identify potential recycling opportunities, the Department of Forests, Parks and Recreation surveyed all sawmills and secondary mills in 1993 to find out the amount and types of wood waste they generate.

Methane recovery yields 800 kilowatts at the Brattleboro landfill, 750 kilowatts at the Burlington landfill, and 150 kilowatts at the Foster Brother Farm in Middlebury. In 1994, the Chittenden County Solid Waste Management District (SWMD) opened a municipal solid waste sludge facility which produces sludge pellets. The SWMD has installed the United States' first wood-chip gasifier dryer to dry sewage sludge, turning it into pelletized fertilizer for commercial use.

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# REGIONAL PROGRAM

The Regional Research and Technology Transfer Program component of the Northeast Regional Biomass Program addresses opportunities and barriers to biomass energy development that are shared by more than one of the region's states. The general direction for the NRBP's Applied Research effort comes from the long-range plan, but specific technical project suggestions are proposed and voted on during regular quarterly meetings of the Steering Committee. Project proposals may be developed in response to opportunities or barriers identified in the course of carrying out state program activities. Likewise, results of the Applied Research projects are disseminated through the state programs, and often generate state-specific follow-up activities.

This section begins with a table listing of all the applied research and technology transfer projects undertaken under the auspices of Oak Ridge Operations Office's administration of the RBEP grant (a period covering 1983-1993, with some projects carrying over into 1994). The table provides a numbered list of the 48 individual applied research projects, 9 support contracts, and 11 technology transfer contracts undertaken over the past decade. The projects, totaling over $2.3 million in NRBP support with a total of approximately $1.2 million in leveraged (cash) co-funding, are grouped thematically:

- wood fuels harvesting and biomass fuels;
- industrial and commercial wood energy conversions;
- residential wood energy use;
- solid waste management and resource recovery;
- environmental impacts;
- regional impacts; and
- support and technology transfer activities.

Project contracts listed in the table are then briefly described in the annotated listing which makes up the main body of this section. Entries in the annotated listing are numbered to correspond to the contracts listed in the table. (In some cases, a single project involved more than one contract; in one case, a single contract covered two projects.)

| No. | Contract | Period | Contractor | *NRBP Amount | **Co-Funding |
|---|---|---|---|---|---|
| **WOOD FUELS HARVESTING:** | | | | | |
| 1. | Impact of Large Demand Centers on Forest Base | 1/85-12/85 | Associations in Rural Development | $54,206 | |
| 2. | Residual Stand Damage, Whole Tree Partial Cutting | 4/88-3/89 | Maine Audubon Society | $38,824 | |
| **BIOMASS FUELS:** | | | | | |
| 3. | Wood Chip Supplies and Markets | 12/83-11/84 | E.C. Jordan | $29,728 | |
| 4. | Recycled Wood Wastes | 12/86-3/88 | Atlantis, Inc. | $21,935 | |
| 5. | Wood Products in the Waste Stream | 3/91-8/92 | C.T. Donovan Associates, Inc. | $80,000 | $251,542 |
| 6. | Fifth National Biofuels Conference | 12/91-11/92 | C.T. Donovan Associates, Inc. | $70,000 | $20,000 |
| 7. | Wood Energy & Recycling Training Program | 5/92-10/92 | C.T. Donovan Associates, Inc. | $20,000 | $11,000 |
| 8. | Industrial Wood/Coal Co-Utilization | 1/85-12/85 | Boston Planning Group | $25,000 | |
| 9. | Wood Fuel Pellet Forum | 4/93-12/93 | Maine State Planning Office | $20,000 | $5,000 |
| 10. | Wood Pellet Fuels Conference | 11/93-8/94 | Northeastern Forest Alliance | $20,000 | |
| 11. | Resource Survey: Large Scale Liquid Fuels | 7/93-8/94 | C.T. Donovan Associates, Inc. | $30,000 | |
| **INDUSTRIAL AND COMMERCIAL WOOD ENERGY USE:** | | | | | |
| 12. | Industrial Conversion Guidebook | 11/83-12/85 | JPR Associates, Maine Audubon | $20,000 | |
| 13. | Resource Notebook, Slide Shows, 1-on-1 Assistance | 1/85-12/85 | Maine Audubon Society | $97,073 | |
| 14. | Conversion of Slide Shows to Video | 8/87-10/87 | Commonwealth Media Services | $6,175 | |
| 15. | Evaluation of Targeted Ind. Conversion Assist. Prog. | 12/85-7/86 | Dartmouth College (RPC) | $34,995 | |
| 16. | Feasibility of Converting Public Facilities to Wood | 4/85-2/86 | Council of State Governments | $13,717 | |
| 17. | [project involved two separate contracts] | 4/85-2/86 | Technical Development Corporation | $13,550 | |
| 18. | PURPA & Use of Biomass for Independent Power | 12/85-12/86 | Harvey Salgo, Esq. | $4,500 | |
| 19. | Directory of Biomass Energy Facilities | 12/86-8/86 | Maine Audubon Society | $28,269 | |
| 20. | [Directory update] | 9/87-9/88 | Maine Audubon Society | $24,887 | |
| 21. | [Directory update] | 9/93-6/94 | Commercial Testing & Engineering | $29,796 | |
| 22. | [Biomass Facility Information System modified] | 5/93-11/93 | Meridian Corporation | $8,756 | |
| 23. | Evaluating Efficiency of Mid-Sized Wood Boilers | 3/92-6/93 | Commercial Testing & Engineering | $36,469 | |
| 24. | Booklet for Key Decision Makers on Wood Chip Heat | 2/93-7/94 | Energy Efficiency Associates | $20,015 | |
| 25. | Facilities Conversion Video | 5/94-10/94 | Shellow/Porterfield | $5,000 | |
| **RESIDENTIAL WOOD ENERGY USE:** | | | | | |
| | Performance Monitoring of Wood Stoves | | | | |
| 26. | [Phase I] | 12/85-12/87 | OMNI Environmental Services | $138,201 | $311,799 |
| 27. | [Phase II] | 12/87-12/89 | OMNI Environmental Services | $60,040 | $491,036 |
| 28. | [Workshop on Stress Testing Methodology] | 12/92-6/93 | OMNI Environmental Services | $10,104 | |
| 29. | Videos on Residential Wood Stoves | 7/87-12/87 | Wood Heating Alliance | $20,000 | |
| 30. | Workshops on Residential Wood Stoves | 10/88-10/90 | C.T. Donovan Associates, Inc. | $25,781 | |
| 31. | Lessons Learned (I) | 3/92-1/93 | NYSERDA (Kelliher/Samets) | $20,000 | $123,000 |
| 32. | Burn It Clean, Burn It Right | 9/92-8/93 | Kelliher/Samets/Volk | $5,856 | |
| 33. | Lessons Learned (II) | 7/93-3/94 | Kelliher/Samets/Volk | $50,000 | |
| **SOLID WASTE MANAGEMENT AND RESOURCE RECOVERY:** | | | | | |
| 34. | Wood Fuel Feedstocks in Resource Recovery Facilities | 1/86-8/86 | Boston Planning Group | $19,993 | |

| No. | Contract | Period | Contractor | *NRBP Amount | **Co-Funding |
|---|---|---|---|---|---|
| 35. | Comparative Risks of Landfill & Resource Recovery | 12/87-6/88 | Energy Systems Research Group | $31,830 | |
| 36. | Equity Adjustments in Resource Recovery Siting | 12/87-8/88 | Energy Systems Research Group | $30,802 | |
| 37. | Modeling Future Waste Streams | 4/89-10/89 | Energy Systems Research Group | $25,000 | |
| 38. | Wood Combustion Emissions Workshops | 5/92-1/93 | NYSERDA | $15,000 | |
| 39. | Impediments to LFG Recovery Project Development | 2/93-2/94 | SCS Engineers | $68,801 | |
| 40. | Comparative Analysis of LFG Recovery Techniques | 10/93-8/94 | SCS Engineers | $40,000 | |
| **ENVIRONMENTAL ISSUES:** | | | | | |
| 41. | Regional Strategies to Mitigate Greenhouse Gases | 8/90-5/91 | Tellus Institute | $39,754 | |
| 42. | Wood Ash Disposal and Recycling Sourcebook | 12/86-12/87 | OMNI Environmental Services | $19,999 | |
| 43. | Air Emission Regs., Small-Medium Wood Boilers | 11/84-1/85 | NESCAUM | $5,000 | |
| 44. | Stack Emissions Standards, Residential Part.Emissions | 12/83-10/84 | Roy F. Weston | $58,406 | |
| 45. | Methhod. for Calculating Environmental Externalities | 9/93-8/94 | Meridian Corporation | $49,935 | |
| **REGIONAL IMPACTS:** | | | | | |
| 46. | Economic Impacts of Wood Energy in the Northeast | 2/85-11/85 | Dartmouth College (RPC) | $59,994 | |
| 47. | Update on Economic Impacts Study | 9/93-8/94 | Resource Systems Group | $59,960 | |
| 48. | Governors Roundtable | 9/93-1/95 | RESOLVE | $15,000 | |
| **SUPPORT CONTRACTS AND TECHNICAL TRANSFER ACTIVITIES:** | | | | | |
| 49. | Technical Coordinator | 8/85-8/86 | Technical Development Corporation | $42,400 | |
| 50. | " | 8/86-8/87 | Technical Development Corporation | $49,360 | |
| 51. | " | 8/87-8/88 | Technical Development Corporation | $59,561 | |
| 52. | " | 10/88-9/89 | Technical Development Corporation | $49,479 | |
| 53. | " | 10/89-9/90 | Technical Development Corporation | $40,770 | |
| 54. | " | 8/90-7/91 | Technical Development Corporation | $49,329 | |
| 55. | " | 8/91-7/92 | Citizens Conservation Corporation | $59,891 | |
| 56. | " | 8/92-6/93 | Citizens Conservation Corporation | $59,938 | |
| 57. | " | 8/93-7/94 | Citizens Conservation Corporation | $70,000 | |
| 58. | NRBP Five-Year Report: 1983-1988 | 2/89-4/89 | Technical Development Corporation | $14,880 | |
| 59. | [project involved two separate contracts] | 2/89-4/89 | C.T. Donovan Associates, Inc. | $3,400 | |
| 60. | NRBP Mission, Accomplishments, Prospects: 1991 | 12/90-3/91 | Technical Development Corporation | $12,915 | |
| 61. | NRBP Mission, Accomplishments, Prospects: 1992 | 6/92-10/92 | Citizens Conservation Corporation | $14,097 | |
| 62. | NRBP Retrospective: 1983-1993 | 10/93-9/94 | Citizens Conservation Corporation | $20,000 | |
| 63. | Support for *Biologue* Publication | 8/87-8/88 | National Wood Energy Association | $50,000 | |
| 64. | " | 10/88-9/89 | National Wood Energy Association | $45,000 | |
| 65. | " | 5/89-12/89 | National Wood Energy Association | $25,000 | |
| 66. | " | 11/89-9/90 | National Wood Energy Association | $44,563 | |
| 67. | " | 3/91-11/91 | National Wood Energy Association | $50,000 | |
| 68. | " | 11/91-1/92 | National Wood Energy Association | $24,813 | |
| | | TOTAL: | | $2,407,747 | $1,213,377 |

*Except in cases where round figures are given the $ figure in this column represents the amount spent out, as opposed to the amount in the original contract.
**In-kind contributions to projects not reported.

# ANNOTATED PROJECT LISTING

## Wood Fuels Harvesting

### 1. IMPACT OF LARGE BIOMASS DEMAND CENTERS ON THE FOREST RESOURCE BASE

***Obstacle/Opportunity Addressed.*** Public perception that wood-fired power plants and other energy-related demand for wood will have a negative impact on the forest resource is a persistent barrier to the development of biomass energy projects.

***Objective.*** Examined the impacts of four wood-fired power plants on wood procurement systems and forest management in their respective "woodsheds".

***Project Description.*** The plants, located in different states, had the aggregate potential to consume over 1.5 million tons of wood chips annually. The study consisted of interviews with foresters, loggers, private, nonindustrial forest landowners, wood-chip brokers, haulers and suppliers, and on post-harvest stand examinations of 37 logging sites in northern New York, Vermont, New Hampshire and Maine.

***Findings/Final Product.*** The study report describes the wood procurement systems for each of the four power plants, and finds that the plants have helped to create and stabilize regional wood chip markets, increasing employment in the wood industry. The study found no dramatic change in the intensity or quality of forest management as a result of fuelwood chip harvesting, which operates much the same as harvesting for pulp and paper or composite board production.

### 2. RESIDUAL STAND DAMAGE IN WHOLE TREE PARTIAL CUTTING OPERATIONS

***Obstacle/Opportunity Addressed.*** The preceeding study found little impact from woodfuel harvesting on forest management practices, but 40 percent of foresters and 30 percent of loggers interviewed reported some increase in residual stand damage. The problem of negative public perception remains.

***Objective.*** Perform a controlled, replicable field study to determine the extent of residual stand damage from harvesting with the equipment most commonly used to supply fuelwood chips: drive-to-bunch fellers and grapple or cable skidders.

***Project Description.*** Eighteen sites, all upland hardwood or mixed hardwood- conifer forests in Northern New England, were chosen for the study. All of the sites had been harvested mechanically within the previous three years. Residual stand damage was assessed using a new classification system developed by the University of Maine.

***Findings/Final Product.*** Damage on study sites averaged 9.6 percent; five sites exceeded 10 percent. Using a logistic regression model correlating the extent of damage with site, stand, and harvest management practices, the study found that the most significant factors in minimizing damage were the care taken in planning the harvest and the experience of the feller buncher operator. The study recommended training for equipment operators, perhaps in concert with a certification program, as a way to improve forest quality and productivity.

## Biomass Fuels

### 3. WOOD CHIP SUPPLIES AND MARKETS

***Obstacle/Opportunity Addressed.*** Lack of comprehensive information on the wood chip supply industry hindering its development; perception that wood chips might be an unreliable fuel source for large demand centers such as wood-fired power plants.

***Objectives.*** Determine whether supply of wood fuel available is adequate to meet needs of large demand centers; identify wood chip suppliers in operation; analyze the costs associated with starting a wood chip harvesting business.

***Project Description.*** First region-wide study to address opportunities and problems associated with harvesting and supplying wood chips for fuel in the Northeast. Identified specific wood chip supply and market sources. Assessed factors affecting development of supply market.

***Findings/Final Product.*** Report presents three case studies of wood chip supply businesses as well as case studies of markets for fuelwood chips: a residence, apartment building, hospital, and manufacturing company. Includes annotated list of chip suppliers in each state. Identifies suppliers of equipment to harvest, handle, and burn whole tree chips. Chip and equipment supplier lists expanded, updated and published separately. Report also presents hypothetical business plans for three supply businesses.

### 4. RECYCLED WOOD WASTES

***Obstacle/Opportunity Addressed.*** Between 20 and 25 percent of the almost 150 million tons of solid wastes disposed of throughout the United States in 1987 were woody materials from demolished buildings, land clearing, and from other industrial and commercial activities such as replacement of wooden pallets and railroad ties. Limited landfill capacity and high tipping fees have focused attention on recycling these materials, potentially a major biofuel resource.

***Objective.*** To estimate the availability of wood and woody materials in the solid waste stream and to determine the economic and technical viability of separating and recycling them for use as fuel.

***Project Description.*** The study assessed the volume of wood wastes disposed of in the region's landfills, and included detailed assessments of market opportunities for wood recycling operations in Boston, New York City and Philadelphia.

***Findings/Final Product.*** In addition to identifying signifi-

cant volumes of wood wastes disposed of in the region's landfills, the study report included a list of nine companies "recycling" wood waste in the region, plus a list of power plants, industries and businesses that use recycled wood for fuel. The supply was found to exceed the existing demand, but with a significant potential for growth in the demand for recycled wood — both for fuel and for other uses.

### 5. WOOD PRODUCTS IN THE WASTE STREAM: CHARACTERIZATION AND COMBUSTION EMISSIONS

***Obstacle/Opportunity Addressed.*** Increasing environmental concerns about the combustion of "treated" wood have placed significant regulatory barriers before waste wood processors, independent power producers, and landfill operators. Treated wood includes wood with a surface coating, an adhesive, or a preservative. While national and state policies place an increasing premium on the combustion of non-fossil fuels and the availability of waste wood at a negative cost are particularly attractive factors to independent power producers, stricter air emissions and ash disposal regulations threaten the prospects for future waste wood combustion facilities.

***Objective.*** To better understand the quantities, composition and characteristics of various treated woods. To assess the way in which state regulators treat waste wood combustion, and to collect and analyze emissions data from operating combustion facilities.

***Project Description.*** The research team surveyed waste wood inventories and state air regulations in eight North American states and one province. Eight major sources of waste wood were identified and grouped into three broad categories: harvested waste wood, mill residue, and urban waste wood. Each major source was assessed for treatment characteristics, ranging from clean/untreated to three treatment sub-groups: coatings; glues/resins; and preservatives. Six common "treated" wood products that account for a majority of the wood in the waste stream were identified, and their chemical composition. Air emissions research was gathered from over 100 wood combustors, revealing few sources from combustion of construction and demolition material, railroad ties, telephone poles and other "treated" wood. Processed wood waste at large facilities are frequently co-fired with "clean" harvested wood, mill residue, coal, or MSW.

***Findings/Final Product.*** Comparison of the scarce data from treated wood combustion to "clean" wood combustion at the same facilities revealed that organic and metals emissions from the treated wood were only slightly higher than for non-treated wood. The findings to date suggest that combusting most of the treated woods will meet existing environmental standards, provided that good combustion conditions are met. Yet the data from treated wood emissions from field sites are quite sparse; more field testing of particular treated wood types and combinations of treated wood products will be required to provide the information regulators will need to license waste wood facilities.

### 6. FIFTH NATIONAL BIOFUELS CONFERENCE: *WOOD PROCESSING AND COMBUSTION FOR ENERGY*

***Obstacle/Opportunity Addressed.*** Concern about global climate change, air pollution, depletion of forest resources, and limited solid waste disposal capacity providing stimulus for interest in the environmental impacts of processing and using waste wood for energy. Co-hosted by the NRBP and the Massachusetts Division of Energy Resources, the Fifth Annual National Biomass Conference and Exhibition served as a showcase for the NRBP's work in the area of wood waste stream identification and characterization.

***Objective.*** Focus attention on the waste biomass resource.

***Project Description.*** Four-day conference held in Newton, Mass., October 1992.

***Findings/Final Product.*** Conference attracted the participation of over 80 moderators and speakers, and was well-attended by Federal and state energy planners and foresters; solid waste and air environmental regulators; waste wood generators, haulers, processors, and solid waste facility operators; boiler manufacturers; forest products industry owners; electric utility and independent power producers; and the biofuels research community. Forty-three papers were published in the conference proceedings.

### 7. WOOD ENERGY & RECYCLING TRAINING PROGRAM

***Obstacle/Opportunity Addressed.*** Utilization foresters serve an important function in promoting wood products for a variety of purposes. The use of wood waste for energy introduces a new market for wood-based products that have already served their originally-intended purpose.

***Objective.*** Provide forestry specialists from throughout the Northeast with in-depth training on wood energy systems, emissions, policy issues, processing equipment and wood fuel procurement.

***Project Description.*** A four-day training course, funded jointly by the U.S. Forest Service and NRBP.

***Findings/Final Product.*** In addition to increasing participants' knowledge and capabilities, the conference helped to create a functional partnership between state forestry and energy personnel in the region.

### 8. INDUSTRIAL WOOD/COAL CO-UTILIZATION

***Obstacle/Opportunity Addressed.*** During the early to mid-1980s, industry concern about fuel supply, emissions regulation, and price stability prompted installation of multi-fuel boilers in the Northeast. Yet few of these facilities had elected to use wood and coal combinations.

***Objective.*** Examine the opportunities and constraints for wood/coal co-utilization in industrial boilers in the region.

***Project Description.*** The study used previous research and technology studies, the results of a user survey, and a case study of the S.D. Warren Company's Westbrook, Maine wood/coal facility.

***Findings/Final Product.*** In the absence of low or no-cost wood residues on or near the point of use, the incentive to co-fire wood in coal boilers is negligible unless new environmental regulations require lower sulfur emissions from coal. Wood and coal are compatible but not identical fuels in their handling and combustion requirements, with wood requiring larger storage areas and more complex handling systems. The study concluded that the decision to blend fuels will in large part be governed by the incremental costs of accommodating both fuels compared to the incremental savings resulting from the lower cost of controlling emissions from wood/coal combustion. In New York and New England, wood/coal co-utilization is most attractive as a form of fuel diversification and to achieve greater combustion efficiency in wood-only boilers. In Pennsylvania, Maryland, and Delaware, where coal and gas are the major industrial fuels, wood is most likely to be introduced as a supplement to coal as a way to meet increasingly stringent sulfur emissions standards.

### 9. WOOD FUEL PELLET FORUM

***Obstacle/Opportunity Addressed.*** Development of the pellet fuel and stove market has been constrained by a chicken-and-egg problem: consumers unwilling to invest in pellet stoves without the assurance of available and affordable fuel; pellet manufacturers hindered in turn by the lack of assurance that there will be a market for their product. Forum designed to bring together key people representing various aspects of wood fuel pellet manufacturing and use, including NRBP, NEFA, and the Fiber Fuels Institute, in a problem-solving forum facilitated by U.S. Forest Service professionals.

***Objective.*** To develop a plan of action that specifies activities and tasks necessary to overcome pellet market impediments, and assigns responsibilities for carrying out those activities and tasks. (Focus of this forum limited to the residential market and to woody pellet feedstock.)

***Project Description.*** Forum held June 28 & 29 in Bedford, NH, with 65 invited participants.

***Findings/Final Product.*** Fifty copies of the *Wood Fuel Pellet Action Plan* published and distributed to the New England Forestry Alliance and the Center. The *Plan's* recommendations include:

- establishment of certification programs and better education of stove dealers by manufacturers;
- enlistment of government and nonprofit organizations such as the Regional Biomass Programs to help educate consumers about the advantages of pellet stoves, as well as their proper use;
- establishment of pellet fuel standards;
- improved stove designs;
- market research to better understand who is or may be buying pellet stoves; and
- government incentives, including tax and emission credits.

### 10. WOOD PELLET FUELS CONFERENCE

***Obstacle/Opportunity Addressed.*** The Northeast is now the fastest growing region for pellet stoves and pellet fuel sales in the nation. Today there are about 25,000 residential pellet stoves in the region's homes, more than double what there were two years ago. Four new pellet manufacturers have located in the region, with collective capacity for manufacturing more than 100,000 tons per year. Today the region utilizes an estimated 75,000 tons annually.

***Objective.*** To inform, motivate, and train participants to carry out the *Wood Fuel Pellet Action Plan* developed at the June 1993 Wood Pellet Fuels Forum. (See Forum description, above.)

***Project Description.*** Conference of 50 participants held in June 1994.

***Findings/Final Product.*** A record of the Conference proceedings is being produced, and will be available from the CONEG Policy Research Center.

### 11. RESOURCE SURVEY OF LARGE-SCALE LIQUID FUEL PRODUCTS FROM BIOMASS

***Obstacle/Opportunity Addressed.*** There exist a variety of laboratory-tested technologies for converting woody and other biomass feedstocks into ethanol and other liquid fuels which can readily be used to displace fossil fuels in various applications, notably the generation of electricity. One important key to the successful transfer of current conversion technologies to commercial- scale liquid fuel production is the availability of a low-cost feedstock. Less well-suited than some other parts of the country to the development of short- rotation crops as part of a dedicated feedstock supply system, the Northeast may prove more competitive in the race to commercialize liquid biofuels by utilizing the waste biomass products it generates (e.g., waste paper).

***Objectives.*** Phase 1 of this project seeks to answer the questions: How much potential feedstock material exists? What is the cost to extract/obtain these materials as feedstock for large-scale production of liquid fuels?

***Project Description.*** The survey identified and quantified a wide range of potential biomass feedstocks, including woody and herbaceous energy crops and agricultural crop residues, clean and treated wood residues and waste materials, waste paper and paper sludge, and food and food processing wastes. For each of the types of waste identified, the study looked at values, costs, and competing uses, and assessed factors affecting the future availability of the feedstock.

***Findings/Final Product.*** Report incorporating both find-

ings of the Resource Survey and a discussion of their implications for the development of a liquid fuel production facility in the Northeast. The region's biomass feedstocks have the potential to produce 2.7 billion gallons of ethanol annually (by comparison, corn currently contributes to the manufacture of 1 billion gallons of ethanol). NRBP anticipates undertaking further evaluation of the region's potential to support a large-scale liquid biofuels conversion facility; and identifying and performing detailed analysis of candidate demonstration sites.

## Industrial/Commercial Wood Energy Use

### TARGETED INDUSTRIAL CONVERSION ASSISTANCE PROGRAM

Comprises four separately contracted projects:

- Guidebook for Industrial Wood Energy Conversion
- Resource Notebook and Slide Shows
- Conversion of Slide Shows to Videotape
- Evaluation of the Targeted Industrial Conversion Assistance Program

***Obstacle/Opportunity Addressed.*** Initiated in 1985, the Conversion Assistance Program was designed to provide information and technical assistance through workshops, and to develop a variety of specialized resources, including a Resource Notebook and a series of slide show case studies of successful industrial conversion projects. The Program offered ten industrial wood energy workshops at various locations in the Northeast, as well as site-specific one-on-one assistance.

### 12. GUIDEBOOK FOR INDUSTRIAL WOOD ENERGY CONVERSION

***Objective.*** To provide facility managers and other decision-makers with a handbook to guide them in making a preliminary feasibility assessment for conversion to wood energy.

***Project Description.*** A Guidebook was compiled, bringing together information on economics; fuelwood procurement; equipment options, including descriptions and drawings of wood storage, handling, and combustion equipment; air pollution regulations and pollution-control equipment options; and worksheets for calculating cost-effectiveness. Financial analysis worksheets were designed for preliminary analysis only, to determine whether more detailed engineering and financial feasibility studies are warranted.

***Findings/Final Product.*** The Guidebook was distributed to over 600 potential wood energy users throughout the Northeast. Two workshops were also held.

### 13. RESOURCE NOTEBOOK AND SLIDE SHOWS

***Objectives.*** In addition to providing one-on-one assistance to individual facilities, the objectives of this contract were to research and document the decision-making process used by industries that had successfully converted to wood.

***Project Description.*** The project contractor:

- developed lists of wood energy engineers and equipment manufacturers;
- provided an information referral service for facility managers; and
- developed five narrated slide programs showing successful wood fuel operations in different types of facilities.

***Findings/Final Product (resource notebook and case studies).*** The Resource Notebook includes nine fact sheets describing each step in the decision-making process; eleven case studies; a users guide to computerized preliminary feasibility assessments; and resource lists for further information. The list of wood energy equipment vendors was updated in 1988 and is published separately as a directory which includes wood chip suppliers.

***Findings/Final Product (slide shows):*** Designed for use at workshops and conferences, each 30-minute slide program includes three case studies of wood-fired facilities in a particular sector: manufacturing industries; commercial greenhouses and nurseries; primary and secondary wood industries; and institutions such as schools and hospitals. The programs present detailed information on equipment costs, fuel cost savings and payback. A fifth slide program provides an overview of industrial wood energy use and summarizes the experience of successful wood-fired installations.

### 14. CONVERSION OF SLIDE SHOWS TO VIDEO

***Objective.*** Increase the outreach of the slide show programs already developed to document successful industrial wood energy installations.

***Project Description.*** Convert slide shows to videotape.

***Findings/Final Product.*** Narrated videotape documenting successful wood-energy operations in five different types of facilities.

### 15. EVALUATION OF TARGETED INDUSTRIAL CONVERSION ASSISTANCE

***Objective.*** Assess the impact of the Targeted Industrial Conversion Assistance Program.

***Project Description.*** See above (12-14) for description of individual components of the Targeted Industrial Conversion Assistance Program.

***Findings/Final Product.*** Over 600 industries reached by one or more of the activities undertaken as part of this program.

### 16-17. FEASIBILITY OF CONVERTING PUBLIC FACILITIES TO WOOD

***Obstacle/Opportunity Addressed.*** Public facilities are among the most inefficiently heated buildings in the commercial sector. Yet yearly appropriations preclude long-term financing obligations; state agencies have not developed straightforward contracting procedures for accommodating heating systems conversions financed from the savings achieved; and agency budgets for facility modernization are often extremely tight.

***Objectives.*** Provide testimony to state facilities that wood boiler conversions were technically and economically feasible.

***Project Description.*** The study examined the dimensions of barriers to converting public facilities and provided recommendations for overcoming them.

***Findings/Final Product.*** A memorandum to the Steering Committee reported on the barriers to boiler conversion in public facilities. Case Studies of successful public building conversions to wood were developed and published.

### 18. PURPA AND THE USE OF BIOMASS FOR INDEPENDENT POWER PRODUCTION

***Obstacle/Opportunity Addressed.*** The passage of the Public Utility Regulatory Policy Act (PURPA) in 1978 established a new set of players in the utility power generation sector: Independent Power Producers (IPPs). In the Northeast, PURPA opened up significant opportunities for wood-burning power plants to compete for sales of power to utilities with high avoided costs.

***Objectives.*** Assess the implications of PURPA for biomass-fueled IPP development

***Project Description.*** Contractor provided advice to CONEG Policy Research Center, state energy offices, and biomass developers how the PURPA regulations could best be used to support the development of independent biomass power production.

***Findings/Final Product.*** In addition to responding to specific PURPA-related questions and issues, the contractor also produced several papers.

### 19-22. DIRECTORY OF BIOMASS ENERGY FACILITIES

***Obstacle/Opportunity Addressed.*** Industrial and commercial facilities which could potentially benefit from conversion to wood energy often have the perception that fuelwood supply is uncertain and that the equipment and service infrastructure for wood combustion is not well developed. In fact, this is not generally the case in the Northeast.

***Objectives.*** To provide information about which industries, businesses, and institutional and utility facilities are using wood to generate energy. (The original Facilities Directory and initial update also included a Directory of Wood Chip and Wood Energy Equipment Suppliers, but this information is now readily available elsewhere and will not be included in the 1994 update.)

***Project Description.*** Preparation of the directory involved surveying businesses across the region, compiling information about wood-fired systems, fuel procurement, and operations. The directory was first produced in 1986 and has been updated twice since then, most recently in 1994, when it was prepared for data entry into the Biomass Facilities Information System.

***Findings/Final Product.*** The original Facilities directory consisted of a hardbound notebook, including short listings of over 400 facilities and detailed profiles of a smaller number of facilities with large wood-fired boilers. The 1994 Directory is to be produced both in hard copy and in a database format corresponding to the Biomass Facilities Information System (BFIS), which was developed for the Southeast Regional Biomass Program and has been modified by the contractor to correspond to the NRBP's facility database needs.

### 23. EVALUATING THE EFFICIENCY OF MID-SIZED WOOD BOILERS

***Obstacle/Opportunity Addressed.*** The engineering community persists in its skepticism towards the performance efficiency of wood combustion systems despite hundreds of successful and cost-effective applications.

***Objectives.*** To determine fuel and capital costs, combustion efficiencies, O&M costs, and overall system performance of wood-fired systems ranging from .5 to 5 million Btu/hour.

***Project Description.*** To address prevalent engineering concerns, field evaluations were conducted on seven direct combustion and gasification wood-chip/residue systems over a period of one full heating season. High-fire, steady state efficiency tests conducted at all seven sites, with a minimum of three tests over a two-week period.

***Findings/Final Product.*** The final report includes a case study of each of seven facilities tested. An audience of 5,000 targeted to receive report.

### 24. BOOKLET FOR KEY DECISION-MAKERS ON POTENTIAL FOR WOOD CHIP HEAT IN COMMERCIAL AND INDUSTRIAL FACILITIES

***Obstacle/Opportunity Addressed.*** Though wood-chip combustion facilities have been in existence for several decades, the technology is unfamiliar to most engineers and facility managers outside the forest products industry.

***Objectives.*** Provide a simple, usable working tool to enable public boards, administrators and other decision-makers, including private owners of commercial or industrial facilities, to:

- consider conversion to, or new installation of, wood-chip energy systems;
- investigate the economics of wood-chip heat, hot water, drying and process steam applications, using life-cycle cost and cash-flow analyses;

- compare different types of wood-chip systems and select a system appropriate to the needs of their facilities; and
- implement wood-chip energy projects.

***Project Description.*** Information compiled for the decision-makers' guidebook included:

- what kinds of facilities might burn wood chips and why;
- wood chips and other types of biomass fuel;
- elements of a wood-chip energy system;
- fuel source, delivery, and on-site storage;
- efficiency of biomass combustion systems;
- types of biomass combustion systems;
- information resources and assistance;
- putting together and implementing a biomass project; and
- operating and maintaining a wood-chip system.

***Findings/Final Product.*** Biomass Energy System Booklet.

### 25. FACILITIES CONVERSION VIDEO

***Obstacle/Opportunity.*** Addressed. In 1993, the Vermont Department of Public Service (DPS) produced a video documenting its successful conversion of electrically-heated schools to wood energy systems. The video, *Heating Schools with Wood Chips*, has proven itself a highly effective tool for educating decision-makers and the general public about the feasibility and benefits of conversion projects.

***Objective.*** Build on the success of the Vermont video by expanding it to include documentation of schools and other types of facilities in other states.

***Project Description.*** Edit the Vermont video so that it incorporates both the Vermont schools material, and documentation of conversions in other states -- including commercial/industrial facility conversions and other insitutional facilities.

***Findings/Final Product.*** The video is scheduled to be completed in the fall of 1994. Copies will be made available to each state in the region.

## Residential Wood Energy Use

### PERFORMANCE MONITORING OF ADVANCED TECHNOLOGY WOOD STOVES

The NRBP's research in the area of advanced technology residential wood stoves took place over a span of eight years, from 1985 to 1993. The work involved multiple contracts, summarized below in three contract phases: Phase I and Phase II research, and the Workshop on Wood Stove Stress Testing Methodology. Subsequent consumer education projects are described under separate entries.

### 26. PHASE I

***Obstacle/Opportunity Addressed.*** Widespread concern about wood-stove efficiency, pollution, and safety prompted the NRBP to undertake a three-year study of fuel savings, creosote build-up and emissions from advanced technology residential wood stoves.

***Objectives.*** Determine the effectiveness of catalytic and non-catalytic advanced technology stoves in reducing fuel use, creosote accumulation, and particulate emissions.

***Project Description.*** The project monitored wood stove performance in 68 homes for a two-year period (1985-87). Twelve stove manufacturers donated a total of 26 catalytic low emissions stoves to volunteer homeowners in Vermont and upstate New York. Conventional air-tight stoves were operated in 28 homes to provide baseline data for at least one year of the two-year effort. Creosote accumulation was measured two to three times annually; wood piles were measured by volume during the heating season. Computer-assisted data logging systems recorded stove temperatures, flue gas oxygen concentrations, and wood weights. Particulate emissions were collected continuously for one minute every half an hour during each of three to four week-long sampling periods during each winter.

***Findings/Final Product.*** The catalytic and non-catalytic low emission stoves generally performed only marginally better than the conventional air-tight stoves. While individual models and stoves demonstrated significantly lower emissions and creosote accumulations, as well as greater efficiency than conventional models, the results for the advanced technology stoves as a group were disappointing. Preliminary results from stove inspections conducted after the second heating season revealed significant leakage of smoke around combustors, a possible cause of high emissions. The research justified setting a different standard for non-catalytic stoves and prompted EPA to require periodic inspections for gaskets and welding leaks in new stoves.

### 27. PHASE II

***Obstacle/Opportunity Addressed.*** The findings from the first two years of field research (see above) pointed to a discrepancy between laboratory stove performance testing and performance in the field. Yet large variations among stoves of the same model, and of the same stove during different testing periods made conclusions difficult. There appeared to be many factors influencing stove performance.

***Objectives.*** To identify the particular factors associated with low particulate emissions in EPA-certified stoves, and to determine the adequacy of the EPA standards in reducing emissions under optimal field conditions.

***Project Description.*** The 1988-89 heating season research focused on testing three brands of catalytic stoves newly installed in 15 households, and two brands of high-technology, non-catalytic certified stoves newly installed in 10 households. Stoves were monitored for emissions, fuel loading, catalyst bypass damper usage and fueling door activity, and catalytic termperatures.

***Findings/Final Product.*** Findings were presented at a meeting of stove manufacturers in August 1989. Another outcome of this second round of field research was a follow-on contract with OMNI to develop a stress-testing methodology to help manufacturers design stoves which persist in performing in the field.

**28. WORKSHOP ON STRESS TESTING METHODOLOGY**

***Obstacle/Opportunity Addressed.*** Certified advanced-technology stoves were consistently found to fall short of lab-tested performance standards when tested in the field.

***Objective.*** Eliminate the discrepancy between the results of laboratory testing of certified advanced-technology stoves with the performance of those stoves in the field.

***Project Description.*** NRBP and its collaborators contracted with OMNI to develop a laboratory stress-testing methodology. (See Phase II, above.)

***Findings/Final Product.*** A workshop was held in 1993 to introduce stove manufacturers to the stress-testing methodology developed by OMNI.

**29. VIDEOS ON RESIDENTIAL WOOD STOVES**

***Obstacle/Opportunity Addressed.*** The issues that prompted the NRBP to develop a residential wood stove workshop also led to the production of a series of videos on wood stove safety, operation and maintenance.

***Objective.*** Increase public awareness of the high efficiency catalytic and non-catalytic stoves certified by the U.S. Environmental Protection Agency.

***Project Description.*** Three videos were produced. The first is a series of 10- and 30-second public service announcements (PSAs) highlighting the safe, efficiency and clean-burning advanced technology wood stoves. The second, intended for use in wood stove retail outlets, is a 7-minute educational documentary covering the same subjects in greater depth, and also presenting information on proper stove sizing and installation, chimney design, wood purchase, and stove operation and maintenance. The third video is a 20-minute documentary, expanding on the same themes with the addition of information about the evolution of wood stove technology and the chemistry of wood combustion and importance of using combustor bypass valves properly. It was produced for cable television, public television stations and as a background resource for news features.

***Findings/Final Product.*** Approximately 100 retailers purchased the 7-minute video and a number of television stations aired the PSAs or the documentary. The videos received exposure not only in the Northeast, but in every region in the country.

**30. WORKSHOPS ON RESIDENTIAL WOOD STOVES**

***Obstacle/Opportunity Addressed.*** The NRBP's field monitoring of residential wood stoves revealed that wood stove retailers, installers and users need information on proper installation and operation of the new high-efficiency, low-emission wood stoves to meet fuel savings and air quality objectives.

***Objectives.*** Address this need for this information, in light of new wood stove emissions standards promulgated by the EPA and subsequent changes in the design, operation and performance of wood stoves and catalytic retrofits.

***Project Description.*** Workshops were organized in held in three states in three successive years.

***Findings/Final Product.*** Initial workshop held in Northampton, Massachusetts in October 1988, attended by over 160 wood stove retailers, chimney sweeps, housing and weatherization specialists and state energy staff from throughout the Northeast. Additional workshops were held in 1989 in Vermont and in 1990 in Pennsylvania. A workshop "notebook" published by NRBP includes:

- "Shoppers Guide to the New Wood Stove Law";
- questions and answers about indoor wood smoke;
- review of certified wood stoves and a description of low-emission catalytic and non-catalytic stoves;
- guides to stove installation and safety and to chimney construction and maintenance; and
- a resource list for further information.

**31. LESSONS LEARNED I**

***Obstacle/Opportunity Addressed.*** Stove sales in 1993 were about 20 percent of what they were in 1983. While declining oil prices and a weaker economy are chiefly responsible for this decrease, lack of consumer awareness also appeared to be a significant factor.

***Objectives.*** Increase awareness among consumers of improved safety and performance of the new generation of wood stoves, and enhance consumer purchases of clean-burning wood stoves, including both first-time stove purchases and change-outs of dirtier, less efficient stoves.

***Project Description.*** Five-pronged communications strategy to educate existing and prospective wood-stove owners about catalytic and non-catalytic stoves. Elements of the strategy include:

- the production of television public service announcements;
- the production of a longer instructional videotape on stove purchase, maintenance and operation;
- the development and dissemination of a comprehensive brochure on the same subject *(Burn It Clean, Burn It Right)*;
- the writing and placement of feature newspaper placement of radio talk show guests; and

- the development of a print advertising strategy based on the theme of changing out stoves for the environment.

***Findings/Final Product.*** Results of the Lessons Learned campaign are described in the first part of this section, in the Residental Wood Stove case study.

### 32. BURN IT CLEAN, BURN IT RIGHT

Although part of the "Lessons Learned" strategy (see above), the *Burn it Clean, Burn it Right* brochure was developed under a separate contract.

### 33. LESSONS LEARNED II

***Obstacle/Opportunity Addressed.*** Build on earlier NRBP communications strategy ("Lessons Learned I").

***Objectives.*** Promote the replacement of older (pre-1989), dirtier, less efficient wood stoves with new cleaner, more efficient stoves. Campaign scheduled to run from mid-January through end of February, 1994 in the New York-New England region.

***Project Description.*** Retail promotional campaign developed, with retailer input and in collaboration with the Northeast Regional Hearth Products Association.

***Findings/Final Product.*** Retail promotional campaign strategy developed; materials include: name, logo, two print advertisements, camera-ready headlines and copy points, a store banner design, and a product hang tag. Print, radio, and TV media targets established in seven-state region; spokesperson designated and radio tour organized; press release materials developed.

Impact of campaign documented through retailer surveys, phone interviews, review of sales data. (See Wood Stove case study.)

## Solid Waste Management and Resource Recovery

### 34. WOOD FUEL FEEDSTOCKS IN RESOURCE RECOVERY FACILITIES

***Obstacle/Opportunity Addressed.*** As part of continuing work exploring new markets for wood wastes, the NRBP sponsored a study to examine the technical and economic feasibility of mixing municipal solid waste (MSW) with wood chips in resource recovery facilities.

***Objectives.*** To identify the circumstances under which it is economical to add wood fuel to municipal waste; to determine if there are limitations to supplementing the waste stream with wood chips, bark and sawdust; and to identify examples of resource recovery projects in the Northeast which demonstrate economic and technological feasibility of co-firing wood and MSW.

***Project Description.*** The study profiled three projects, including a 22 MW plant and a 24.6 MW facility, both located in Maine. The study also examined wood procurement requirements and infrastructure, and analyzed woodfuel availability in four states. A model for doing financial analysis was created and applied to four scenarios, involving facilities of different sizes using varying MSW/wood ratios.

***Findings/Final Product.*** Five reasons for supplementing MSW with wood fuels in resource recovery facilities were identified, including the need for additional volume; the need for an interim/stopgap fuel; the need to diversify fuel sources; and emissions reduction requirements. The study concluded that wood and MSW are compatible solid fuels, and that there are no technological barriers to co-utilization. Meeting threshold fuel volumes and co-firing as an interim fuels strategy are the most probable short-term incentives. Project economics are highly sensitive to electricity purchase rates, the critical determinant of project feasibility.

### 35. COMPARATIVE RISKS OF LANDFILL AND RESOURCE RECOVERY FACILITIES

***Obstacle/Opportunity Addressed.*** A combination of rising disposal costs, landfill exhaustion and environmental degradation has spurred much public debate over solid waste management strategies. In 1988 the NRBP sponsored a study to provide policy guidance to state and local officials in comparing the health, safety, and environmental risks of landfills with those of state-of-the-art resource recovery facilities — options which will remain necessary even after aggressive source reduction and recycling strategies are implemented.

***Objectives.*** To inform decision-makers and the public about what is known and not known about the relative health and environmental risks of these two disposal options, and to suggest how such information can be used in formulating local and regional MSW management strategies.

***Project Description.*** The study developed a demographic and waste profile of a typical area of the Northeast. Assuming a waste stream first minimized by aggressive recycling, the study evaluated the risks to public health and safety, and to the environment, of disposing of the remaining wastes either in a landfill designed to meet all existing state and federal regulations; or in a state of the art mass-burn resource recovery facility using an ashfill for handling residual materials. Synthesizing studies providing quantitative and qualititative analyses of the nature and magnitude of various risk sources, the study identified specific hazards and developed estimates of potential detrimental impacts on the public. The study stressed the limitations of risk assessment figures, emphasizing that their value is not in absolute terms, but in terms relative to each other.

***Findings/Final Product.*** The study found that landfills fall into two types, with widely divergent risks. Uncontrolled landfills, which comprise the vast majority of the nation's active and

inactive facilities, present much greater risks than either controlled landfills or state-of-the-art mass-burn resource recovery facilities, which present risks within a comparable range. The study lists additional considerations concerning risks, and concludes with guidelines on communicating comparative risk information effectively.

### 36. EQUITY ADJUSTMENTS IN RESOURCE RECOVERY FACILITY SITING

***Obstacle/Opportunity Addressed.*** Resource recovery facilities are increasingly difficult to site in the Northeast, chiefly because those who bear the risks of these facilities are not necessarily those who benefit.

***Objectives.*** Come up with guidelines for resolving such disparities through the use of equity adjustments.

***Project Description.*** The NRBP examined the use of equity adjustments for host communities and developed guidelines to use in formulating such adjustments. The study began with a description of actual and perceived risks and surveyed existing resource recovery facilities to examine how different types of equity adjustment measures have been used to offset these risks.

***Findings/Final Product.*** The survey showed that monetary payment to the host community based on a facility's use is the most prevalent compensation. Payments in lieu of taxes, provision of special services and grants, and public service payments are also frequently used. Drawing on the experience of hard-to-site facilities in California and elsewhere, the study recommends procedures, principles and measures to use in formulating equity adjustment packages.

### 37. MODELING FUTURE WASTE STREAMS

***Obstacle/Opportunity Addressed.*** Planning for future resource recovery facilities must take into account the changing nature of the waste stream and the impact of recycling and source reduction requirements being put in place. Determining the energy value of a given ton of MSW depends a great deal what assumptions one makes about paper recycling, packaging, composting, recycling mandates, and landfill disposal costs.

***Objectives.*** To help municipalities, resource recovery facility operators, developers, and solid waste management officials at the state level understand current waste stream configurations and estimate future energy balances.

***Project Description.*** User-friendly software model developed to project the volume and energy value of future waste streams. By varying the assumptions, the planner can determine the cost-effectiveness of alternative waste management strategies.

***Findings/Final Product.*** The spreadsheet model, called WastePlan, was tailored to model the current and projected waste stream for each state in the Northeast region.

### 38. WOOD COMBUSTION EMISSIONS WORKSHOP(S)

***Obstacle/Opportunity Addressed.*** Waste wood is a potentially large resource for New York (over 400 MW equivalent in New York City). Yet there is concern that the combustion of contaminated wood for energy production might result in unacceptable impacts on air quality.

***Objectives.*** To identify barriers to increased use of waste wood for fuel (such as inconsistencies in applicable regulations), develop strategies for addressing the barriers, and identify future information and research needs.

***Project Description.*** The purpose of this project was to disseminate and discuss results of the landmark NRBP study "Wood Products in the Waste Stream: Characterization and Emissions Testing Protocol Development," and to identify key issues that impact the combustion of waste wood in New York. The workshop was designed to be a working session for public and private-sector officials involved in developing, siting, regulating, and permitting waste wood processing and combustion facilities.

***Findings/Final Product.*** Workshop held in New York State in 1992.

### 39. IMPEDIMENTS TO DEVELOPMENT OF LANDFILL GAS RECOVERY PROJECTS IN THE NORTHEAST

***Obstacle/Opportunity Addressed.*** The technology of converting landfill gas (LFG) to energy has been known for some time, and numerous LFG recovery projects have been operating in the West. However, despite the prevalence of landfills in the densely populated Northeast, the development of such projects has been slow in this region.

***Objectives.*** Assist potential developers of LFG projects, as well as policy and regulatory personnel, in understanding and realizing LFG development opportunities in the Northeast.

***Project Description.*** *Phase I:* Identify parameters for a successful LFG recovery project and identify potential impediments; develop project feasibility and siting criteria, and development strategies. *Phase II:* Develop database of active landfills over 100 tons-per-day (TPD) in the region, ranked by state for attributes favoring development; develop software package for estimating LFG yield and economic feasibility.

***Findings/Final Product.*** Handbook providing potential developers and other key decision-makers with LFG project feasibility criteria, technical siting criteria, and strategies for overcoming technical and other barriers to development. Model for estimating LFG yield and economic feasibility, available both in hard copy and as a software package.

### 40. COMPARATIVE ANALYSIS OF LANDFILL GAS RECOVERY TECHNOLOGIES

***Obstacle/Opportunity Addressed.*** There exist 4-5 alternative technologies for recovering energy from landfill gas (LFG), which are either not yet commercialized or recently commercialized.

***Objective.*** Identify which LFG recovery technologies are most favorable from project economics, efficiency, and environmental perspectives.

***Project Description.*** The anaylsis consists of a series of tabulations comparing alternative conversion technologies along the following parameters:

- efficiency, capital cost, power generation cost, and air emissions;
- impact on project economics of federal economic incentives and current purchase prices utilities in the region are required to offer for electricity from LFG projects of 5,000 kW or less;
- comparison of air emissions changes at landfill sites before and after implementation of each LFG conversion technology, for several source pollutants.

***Findings/Final Product.*** Final report expected to be available in early 1995.

## Environmental Issues

### 41. REGIONAL STRATEGIES TO MITIGATE THE ACCUMULATION OF GREENHOUSE GASES

***Obstacle/Opportunity Addressed.*** Growing concern about the accumulation of carbon dioxide, methane and other gases in the atmosphere, and the potential impact of these gases on global climate, has occasioned renewed interest in the role of biomass.

***Objective.*** Combat a common perception that links biomass energy development to deforestation and the exacerbation of the "greenhouse" effect.

***Project Description.*** The study consisted of a secondary literature review and policy analysis aimed at developing strategies to mitigate the region's net contribution to the atmospheric accumulation of carbon dioxide and methane through the careful management and utilization of biomass resource.

***Findings/Final Product.*** Far from resulting in deforestation, the study showed that increased reliance on biomass for energy depends on strengthening afforestation and forest management efforts, including urban forestry and short rotation crop production in addition to better management of existing forests. Though less thermally efficient than fossil fuels, given current commercial-scale combustion technologies, biomass is a "conditionally renewable" fuel which offers the possibility of closing the carbon cycle. The report suggests a need for discussion among foresters, ecologists, utility regulators, and other policymakers to ensure that biomass' full greenhouse gas mitigation potential may be realized. Report on findings, recommendations. Follow-up article published in *Biologue*.

### 42. WOOD ASH DISPOSAL AND RECYCLING "SOURCEBOOK"

***Obstacle/Opportunity Addressed:*** Approximately 125,000 tons of wood ash are produced annually in the region's industrial and commercial boilers. Currently, 80 percent of this is spread (as a liming agent) on agricultural lands, while another 15 percent is landfilled, at increasing cost to the facility which must dispose of the ash.

***Objective.*** Facilitate development and implementation of low-cost, environmentally acceptable uses for wood ash.

***Project Description.*** The Sourcebook summarizes disposal and utilization options, state and local wood ash disposal regulations, and related research on wood ash conducted in the United States and Europe.

***Findings/Final Product.*** The "Sourcebook" begins with a characterization of wood ash, and identifies additional utilization options besides spreading on agricultural lands. Uses include: spreading on forest lands, use as a sewage sludge composting agent, use in cement production, and as an additive to roadbase materials. The Sourcebook provides abstracts of 45 American and European research articles and identifies research and government and commercial contacts who might assist those interested in disposal options.

### 43. AIR EMISSION REGULATIONS FOR SMALL TO MODERATE SIZED WOOD-FIRED BOILERS

***Obstacle/Opportunity Addressed.*** One impediment to the full utilization of the wood energy resource is the perception among potential commercial wood burners that air pollution regulations pose special difficulties.

***Objectives.*** To provide potential wood energy users with information to evaluate the technical and economic feasibility of meeting their state's emissions standards.

***Project Description.*** The scope of work included a review of air quality standards in the eleven Northeast states and identification of those regulations applying to small and medium-sized units.

***Findings/Final Product.*** The study found that the emissions regulations and the minimum size of boiler to which they apply vary from state to state. Often, the applicable standards were not developed specifically for wood-fired boilers. In all states except Connecticut and Maryland, boilers less than 1 MMBTU/hr are exempt. The report includes an overview of particulate control operating strategies and equipment, and cites particulate control requirements by state. Beyond a number of general rules, however, case by case consultation with regulatory agencies is the only way to insure that specific requirements are taken into account.

### 44. STACK EMISSIONS STANDARDS AND RESIDENTIAL PARTICULATE EMISSIONS

#### STACK EMISSIONS STANDARDS FOR INDUSTRIAL WOOD-FIRED BOILERS

***Obstacle/Opportunity Addressed.*** A lack of emissions test data from industrial wood fuel combustion resulted in an inconsistent and sometimes inappropriate data baseline being used by different states in the development and modification of emissions standards. The consequent uncertainty surrounding state air emissions regulations has led to confusion for small- to moderate-sized industries considering conversion to wood. In 1985, the NRBP sponsored a project to address fundamental technical, economic and regulatory issues associated with the control of pollutant emissions from wood-fired industrial boilers in the region.

***Objective.*** To provide, in a single document, the best current emissions test data available for industrial wood fuel combustion in the Northeast region.

***Project description.*** The study identified: the current distribution of wood-fired industrial boilers in the Northeast; pollutants of concern from these boilers and their expected rates of emission; relevant federal and state regulations and the economic impact of meeting those regulations; and state-of-the-art combustion and emissions control technology.

***Findings/Final Product.*** One finding was that innovative methods of operation can eliminate the requirement for air pollution control equipment, or at least reduce its cost. The report discusses in detail the equipment design and operating practices, as well as the control technologies, that will reduce particulate emissions. Appendices to the report include the data on particulate and other emissions analyses which are referenced in the body of the report.

#### PARTICULATE EMISSIONS FROM RESIDENTIAL WOOD COMBUSTION

***Obstacle/Opportunity Addressed.*** In response to increasing community and regulatory concerns about air quality impacts from residential wood combustion, the NRBP initiated in 1985 a study to analyze its impact on ambient air quality and public health in the Northeastern states.

***Objectives.*** In addition to analyzing the impacts of residential wood combustion, the study investigated the appropriateness and feasibility for applying in the Northeast strategies similar to those recently implemented in Oregon and other western states. A secondary objective was to provide a resource document for states to use in analyzing and addressing localized air quality problems resulting from residential wood burning.

***Project description.*** The study included comprehensive review of emissions characterizations, impact analysis methodologies, relevant health effects, indoor air quality, and toxic air pollutant studies related to residential wood combustion.The study assessed emissions rates for total suspended particulates (TSPs) and benzo(a)pyrene (BaP) from wood burning stoves, estimated the impact on ambient air quality, and identified policy options available to the states.

***Findings/Final Product.*** The study found that in the 30 Northeastern counties exceeding primary or secondary national ambient air quality standards (NAAQS) for TSPs, the contribution of residential wood burning to TSP levels is very low compared to other point sources. Subsequent to the NRBP's completion of this study, the U.S. EPA promulgated standards for emissions from wood stoves and began a program of stove certification. Subsequent NRBP research made a major contribution to the development of certification standards (see above).

### 45. METHODOLOGY FOR CALCULATING ENVIRONMENTAL EXTERNALITIES THAT ACCOMMODATES BIOMASS FEEDSTOCKS

***Obstacle/Opportunity Addressed.*** In the valuation process undertaken by public utility commissions (PUCs), woody biomass is penalized because the full life-cycle of the resource is not included in the evaluation of its environmental externalities. As a result, biomass is treated as though its emissions impacts were comparable to those of coal.

***Objectives.*** Develop a credible methodology for incorporating the $CO_2$ sequestration impacts of growing biomass in an externalities calculation methodology.

***Project Description.*** In addition to surveying existing externalities valuation methodologies, the analysis involved the development of a proposed methodological approach, and the identification of existing PUC methodologies most amenable to such a modification.

***Findings/Final Product.*** Final report incorporating the findings, analyses, methodologies and recommendations, including opportunities to influence or modify the region's utility resource planning processes; and a strategy for pursuing the most promising opportunities.

## Regional Impacts

### 46. ECONOMIC IMPACTS OF WOOD ENERGY IN THE NORTHEAST

***Obstacle/Opportunity Addressed.*** An important argument for the development of a vigorous biomass energy industry in the Northeast has been wood's potential to displace imported fuels with local resources.

***Objectives.*** Determine the impacts of wood energy use on employment and income in the region.

***Project Description.*** The study gathered data on the volume of wood energy used and the fuels displaced. Direct employment impacts were determined for the activity categories of harvesting, transport, and end-use operations; a U.S. Forest Service model was used to assess the indirect impacts.

***Findings/Final Product.*** The report identified 78,000 jobs created in the eleven Northeast states by the wood energy industry. This estimate takes into account jobs displaced from the conventional fuel industries. The net employment gain from wood energy-related activities created $1.8 billion of personal income annually. The bulk of the new jobs and income were generated by the residential wood fuel industry; two-thirds of the 8.9 million tons of fuelwood consumed in the region's industrial sector were manufacturing by-products, thus generating relatively few new jobs and income. A major economic impact found was the savings which accrue to users as a result of displacing more expensive conventional fuels with wood.

Published reports from the project included a report for each of the eleven Northeast states, a regional summary, and a technical appendix. The project also produced a spreadsheet model for use in tabulating employment and income effects.

### 47. UPDATE ON ECONOMIC IMPACTS STUDY

***Obstacle/Opportunity Addressed.*** At a time when the economic impacts of biomass development are more important than ever, many of the crucial assumptions used to estimate those impacts in 1985 have changed dramatically.

***Objectives.*** Establish the economic impacts of biomass development in the Northeast, based on up-to-date information and assumptions.

***Project Description.*** Estimate and document the dollar savings, direct and indirect economic impacts, including job creation, associated with the wood energy industry.

***Findings/Final Product.*** Final report and regional presentations. Economic Impact Model to be developed and a simplified project version with manual and workbook developed for use by states.

### 48. GOVERNORS' ROUNDTABLE

***Obstacle/Opportunity Addressed.*** Governors and other top policymakers in state government do not fully appreciate the extent to which biomass already contributes, and can further contribute, to the region's energy mix and the sustainability of its economy. The Roundtable is designed to bring attention to these contributions, and to overcome some of the critical obstacles to the commercialization of biomass technologies in the Northeast region.

***Objectives.*** To raise the visibility and viability of regional biomass development activities, including the work of the NRBP; to identify barriers to the environmentally acceptable penetration of biomass technologies; to set clear goals and to establish a plan of actions for overcoming those barriers and meeting those goals.

***Project Description.*** A series of professionally-facilitated policy forums will be used to identify issues and suggest solutions among a relatively small but influential group of stakeholders in the region.

***Findings/Final Product.*** Final report of the Roundtable scheduled to be presented to the Governors in 1995.

## Support Contracts and Technology Transfer Activities

### 49-57. TECHNICAL COORDINATOR

***Obstacle/Opportunity Addressed.*** Long range planning and applied research project development require research and consultation activities above and beynd the administration and oversight of the Program, carried out by the Program Manager, and the direct conversion and biomass development assistance and other technology transfer activities carried out at the state level.

***Objective.*** Support the work of the Program Manager and Steering Committee.

***Project Description.*** The Technical Coordinator serves to coordinate strategic planning, the Steering Committee's project selection process and technical project review committees; research and prepare Requests for Proposals for technical and applied research projects; and otherwise support the Program Manager.

***Findings/Final Product.*** This work is ongoing.

### 58-62. REPORTS ON NRBP MISSION, ACTIVITIES AND ACCOMPLISHMENTS

***Obstacle/Opportunity Addressed.*** Technology transfer strategies are an integral part of the scope of work for individual projects undertaken by the NRBP, but outside of the periodical Biologue, there was no one published source of information about the Program and its work.

***Objective.*** Provide a ready reference for the NRBP and its member states, the other Regional Programs, DOE, and others interested in biomass energy development and the role and activities of the Regional Program.

***Project Description.*** See below for summary descriptions of each report.

***Findings/Final Product.*** The NRBP has published and distributed four reports introducing the Program and documenting its activities:

- Five-Year Report: 1983-1988
- NRBP Mission, Accomplishments, Prospects: 1991
- NRBP Mission, Accomplishments, Prospects: 1992
- NRBP Retrospective: 1983 to 1993

### 58-59. FIVE-YEAR REPORT, 1983-1988

Two separate contracts were involved in producing this five-year retrospective report, which introduced the Northeast Regional Biomass Program, its origins, mission, activities, and accomplishments over its first five years.

### 60. MISSION, ACCOMPLISHMENTS, PROSPECTS: 1991

This publication updated the information in the Five-Year Report, 1983-1988.

### 61. MISSION, ACCOMPLISHMENTS, PROSPECTS: 1992

This publication updated the 1991 report.

### 62. NRBP RETROSPECTIVE: 1983 TO 1993

This report is the latest in a series of reports summarizing and updating the activities and accomplishments of the Northeast Regional Biomass Program. Covering a period corresponding to that of the administration of the Program grant through DOE's Oak Ridge Operations Office, this report serves a double purpose as an account of activities conducted under the Oak Ridge grant, and as a reference document for Program participants and agencies and individuals interested in biomass development in the region.

### 63-68. SUPPORT FOR *BIOLOGUE* PUBLICATION

***Obstacle/Opportunity Addressed.*** Published by the National Bioenergy Industries Association (formerly the National Wood Energy Association), *Biologue* has been the main organ for the dissemination of applied technical and policy research and other projects carried on by the Regional Biomass Programs.

***Objective.*** Support the publication of *Biologue.*

***Project Description.*** In addition to regularly submitting articles on applied research and technical transfer projects carried on by the region and within each of the northeastern states, the NRBP has contributed financially to the publication of *Biologue.*

***Findings/Final Product.*** *Biologue* comes out three to four times per year.

# LOOKING AHEAD: THE 1993 LONG-RANGE PLAN

In 1993, the NRBP concluded its tenth program year and entered its second decade with a reassessment of the Program's accomplishments to date, its objectives and plans in the context of current biomass resource development issues and institutional considerations.

As in 1989, this long-range planning process took place over several months. The first phase of the exercise was to map out the major resources, conversion technologies, and end uses/users, and to identify in broad terms the opportunities for and barriers to forging and strengthening the connections among these categories. This phase included a review of available literature, consultation with experts and representatives of key stakeholders, including foresters, equipment manufacturers, air and solid waste regulators, wood stove trade associations, state energy offices, the U.S. Department of Energy, the U.S. Environmental Protection Agency, biomass consultants and contractors, landfill gas-to-methane plant operators, biomass facility managers, laboratory researchers, and other Regional Biomass Program directors. Materials were prepared to inform and guide discussions among Steering Committee members and Advisory Panels convened to address specific opportunities and barriers.

In addition to these substantive topic areas, the 1994 Long Range Plan identifies a number of opportunities for the NRBP to ensure that stakeholder participation and strategies for effective dissemination of research findings are routinely considered and consistently exploited.

An initital draft plan was submitted for review and comment by the Steering Committee.

The final phase of the planning process will be to integrate recommendations of two parallel planning and goal-setting efforts:

1) Regional Biomass Energy Programs Strategic Plan - a joint effort of all five regional programs to develop a strategic "roadmap" that identifies and describes opportunities for the Regional Programs to participate in major Federal initiatives, including: the Clean Air Act, Energy Policy Act, and the Climate Change Action Plan.
2) Governors' Biomass Policy Roundtable - convening representatives of utilities, private developers, researchers, environmental advocates, consumers, the forest and paper industries, and state regulatory and policy officials to discuss biomass potential, opportunities and concerns, and to advise the Northeastern governors on setting goals for biomass development in the region.

# APPENDICES

# PUBLICATIONS

## WOOD FUELS HARVESTING

*A Guide to Maryland's Regulation of Forest Products Industries: Energy Conservation, Energy Production and EnvironmentalProtection through Production and Utilization of a Renewable Resource.* State of Maryland Department of Natural Resources Forest, Park & Wildlife Service, June 1990.

* *Impact of Large Biomass Demand Centers on the Forest Resource Base.* Associates in Rural Development, Inc., August, 1986.

* *Evaluation of Residual Stand Damage Following Partial Cutting in Northern Forest Types.* Maine Audubon Society, June 1990.

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* Copies of starred publications can be obtained from:
CONEG Policy Research Center, Inc.
400 N. Capitol Street, Suite 382
Washington, DC 20001
(202) 624-8454

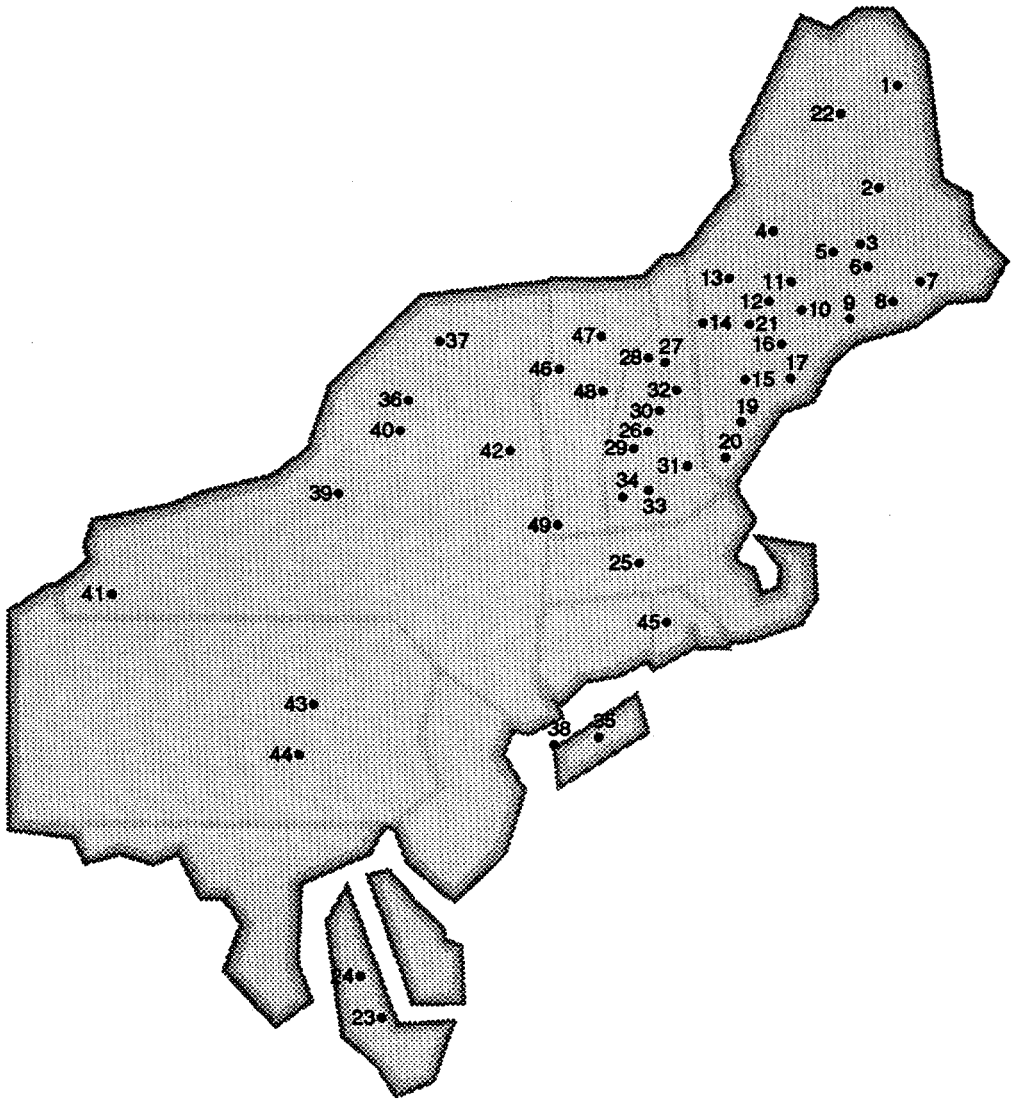
Copies of all other publications can be obtained from the Biomass Energy Contact person for the state, or from the author.

# WOOD-FIRED POWER PLANTS IN THE NORTHEAST

The map (page 78) and accompanying table show all existing, planned, and proposed wood-fired electric plants in the region, grouped by state.

There are currently no plants located or proposed in Connecticut[1], Delaware or New Jersey.

| *Map index* | *City/town* | *State* | *Owner/operator/plant name* | *Capacity(megawatts)* | *Status* |
|---|---|---|---|---|---|
| 1 | Ft. Fairfield | Maine | Fairfield Energy Ventures | 32.00 | Existing |
| 2 | Sherman Stn. | Maine | Wheelabrator Sherman Energy | 16.50 | Existing |
| 3 | Chester | Maine | Beaverwood | 15.39 | Existing |
| 4 | Greenville | Maine | Greenville Steam | 13.80 | Existing |
| 5 | Mattawamkeag | Maine | Forster Manufacturing | 1.00 | Existing |
| 6 | West Enfield | Maine | Ultrapower | 24.50 | Existing |
| 7 | Jonesboro | Maine | Ultrapower | 24.50 | Existing |
| 8 | Cherryfield | Maine | Down East Peat | 23.00 | Existing |
| 9 | Bucksport | Maine | Champion | 32.70 | Existing |
| 10 | Athens | Maine | Gorbell, Inc. | 13.65 | Existing |
| 11 | N. New Portland | Maine | Dirigo Dowell | 0.30 | Existing |
| 12 | Strong | Maine | Forster Manufacturing | 1.25 | Existing |
| 13 | Stratton | Maine | Stratton Energy Association | 36.80 | Existing |
| 14 | Rumford | Maine | Boise Cascade | 75.00 | Existing |
| 15 | Lewiston | Maine | Lewiston Steam & Power | 11.80 | Existing |
| 16 | Hinkley | Maine | Scott Paper Company | 45.49 | Existing |
| 17 | Winslow | Maine | Scott Paper Company | 18.80 | Existing |
| 18 | Searsmont | Maine | Robbins Lumber Company | 1.20 | Existing |
| 19 | Westbrook | Maine | Scott Paper Company | 62.50 | Existing |
| 20 | Sanford | Maine | AR Lavalley Lumber | 1.25 | Existing |
| 21 | Livermore Falls | Maine | Alternative Energy Inc. | 30.00 | Existing |
| 22 | Ashland | Maine | Alternative Energy Inc. | 30.00 | Planned |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| *Map index* | *City/town* | *State* | *Owner/operator/plant name* | *Capacity(megawatts)* | *Status* |
|---|---|---|---|---|---|
| 23 | Westover | Maryland | Eastern Shore Correctional Inst. | 2.20 | Existing |
| 24 | Linkwood | Maryland | Dorchester Lumber Co. | .75 | Existing |
| 25 | Westminster | Massachusetts | Kenetech Energy Systems, Inc. | 18.00 | Existing |
| 26 | Alexandria | New Hampshire | Alexandria Power Station | 15.00 | Existing[2] |
| 27 | Bethlehem | New Hampshire | Pinetree Power | 17.00 | Existing |
| 28 | Whitefield | New Hampshire | Whitefield Power & Light | 14.00 | Existing |
| 29 | Springfield | New Hampshire | Hemphill Power & Light Co. | 13.00 | Existing |
| 30 | Bridgewater | New Hampshire | Bridgewater Steam & Power | 18.00 | Existing |
| 31 | Barnstead | New Hampshire | Timco | 4.00 | Existing |
| 32 | Tamworth | New Hampshire | Pinetree Power | 20.00 | Existing |
| 33 | Concord | New Hampshire | New Hampshire Hospital | 2.00 | Existing |
| 34 | W. Hopkinton | New Hampshire | Bio Energy | 12.00 | Existing |
| 35 | Bay Shore | New York | Hubbard Sand & Gravel | 3.00 | Existing |
| 36 | Lyonsdale | New York | Diamond Energy | 19.00 | Existing |
| 37 | Chateaugay | New York | Kenetech Energy Systems | 17.00 | Existing |
| 38 | Staten Island | New York | Owl Development | 25.00 | Planned |
| 39 | Geddes | New York | Atlantic Energy Systems, Inc. | 5.00 | Planned |
| 40 | Rome | New York | Atlantic Energy Systems, Inc. | 7.50 | Planned |
| 41 | Ellicottville | New York | Ellicottville | 4.00 | Proposed |
| 42 | Whitehall | New York | Meridien Group (developers) | 20.00 | Proposed |
| 43 | Montgomery | Pennsylvania | Koppers Industries, Inc. | 10.00 | Existing |
| 44 | Northumberland | Pennsylvania | Viking Energy | 18.50 | Existing |
| 45 | Johnston | Rhode Island | Louis Vigrano | 5.00 | Proposed |
| 46 | Burlington | Vermont | Burlington Electric Department | 50.00 | Existing |
| 47 | Gillman | Vermont | Simpson Paper | 3.00 | Existing |
| 48 | East Ryegate | Vermont | Ryegate Wood Energy Company | 18.00 | Existing |
| 49 | Bennington | Vermont | To Be Announced | 20.00 | Proposed |

[1]An agreement was struck between Connecticut Light & Power and developers of wood-fired plants planned for Torrington and Killingly to rescind the power purchase contracts and cancel both projects. The agreement was approved in June 1992, by a special act of the Connecticut Legislature. A 24 MW plant planned for Naugatuck has also been cancelled.

[2]Pulp and paper mills and a variety of other facilities in New Hampshire and Pennsylvania use primarily biomass fuels to cogenerate thermal and electric power, all or most of which they use on site. These cogenerators account for approximately another 35 megawatts in New Hampshire and another 50 megawatts in Pennsylvania.