Emissions from Burning Wood Fuels Derived from Construction and Demolition Debris

Prepared by
NESCAUM

May 2006

Members of Northeast States for Coordinated Air Use Management

Emissions from Burning Wood Fuels Derived from Construction and Demolition Debris

Prepared by
NESCAUM

May 2006

Emissions from Burning Wood Fuels Derived from Construction and Demolition Debris

<u>Project Director</u>
Lisa Rector, NESCAUM

Acknowledgments

NESCAUM gratefully acknowledges the funding support provided by the New Hampshire Department of Environmental Services.

NESCAUM also thanks the following individuals for contributing to this effort:

Marc Cone, Maine Department of Environmental Protection
Doug Eliot, Vermont Department of Environmental Conservation
Mike Jennings, New York Department of Environmental Conservation
James McQuade, Massachusetts Department of Environmental Protection
Doug McVay, Rhode Island Department of Environmental Management
Gary Rose, Connecticut Department of Environmental Protection
Donald Squires, Massachusetts Department of Environmental Protection
Craig Wright, New Hampshire Department of Environmental Services

Printed: July 2006

TABLE OF CONTENTS

Executive Summary

This report was undertaken by the Northeast States for Coordinated Air Use Management (NESCAUM) to gain a better understanding of emissions and related environmental issues from the use of construction and demolition (C&D) wood for power generation. As the cost to dispose C&D materials increases, companies are investigating alternatives, such as energy recovery and power production, to lower disposal rates and thereby lower overall costs.

The use of biomass fuels, such as wood derived from C&D debris, as an energy source has become more attractive in today's economic and regulatory climate. Current estimates indicate that it costs $10 to $20 less per ton of wood to process wood chips for fuel than to send it to a landfill.[1] Two other factors also support the use of C&D wood for fuel: (1) the increased cost of oil and natural gas and (2) the increased regulatory incentives to use renewable energy sources.

Until recently, the economic viability of biomass-fired electric generating units (EGUs) was questionable. Now, with the rising cost of natural gas and oil, the increased control costs related to coal use, and the availability of renewable energy credits (RECs) for biomass generated electricity, interest in the use of virgin biomass and C&D wood has increased. To date, three states in the NESCAUM region have received permit applications proposing new wood-fired power plants that could be fired with wood derived from C&D waste. The proposed facilities are in Athens, Maine, Russell, Massachusetts, and Hinsdale, New Hampshire. In addition, some existing plants are assessing the addition of C&D wood to their fuel profile.

While public response and perception to the use of C&D woodchips for power generation has been strongly negative, a review of the data shows that the use of appropriately processed C&D wood is similar in its emission profile to that of virgin wood[2] and other power generation fuels such as coal and oil. It is likely that control requirements for plants opting to burn wood derived from C&D would be similar to or more stringent than that required for plants burning virgin ("clean") wood. For example, air pollution controls proposed for the plant in Athens, Maine would include control equipment similar to that found on municipal waste combustors.

The restrictions on the use of C&D wood vary throughout the region, as seen in the summary given in Table ES-1. Only New Hampshire, via a temporary moratorium likely to continue until December 31, 2007, has restricted the use of C&D wood for fuel. Other states do not have official restrictions, but do place operational limitations on these sources through their regulatory process. Three states in the NESCAUM region, Maine, Massachusetts and New Hampshire, have companies who have expressed interest in constructing new power plants that could be permitted to burn C&D wood.

The report finds that a critical element for use of C&D wood as a fuel source is the development of strict fuel standards. The elimination of treated wood such as

[1] Concord Monitor, "Bio Energy foes: State may become 'dumping ground,'" November 7, 2004. Available at http://www.cmonitor.com/apps/pbcs.dll/article?AID=/20041107/REPOSITORY/411070323/1001/NEWS01 (accessed April 19, 2006).

[2] In this report, we consider virgin wood as wood chips derived directly from the harvesting of trees.

chromated copper arsenate (CCA) wood and penta-treated wood significantly reduces arsenic emissions. Furthermore, fuel standards minimizing contamination from other C&D materials and removing C&D fine material (known as "fines")[3] from the fuel chips increases fuel quality substantially, resulting in lower metal and other air toxic emissions. Finally, requirements for comprehensive testing and sampling of the fuel at both the processing facility and the location of the end user will assure that the fuel quality is maintained.

Table ES-1. Summary of C&D Wood Activities in New England

State	
Connecticut	• In-state generation of C&D wood is approximately 450,000 tons per year (tpy). • Processed C&D wood may be disposed of at a resource recovery facility (RRF) in accordance with regulations pertaining to "special waste" that subject such wastes to uniform procedures for screening, testing, acceptance, record-keeping, handling, and disposal. • C&D wood may be landfilled. • No specific ban on C&D wood combustion. • CT DEP permitted a RRF to burn C&D wood as part of the approved feed mix.
Maine	• In-state generation of C&D wood is approximately 145,000 tpy. • C&D wood may be landfilled. • No specific ban on C&D wood combustion. • Several wood boilers are permitted and in operation to combust C&D wood. Maine's regulations allow up to 50% of the fuel to come from C&D wood. • Application filed by GenPower for construction of a 40 MW facility in Athens, ME. The facility has proposed to combust up to 100% C&D wood. Recent legislative action would limit use of C&D wood to 50% annually. The 50% limit will be evaluated in a report to the legislature from the Department next year.
Massachusetts	• In-state generation of C&D wood is approximately 400,000 tpy. • Effective July 1, 2006, the landfilling of all wood will be prohibited. • Massachusetts is not proposing a ban on C&D wood combustion facilities. It would allow municipal waste combustors to continue receiving and combusting C&D wood, although this appears to be a very small amount of the total C&D wood generated in the state. • Massachusetts has not issued permits for any C&D wood combustion facilities at this time. • Application filed for a 50 MW facility in Russell, MA. GenPower has expressed interest in building a C&D wood-fired power plant in Barre, MA.

[3] "Fines" are defined as material passing through a #4 sieve with a 0.187 inch (4.75 mm) opening.

State	
New Hampshire	• In-state generation of C&D wood is approximately 160,000 tpy, virtually all of which is sent to combustors in Maine. • C&D wood may be landfilled. • Moratorium on C&D wood combustion scheduled to sunset on June 30, 2006 but legislation is pending to extend this until December 31, 2007. • If the moratorium is lifted, then new facilities requesting a permit to combust C&D material must comply with "enhanced" BACT (for lead, mercury, and dioxin), perform a health risk assessment, and submit (and comply with) a fuel monitoring plan. These requirements would be in addition to the "traditional" BACT requirement (for pollutants such as particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and lead, as applicable).
Rhode Island	• In-state generation of C&D wood is approximately 30,000 tpy. • C&D wood is currently processed for use as landfill erosion control cover or as a boiler fuel. • No permitted C&D wood combustion facilities at this time. • On August 4, 2004, the Massachusetts Division of Energy Resources (MA DOER) gave an advisory ruling to GenPower to qualify for Renewable Energy Credits for a 20 MW C&D wood-fired plant in Rhode Island. GenPower, however, has had no formal discussions with RI DEM and has not filed an application with RI DEM for an air permit.
Vermont	• In-state generation of C&D wood is approximately 20,000 tpy. • C&D wood is currently landfilled, or shipped out of state to be used as landfill cover or as a boiler fuel. • One 50 MW facility (McNeil) is permitted to burn non-painted demolition wood on a case-by-case basis.

1. INTRODUCTION

The boom in construction and remodeling activities in the Northeast has increased the amount of construction and demolition (C&D) debris across the region. At the same time, landfill space continues to shrink, and the permitting and siting of new landfills are increasingly difficult to complete. Along with landfill issues, a surge in fossil fuel prices and economic incentives created by renewable energy policies in various states, such as Massachusetts, have increased interest in using wood chips derived from C&D as a fuel source for power plants. The potential for greater use of C&D wood in power generation makes its management an emerging area of environmental and public health concern.

Waste wood represents an alternative to the combustion of fossil fuels and virgin wood. Regulators, the environmental community, and the general public are concerned that the waste wood may be contaminated with paint, adhesives and other building materials, which could potentially create unacceptable levels of air pollution. In order to gain a better understanding of this issue, NESCAUM has compiled data to provide an overview of the current and potential use of biomass in the Northeast, the makeup of C&D wood chips, the existing emissions test data, and a comparison of pollution limits between C&D wood and other fuel sources.

There are several critical questions that need to be addressed:

- What are the likely contaminants in wood chips?
- How do emissions from C&D wood chips differ from other waste wood or virgin wood?
- What emission controls are necessary to ensure that the public is protected from the emissions from these facilities?

The following sections of this report present information pertaining to these questions in order to inform policymakers and the public on the emerging use of C&D wood as a combustion fuel for power generation.

2. C&D WOOD CHARACTERIZATION

Construction debris and demolition debris are often thought of as a single type of waste because they are typically discarded together at processing facilities or landfills. These waste streams, however, come from two entirely different processes. For example, demolition debris from older buildings is likely to contain plaster, while new construction debris may contain significant amounts of drywall, laminates, and plastics.

The total amount of wood contained within the construction and demolition waste streams varies from 15% to 85% (based on weight).[4] Table 2-1 provides average composition rates by activity type. In 2002, construction and demolition activities generated 29.9 million metric tons of usable waste wood nationwide. This translates into potential power generation from waste wood of 2,920 MW.[5] New construction or remodeling generated an estimated 19.3 million tons of waste wood nationwide, while estimates indicate that 10.6 million tons of waste wood were recoverable from demolition activities in 2002.[6]

Table 2-1. Average Composition of C&D Waste[6]

Material	*Residential Construction*	*Residential Remodeling*	*Residential Demolition*	*Non-residential Demolition*
Wood	42%	45%	42%	16%
Drywall	27%	21%		
Brick	6%			1%
Roofing	6%	28%		1%
Concrete			24%	66%
Plastics	2%			
Metals	2%	1%	2%	5%
Misc.	15%	6%	32%	11%

2.1. Construction Waste Characterization

Construction waste originates from construction, repair or remodeling activities. The materials generated from these activities tend to be clean and readily separated prior to disposal or processing. This waste stream typically consists of a variety of building products such as roofing, gypsum wallboard, and wood products. The waste wood tends to consist of wood scraps from dimensional lumber, siding, laminates, flooring (potentially stained), laminated beams, and moldings (potentially painted).

2.2. Demolition Waste Characterization

Demolition waste comes from the destruction of buildings or other structures. Typical constituents include aggregate, concrete, wood, paper, metal, insulation, glass, and other building materials. Waste from this process is often contaminated with paints,

[4] C.T. Donovan Associates, Inc., Waste Wood Resource Supply Assessment, NYSERDA, August 1990.
[5] This figure assumes that it takes 10,000 tons of waste wood to fuel one MW of generation capacity.
[6] NEWMOA, Interstate Flow of Construction and Demolition Debris Waste among NEWMOA States 2002, January 20, 2005.

fasteners, adhesives, wall covering materials, insulation, and dirt. EPA analysis suggests that the composition of demolition debris varies significantly, depending on the type of project from which it comes.

2.3. C&D Processing

Wood from C&D activities becomes available for combustion fuel through a variety of methods. Typically, C&D wood chips used for energy recovery come from a processing facility. Municipal haulers, private haulers, construction companies, or individuals can deliver the waste wood to the processing facility. The waste wood can arrive commingled with other C&D debris such as gypsum wall board, metals, and plastics, or it may arrive sorted. Depending on the facility, the waste may be processed in commingled form or the wood may be separated before processing.

Waste wood processed for use as a fuel typically requires removal of non-wood materials and size reduction into chips prior to its use. Fuel specifications for wood-fired power plants usually include minimum and maximum sizes, amount of C&D fines, maximum moisture content, and amount of contaminants.[7]

An issue related to processing is the lack of clear guidelines on how to differentiate between "clean" and "treated" wood. Most processors consider pallets, plywood, spools, furniture scraps, mill residue, particleboard, painted wood, and demolition wood as clean and acceptable for use as fuel chips. Processors, however, may differ on their sorting methods for creosote-treated, penta-treated, and CCA-treated wood. This can have a significant effect on fuel chip quality. Additional factors that can affect fuel quality include the processing facility's ability to remove non-wood materials, such as plastics. Critical factors affecting a processing facility's ability to produce high quality fuels are:

- Amount of redundancy in the processing line
- Amount of time waste spends at "cleaning" stations
- Composition of materials when it arrives at the cleaning station
- Design capacity versus actual operating capacity of the processing equipment[8]

2.4. Composition of C&D Wood Chips

In 2004, the Maine Department of Environmental Protection (Maine DEP) conducted a study analyzing the C&D wood chips used as fuel at the Boralex Athens Energy facility in Athens, Maine. The Maine study examined the type, size, and chemical content of the chips.

[7] Arcate, Jim. Waste Wood for Fuel on Oahu, Hawaii. Available at http://techtp.com/archives/waste%20wood.htm (accessed April 19, 2006).
[8] C.T. Donovan Associates, Inc. Waste Wood Resource Supply Assessment. NYSERDA, August 1990.

The study divided the samples into six categories:

- Plastics, including plastic laminates and synthetic carpeting
- Painted wood (painted non-CCA treated wood)
- Pressure-treated (PT) wood, including CCA- and penta-treated wood
- Burnable wood, including non-painted, non-CCA wood, plywood, oriented strandboard, particle board, cardboard, and paper
- Non-burnable debris, including nails, stones, and wire
- Fines, which likely include materials from all of the above categories

The Maine study analyzed five municipal samples and three commercial samples. Figure 2-1 illustrates the results. In general, two-thirds of the material was untreated wood. C&D fines were 20% to 26% of the total mass. The study concluded that, the fines in the fuel had the highest concentration of metals and dioxin. The small particles of various C&D materials caused many Maine facilities that purchased C&D fuel chips to place limitations on the use of fines in the fuel. Painted wood, pressure-treated wood, non-burnables, and plastic made up less than 10% of the total mass. The study concluded that the majority of arsenic in the fuel came from pressure-treated wood.

2.5. Wood Generation Rates and Processing Capacity

Formal tracking methods regarding the amount of waste wood generated from construction and demolition activities have not been tracked by the States or EPA. However, using available information, we estimate that New England and a portion of southern New York generate about 1,735,000 tons per year of C&D waste wood annually.[9] Figure 2-2 shows the estimated C&D generation by state.

Much of this waste is disposed of in landfills. Increasingly, however, shrinking landfill capacity and increased tipping fees have diverted this waste stream to C&D processing facilities. Therefore, the key factor in producing power with C&D derived wood is the capacity of C&D processing facilities. While this report was not able to verify the actual amount of wood produced by C& D processors for energy recovery purposes, we estimate that the region has the capacity to that C&D wood could provide power to support 173 MW of power generation capacity. However, if C&D processing capacity were maximized, the region could supply 500-600 MW of generation capacity.

[9] We estimate this amount based upon information provided to NESCAUM by state solid waste programs and trade association representatives.

Figure 2-1. Analysis of C&D Wood Chips

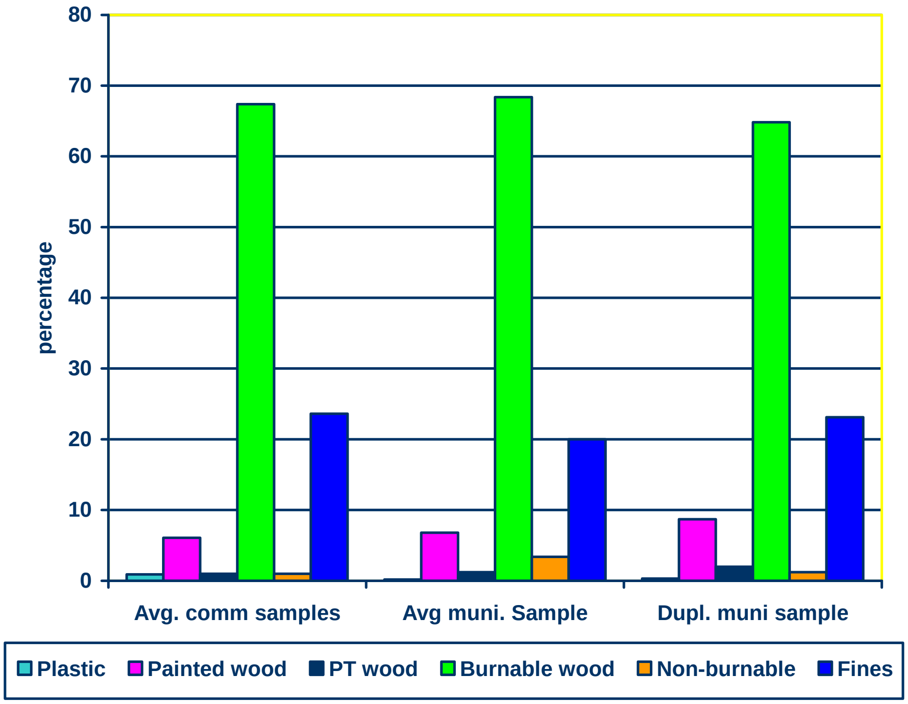
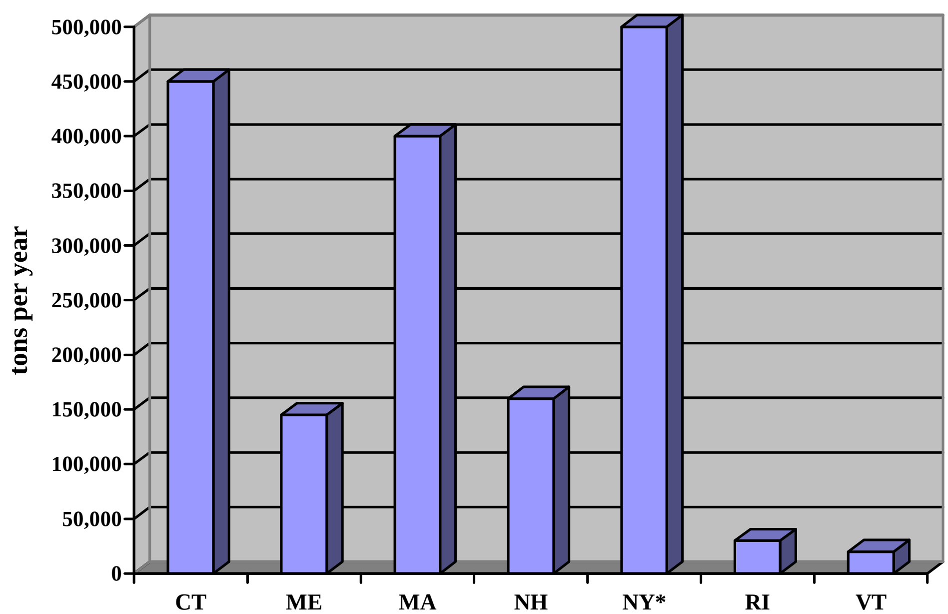


Figure 2-2 C&D Generation Rates



*This captures the portion of waste generated in Southern New York

3. USE OF C&D WOOD FOR ENERGY RECOVERY

While the use of C&D wood has been limited in the Northeast, a study conducted by the Coalition of Northeastern Governors (CONEG) identified nineteen facilities nationwide that have been permitted to burn waste wood as a fuel source. These facilities, located in California, Florida, Maine, Michigan, Washington, and Wisconsin, represent 509.9 MW in total capacity (detailed information on these facilities can be found in Appendix A). Depending on state regulations, the waste wood burned at these facilities includes a mix of agricultural waste, urban wood waste, C&D wood, and creosote-treated and pentachlorophenol-treated wood.

Table 3-1. Overview of Generation Capacity of C&D Wood Facilities

State	# of Facilities	Total MW
California	9	256
Florida	1	40
Maine	4	98
Michigan	3	67.4
Washington	1	18.5
Wisconsin	1	30

In addition to national generation capacity from waste wood, the CONEG study also quantified annual generation in megawatt-hours (MWh) from combustion of wood and waste wood. The generation from wood combustion for all states in the Northeast follows:

- Connecticut None
- Maine 2,568,527 MWh
- Massachusetts 100,463 MWh
- New Hampshire 810,891 MWh
- New Jersey None
- New York 717,552 MWh
- Rhode Island None
- Vermont 397,362 MWh

The following section provides details for the information provided above. In addition, the state summaries provide a detailed overview of the types of biomass-related power generation in the state and the likely application of air pollution control regulations on new facilities.

3.1. Connecticut

There are no large, wood-fired boilers in Connecticut. If Connecticut were to receive an application to construct a biomass-fired power plant, each project would be reviewed on a case-by-case basis. It, however, is likely that the state would limit the total percentage of C&D derived fuel that could be used.

3.2. Maine

Maine has ten large wood burning power plants, two of which burn C&D wood chips. There are also many smaller boilers throughout the state. Maine has experienced fire and smoke problems due to poor fuel pile management practices.

Any new facility proposed for construction in Maine would have emission limits set by Best Available Control Technology (BACT), Maine's Ambient Air Quality Standard and Ambient Air Toxicity Guidelines, determined by stack testing and modeling. Currently, the state is revising its Beneficial Use Licensing regulations for C&D woodchips. The current solid waste rules define any unit that burns greater than 50% C&D as an incinerator. In addition, Maine DEP would require that the C&D fuel maintain a sampling management plan that would remove chemically treated wood and wood mixed with roofing and other non-wood related demolition products in order to comply with the state's Solid Waste Bureau's Schedule of Compliance Requirement.

GenPower Athens is proposing to build a biomass electric generating facility at the former Boralex/Gorbell-Thermoelectron site in Athens, Maine. The company has proposed the construction of two boilers with each having a heat input rating of approximately 300 mmBtu/hr. If it is built, the facility will be capable of operating on 100% whole tree chips, sawmill residue, bark, or other "clean" waste wood, or 100% C&D wood fuel, or any combination of these fuels. Appendix B provides the proposed BACT emission limits information.

3.3. Massachusetts

Massachusetts has one wood-fired power plant, Pine Tree Power, which burns "clean" wood. In addition, there are a number of smaller wood-fired boilers operating in the state. Currently, the Massachusetts Department of Environmental Protection (MA DEP) has an application pending from Russell Biomass to construct a new 50 MW wood-fired facility in Russell, Massachusetts. In addition, recent reports indicate that GenPower plans to propose construction of another wood-fired facility in Barre, Massachusetts that would be capable of burning a large percentage of C&D wood chips.

A significant regulatory driver for burning wood in Massachusetts is the renewable energy credits (RECs) provided to facilities that burn approved renewable materials. The RECs currently are trading at $51 per MWh, and are paid to the generating facility. For this reason, wood burning has become increasingly appealing and profitable.

3.4. New York

New York has two major boilers in the state and a number of small boilers at manufacturing facilities that burn wood. The wood entering these boilers is visually screened to check that it is clean. The Boralex plant in Chateguay is permitted to burn only “clean” recycled wood.

If a facility were to propose the use of C&D wood as a fuel source, the New York Department of Environmental Conservation would subject the source to emission controls required for municipal solid waste combustors.

3.5. Vermont

Currently, there is one wood-fired power plant in the state – McNeil. This plant burns “clean” wood. While there are no incinerators in Vermont, the state does allow on-site burning of plywood scrap.

If a new plant were to be proposed for Vermont, it is likely that Vermont’s Air Toxics regulations would make it unlikely that burning of C&D wood chips would be allowed.

4. REGIONAL AIR EMISSION REQUIREMENTS

NESCAUM surveyed seven northeastern states – Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island and Vermont – on industrial use of biomass and C&D wood for energy generation. The following section provides an overview of the findings.

4.1. Criteria Pollutants

A survey of Northeast state permit programs found that all states require the installation of BACT or LAER controls for criteria pollutants and compliance with air toxics limits wood-burning power generation. Several factors affect the establishment of emission limits, such as time of application and classification of the source as an energy producer or incinerator (which often differs depending on the type and amount of C&D fuel burned). NESCAUM encountered difficulties in comparing emission requirements between states since each state has a slightly different method for calculating emission limits. As a result, only Massachusetts was able to provide data for all the criteria pollutants. Table 4-1 provides an overview of state emission limits that states have established for other types of power generation facilities , these limits do not necessarily reflect actual operating limits for burning of C&D wood. The table below does not have information for Connecticut, Rhode Island, and Vermont due to lack of facilities using C&D wood chips. Massachusetts has begun the process to revise their standards for solid biomass fuels, so it is likely that the Massachusetts limits will be revised.

Table 4-1. State Comparison of Emission Limits

Pollutant	Maine	Mass	NH	New York
CO lb/mmBtu	0.25 - 0.5	0.11→0.25	0.10 → 0.5	0.22
NO_x lb/mmBtu	0.15→0.30	0.075→0.093	0.075 → 0.33	
PM lb/mmBtu	0.02 – 0.04		0.01 → 0.10	
SO_2 lb/mmBtu	0.05	0.025	0.01 → 0.10	
VOC lb/mmBtu	0.016	0.011	0.005 → 0.096	
Ammonia	0.01 lb/mmBtu	13 ppm → 25 ppm @ 3% O2	10 ppm @ 7% O2 → 20 ppm @ 6% O2	
Opacity	20%	10%		
HCL	0.09 lb/mmBtu		10 → 20%	
Arsenic, Antimony, Beryllium, Cadmium, Chromium III, Chromium VI, Copper, Lead, Mercury, Nickel, and Selenium (wood containing C&D wood)	0.000009 lb/mmBtu for mercury	85% removal of mercury and 99.9% removal of the other metals. Ambient modeling to assure compliance.		

4.2. Hazardous Air Pollutants

In addition to data on emission limits for criteria pollutants, NESCAUM also collected data on air toxics emission limits from biomass burning facilities in four states: Connecticut, Vermont, Rhode Island, and Maine. Each state has slightly different methods and thresholds for calculating air toxics impacts, and Table 4-5 provides data on emission limits.

Connecticut bases its allowable emission levels on a Hazard Limit Value (HLV) for each compound. The state calculates Maximum Allowable Stack Concentrations (MASC) for discharge points less than or equal to 20 meters or greater than 20 meters in height that are based on the flow rate and the distance to the nearest property line.

Rhode Island has established Acceptable Ambient Levels (AALs) for certain air toxics. Sources are required to demonstrate, through the use of air quality modeling, that emissions from the facility will not cause an increase in the ground-level concentration of an air toxic in exceedance of the AAL.

Vermont sets “action levels” for air toxics emissions from these facilities. These action levels are applied differently for existing or new stationary sources. The state “grandfathers” existing facilities and does not require additional controls. However, if an existing facility has a modification that increases its actual emissions beyond the action levels, then Vermont requires a review of controls and establishes source-specific limits. For new stationary sources, if actual emissions are less than the action levels, then Vermont requires no additional controls. If the actual emissions exceed the action levels, the state requires a review of controls and establishes case-by-case emission rates based on this review.

4.3. Emissions Testing

Several studies have been completed analyzing air emission from facilities burning C&D wood. Maine DEP conducted stack tests at Boralex Stratton, Boralex Livermore Falls, and SAPPI Westbrook. The following section provides an overview of the results.

4.3.1. Boralex Stratton and Livermore Falls

As part of an enforcement action, Maine DEP conducted a series of stack tests at the Boralex Stratton and Boralex Livermore Falls wood burning facilities to determine potential dioxin, furan and arsenic emissions that could occur from the burning of C&D fuel. The tests consisted of three test burns consisting of 100% clean wood, 90% clean wood with 10% C&D wood and penta-treated wood, and 50% C&D and 50% penta-treated wood. The study found that levels of arsenic and dioxin for all three runs were well below Maine's air quality guidelines. Actual arsenic emissions ranged from 0.01 - 0.16 ng/dcsm, which are well below levels found at well-controlled municipal waste combustors. Maine DEP modeled the results and compared them to ambient concentrations, and the impacts were below the guidelines, even using worst-case assumptions. In addition, the 10% mix had lower dioxin levels than the test using 100% clean wood. The report concluded that an electrostatic precipitator (ESP) was an effective control technology for lead removal.

4.3.2. SAPPI Westbrook

Maine DEP conducted stack testing at the SAPPI Westbrook facility. Based upon these test results, Maine DEP modeled the potential impacts for a facility that burned a mix of clean wood, C&D wood, and coal. Table 4-2 compares the results of the scaled impact of burning C&D wood at the SAPPI Westbrook facility with Maine's Ambient Air Guidelines and New Hampshire's emission limits. This comparison indicates that burning of C&D wood would not violate existing emission standards.

Table 4-2. Modeling Results of SAPPI Test Results

Metal	SAPPI Trial Burn Scaled Impact* ($\mu g/m^3$)	NH DES Limits	Maine Bureau of Health Ambient Air Guideline
Arsenic	0.00062	0.024	0.002
Cadmium	0.000039	0.005	0.006
Chromium	0.00029		N/A
Copper	0.00039	2.4	2
Lead	0.0034	0.12	N/A
Manganese	0.00088		0.05
Mercury	<0.00029	0.3	0.3

*Scaled Impact Analysis is a worst-case analysis

4.4. BACT Determinations

The most recent BACT analysis for a wood burning power plant was submitted to the Maine DEP in 2005 as a requirement of GenPower's Athens permit application. GenPower's consultant reviewed the data in EPA's RACT/BACT/LAER Clearinghouse to identify control technology determinations pertaining to the combustion of biomass and C&D wood in boilers. The review concluded that there were no recent BACT determinations for biomass power plants proposing to burn C&D materials. There were entries, however, for biomass combustion and waste wood in boilers.

Table 4-3 summarizes the proposed BACT levels (center column) for the given air pollutants (left-side column) for the GenPower Athens plant. For purposes of comparison, the right-side column of Table 4-3 lists the most stringent emission limits for existing plants that NESCAUM identified in its survey. This table illustrates that the proposed BACT limits are comparable or more stringent than those currently required for biomass facilities. In addition, Table 4-4 provides a comparison of GenPower's proposed BACT levels with emission limits for existing plants burning other fuel types. With the exception of natural gas, the limits are as stringent as or more stringent than the emission limits imposed on coal, "virgin" wood, distillate, and oil-fired power plants. From these data, it appears that facilities with such BACT emission limits will emit no more pollution than other fuel sources.

Table 4-3. Comparison of Proposed BACT limit with current emission limits

Pollutant	Proposed BACT limits for GenPower, Athens, ME	Lowest emission limits from NESCAUM survey
PM_{10}	0.01 lb/mmBtu	0.02 lb/mmBtu
NO_x	0.075 lb/mmBtu	0.075 lb/mmBtu
SO_2	0.02 lb/mmBtu	0.025 lb/mmBtu
HCl	0.02 lb/mmBtu	0.09 lb/mmBtu
CO	0.08 lb/mmBtu	0.11 lb/mmBtu
VOC	0.005 lb/mmBtu	0.011 lb/mmBtu
Hg	0.000003 lb/mmBtu	0.000009 lb/mmBtu
NH_3	10 ppm @ 7% O2	

Table 4-4. Comparison of Proposed BACT limit with other fuel types

Pollutant	C&D Wood Proposed BACT for GenPower Athens, ME	"Virgin" Wood	Coal	Distillate	Natural Gas	#6 Fuel oil
PM10 (lb/mmBtu)	0.01	0.025	0.025-0.270	0.02-0.04	0.004-0.053	0.053
NOx (lb/mmBtu)	0.075	0.075	0.075-0.25	0.035	0.009-0.20	0.20

Table 4-5. Air Toxics Ambient Limit Overview

	Connecticut	Vermont	Rhode Island			Maine		
Pollutant	8hr HLV $\mu g/m^3$ (unless noted)	Action Level lbs/hr	$\mu g/cm^3$	24 hr $\mu g/cm^3$	Annual $\mu g/cm^3$	$\mu g/cm^3$	24 hr $\mu g/cm^3$	Annual $\mu g/cm^3$
Acrolein	5	0.11	0.1	0.02				
Antimony Compounds	10	2.1		0.2	0.021			
Arsenic Compounds	0.05	0.000019	0.2		0.0002			
Beryllium Compounds	0.01	0.0001		0.02	0.0004			
Cadmium Compounds	0.4	0.000047		0.01	0.0006			
Chromium Compounds		0.0000071					0.3	0.05
Chromium (II)	10							
Chromium (III)	10							
Chromium (IV)	0.5	0.01	100		2			
Chromium VI, Mist and Aerosol				0.008	0.00008			
Chromium VI, particulate				1	0.00008			
Copper Compounds	20	4.2						
Dioxin/Furan (TEQ equiv)	0.7 pg / 8 hour	0.0000000016			3×10^{-9}			
Formaldehyde	12	0.0066	50	40	0.08			
Hydrogen Chloride	0.87 lbs / 8 hrs	2000		9				
Lead Compound		4.9		0.00032	0.008		1.5	
Lead Inorganic	3							
Lead Arsenate	3							
Mercury Compounds		0.01						
Mercury Vapor	1							
Mercury (Aryl & Inorganic)	2/							
Mercury, Alkyl Compounds	0.2	0.002						
Methylmercury			2	0.3	0.009			
Mercury Elem.				0.3	0.003			
Nickel (II)	0.3							
Nickel (III)	0.3							
Nickel (Other)	0.3							
Nickel, except nickel subsulfide			6		0.004			
Nickel subsulfide			6		0.002			
Nickel Compounds		0.00026						
Selenium Sulfide				20	0.2			
Selenium, except hydrogen selenide and selenium sulfide					20			
Selenium-Hydrogen selenide			5					
Selenium Compounds	4	0.4						
Vanadium Dust	1							
Vanadium Fumes	1							

5. CONCLUSIONS & RECOMMENDATIONS

5.1. Conclusions

The following provides an overview of the findings of this report:

- Current estimates indicate that it costs $10 to $20 less per ton of wood to process wood chips for fuel than to send them to a landfill.
- The rising cost of natural gas and oil, the increased control costs related to coal use, and the availability of RECs for biomass generated electricity, has provided new incentives to use biomass and C&D wood.
- Three states in the NESCAUM region have permit applications submitted that propose the construction of new wood-fired power plants that could be fired with wood derived from C&D waste. These facilities have been proposed in Athens, Maine; Russell, Massachusetts, and Hinsdale, New Hampshire. In addition, some existing plants are assessing the use of adding C&D wood to their fuel profile.
- The report estimates that the New England region produced 1,735,000 tons of C&D wood in 2002. This could supply 173.5 MW of electric generation capacity.
- The report estimates that the New England region has the capacity to process five to six million tons of C&D wood annually. This translates into a fuel supply for potentially 500 to 600 MW of electric generation capacity.
- Restrictions on the use of C&D wood vary throughout the region, however only New Hampshire has placed a moratorium, which is temporary, on the use of C&D wood as a fuel source. The moratorium will likely continue until December 31, 2007.
- A review of the data shows that the use of appropriately processed C&D wood is similar in its emission profile to that of virgin wood
- It is likely that control equipment for plants opting to burn wood derived from C&D would be similar to or more stringent than that required for plants burning virgin (“clean”) wood.
- The critical element in minimizing air emissions, especially air toxics, is the elimination of CCA- and penta-treated wood from the fuel and minimizing C&D fines.
- Requirements for comprehensive testing and sampling of the fuel at both the processing facility and the location of the end user will assure that the fuel quality is maintained.

5.2. Recommendations

The following provides an overview of recommendations based upon the report findings:

- States should establish fuel specifications and fuel management procedures for C&D wood if they plan to support the use of C&D wood for energy generation.
- Existing biomass plants may need to upgrade emission controls if they wish to burn C&D wood.

Appendix A: Overview of Biomass Power Facilities Using Fuel Derived from Construction or Demolition Debris

Appendix A: Overview of Biomass Power Facilities Using Fuel Derived from Construction or Demolition Debris

A.1. California

AES, Delano, Inc., Delano   Capacity: 49.9 megawatts

- **Fuels:** Woody waste from orchards, urban wood waste recycled from Kern County landfills.
- **Volume of urban wood waste utilized:** "Tens of thousands of tons each month;" "40 percent of all urban wood waste generated in the county."
- **Permit summary:** The facility is regulated under a permit issued by the San Joaquin Valley Air Pollution Control District. The permit has no limits on the amount of wood from construction or demolition debris activities. Such waste is defined as wood waste and is not limited by amount.

  There is a general biomass fuel contamination standard that requires that no biomass fuel shall exceed 0.04% by weight plastics or 0.62% by weight total of the following materials: metals, plastics, paper, painted wood, particle board, wood treated with preservatives, and non-wood roofing materials.

  Biomass fuel contamination limits are demonstrated by sorting a District-approved 25 ton representative sample of biomass fuel in the reclaim pile upon District request.

AES, Mendota, Inc., Mendota   Capacity: 25 megawatts

- **Fuels:** Woody waste from almond, peach & nectarine orchard, wood waste recycled from local landfills in Fresno, Madera, and other local county landfills.
- **Volume of urban wood waste utilized:** Same volume as AES Delano.

Colmac Energy, Inc., Mecca   Capacity: 47 megawatts

- **Fuels:** Urban wood waste and agricultural residue.
- **Volume of urban wood waste utilized:** Over 300,000 tons per year from the greater Los Angeles basin area.
- **Wood fuel specifications:** Less than 1% wood with paint, preservatives, glue, varnish and foreign matter. Wood treated with creosote is not acceptable. Wood must be ground or chipped by the suppliers so that 99% is smaller than 3 inches in all dimensions. The maximum allowable amount of foreign matter is 3%; the maximum allowable moisture level is 35%.

HL Power Co, Susanville   Capacity: 30 megawatts

- **Fuels:** Mill waste, in-forest chips, and urban wood waste.
- **Volume of urban wood waste utilized:** Unknown.

Madera Power, Madera   Capacity: 28 megawatts

- **Fuels:** Almond tree prunings, rice and wheat straw, cotton stalks, and urban/demolition waste.
- **Volume of urban wood waste utilized:** Unknown.
- **Permit summary:** In late 2001, the ownership of this plant was transferred to Madera Power, LLC from San Joaquin Valley Energy Partners. In order for this ownership change to take place, all existing permits had to be renewed or transferred and a number of new permits had to be obtained. A complete list of all required environmental permits follows:
  - A Hazardous Material Release Response plan
  - A Title V Operating Permit
  - Renewal of the existing Permit to Operate
  - Transfer of the Water Discharge Permit

Chinese Station, Jamestown Capacity: 22 megawatts

- **Fuels:** Urban wood waste, agricultural wood waste, sawmill residue, in-forest clearing and agricultural shells.
- **Volume of urban wood waste utilized:** Unknown.

Rio Bravo Rocklin, Roseville, California Capacity: 25 megawatts

- **Fuels:** Urban wood waste, in-forest brush and clearing and other wood related products.
- **Volume of urban wood waste utilized:** Unknown.

Chowchilla Project, Chowchilla, California Capacity: 12.5 megawatts

El Nido Project, El Nido, California Capacity: 12.5 megawatts

- **Fuels:** Almond tree and vineyard prunings, rice & wheat straw, cotton stalks, other agricultural wastes, and demolition urban wood wastes.
- **Volume of urban wood waste utilized:** Unknown.

A.2. Florida

Ridge Generating Station, Auburndale Capacity: 40 megawatts

- **Fuels:** Urban wood wastes, scrap tires, and landfill gas.
- **Volume of urban wood waste utilized:** 250,000 tons/year.
- **Wood fuel specifications:** Accepts all types of wood wastes including treated wood. About 10-15% of the total wood waste is C&D wood debris.

A.3. Michigan

Genesee Power Station, Flint Capacity: 35 megawatts

- **Fuels:** Wood chips, industrial wood waste and wood from construction and demolition debris.
- **Volume of urban wood waste utilized:** Unknown.
- **Permit summary:** The Title V Air Quality Permit required the facility to establish a Wood Waste Procurement and Monitoring Plan that required:
  - High quality construction and demolition wood waste must be processed at a wood waste recycling facility in accordance with defined procedures.
  - Sampling and inspection protocol must be defined in the plan.
  - Unacceptable wood waste included: unprocessed construction/demolition wood and unprocessed wood obtained directly from landfills, wood containing plastics or vinyl, pressure treated wood, railroad ties, telephone poles, marine pilings, and bridge timbers.
  - Non-wood materials are prohibited; however, incidental amounts of unacceptable wood waste and non-wood materials may be contained in processed construction and demolition wood waste.

Lincoln Power Station, Lincoln, Michigan Capacity: 16.2 megawatts

- **Fuels:** Waste wood, natural gas, waste tire chips, creosote-treated wood, and pentachlorophenol-treated wood.
- **Volume of urban wood waste utilized:** Unknown.
- **Permit summary:** The Title V Air Quality Permit established the following fuel limits:
  - No more than 60,200 tons per year of creosote treated wood on a 12 month rolling time period.
  - No more than 168 tons per day of creosote treated wood based on a 24 hour period.
  - No more than 14,308 tons per year of pentachlorophenol treated wood per year.
  - No more than 39.2 tons per day of pentachlorophenol treated wood.
  - No more than 6,935 tpy of particle board/plywood.
  - No more than 29.2 tpd of particle board/plywood.

McBain Power Station, McBain, Michigan Capacity: 16.2 megawatts

- **Fuels:** Waste wood, creosote-treated wood, and tire-derived fuel
- **Volume of urban wood waste utilized:** Unknown.
- **Permit summary:** Title V Air Quality Permit established the following fuel limits:
  - No more than 96,336 tons per year of construction/demolition wood.
  - No more than 268 tons per day of construction/demolition wood based on a 24 hour period.
  - No more than 189,300 tons of creosote treated wood per year.
  - No more than 528 tons of creosote treated wood per day.
  - No more than 35,604 tons per year particle board/plywood.
  - No more than 99 tons of particle board/plywood per day.

A.4. Washington

Tacoma Steam Plant No. 2, Tacoma Capacity: 18.5 megawatts

- **Fuels:** 68% waste wood, 20% RDF, and 12% coal.
- **Volume of urban wood waste utilized:** During 1993-1996, roughly 13% of the wood waste consisted of urban wood. Beginning in 1997, a concerted effort was made to obtain lower-cost wood fuel. How this effort has modified the percentage of urban wood waste was not stated.

A.5. Wisconsin

NSP, French Island Power Station, LaCrosse Capacity: 30 megawatts

- **Fuels:** 50% RDF and 50% wood waste.
- **Volume of urban wood waste utilized:** Unknown.

Appendix B: Overview of Proposed BACT

Appendix B: Overview of Proposed BACT

As requirements for GenPower's permit application, the company submitted a BACT analysis for its proposed plants. The following provides an overview of key data points included in that analysis.

A consultant reviewed data in the RACT/BACT/LAER clearinghouse to identify control technology determinations pertaining to the combustion of biomass or C&D wood in boilers. They did not find any recent BACT determinations. There were, however, entries for biomass combustion and wood waste in boilers. The table below summarizes the most stringent emission limits found.

RACT/BACT/LAER Clearinghouse Most Stringent Emission Limits

Pollutant	Emission Limit	Control Technology
PM_{10}	0.025 lb/mmBtu	Multicyclone and fabric filter
NOx	0.075 lb/mmBtu	SNCR
SOx	0.02 lb/mmBtu	Limestone injection
HCl	0.02 lb/mmBtu	Limestone Injection
CO	0.1 lb/mmBtu	Fluidized Bed, Good Combustion Practices
VOC	0.005 lb/mmBtu	Fluidized Bed, Good Combustion Practices
Hg	0.000003 lb/mmBtu	Fluidized Bed, Good Combustion Practices
NH_3	10 ppm @ 7% O_2	

B.1. BACT for Particulate Matter

- Applicable control devices include multicyclones, wet scrubbers, electrified gravel bed filters, electrostatic precipitators (ESPs), and fabric filters.
- Higher particulate loading associated with solid fuel combustion requires the use of an upstream multicyclone to lower particle loadings to the fabric filter or ESP.
- Fabric filter and multicyclone >99% efficient, ESP and multicyclone >99% efficient, wet scrubber 85% efficient, electrified gravel bed filter 50 – 80% efficient, and multicyclone 25 – 60% efficient.
- Recommended BACT is control fabric filter with multicyclone.

B.2. BACT Analysis for Metals

- Combustion of C&D wood has the potential for increased levels of metals due to contaminants contained in the fuel mix relative to combusting whole tree chip or virgin wood fuel.
- Fuel suppliers must be required to meet specifications that will remove the majority of the contaminants and non-burnables.
- With the exception of mercury (Hg), metals contained in the exhaust gas are expected to condense onto PM particles and be captured in the fabric filter.
- The use of a dry scrubber for the control of acid gases will have a collateral effect of improving metals removal by providing a surface for small particles to adhere to prior to capture in the fabric filter.
- Recommended BACT is control fabric filter with multi-cyclone.

B.3. BACT Analysis for NOx

- Two types of NOx formation (thermal and fuel bound NOx) are dependent on the combustion and fuel characteristics.
- Combustion controls include minimizing excess air in the furnace and providing over-fire air (OFA); post-combustion NOx control technologies include selective non-catalytic reduction (SNCR) and selective catalytic reduction (SCR).
- Due to the higher particulate loading from solid fuel firing, SCR use has not typically been employed on biomass fired boilers.
- Equipment vendors are not willing to guarantee the performance or operating life for use on biomass or C&D wood fuel, therefore SCR is not considered technically feasible.
- SNCR 40 – 75% efficient, over-fire (OFA) variable efficiency, low excess air variable efficiency.
- BACT for NOx is use of a fluidized bed combustor with SNCR.

B.4. BACT for Ammonia

- When NOx removal is accomplished with SNCR, the molar ratio of ammonia injected to NOx is based on the stoichiometric ratio needed to achieve the necessary NOx reductions. In typical operations, more than the theoretical amount of reagent is injected to meet targeted NOx levels. This results in the release of unreacted ammonia, commonly referred to as ammonia slip.
- BACT for ammonia slip is 10 ppm (30 day rolling average; 20 ppm on a 24 hour block average).

B.5. BACT Analysis for Acid Gases

- For the purposes of this BACT analysis, SO_2 is used as a surrogate for all acid gases.
- Establish fuel specifications and practice source separation on-site to remove much of the sulfur containing materials (wallboard).
- Control technologies available to reduce the SO_2 emissions are limestone injection and add-on scrubbing technologies (wet scrubbing, dry scrubbing, and dry sorbent injection).
- Furnace injection/dry scrubber 80 - 95% efficient, wet scrubber 80 - 95% efficient, dry scrubber 70 – 90% efficient, dry sorbent injection 25 – 70% efficient and furnace injection 25 – 50% efficient.
- Proposed BACT technology is limestone (>95% $CaCO_3$) injection into the fluidized bed in conjunction with a dry scrubber downstream of the boiler.

B.6. BACT Analysis for Carbon Monoxide and Volatile Organic Compounds

- Available controls include combustion controls and add-on emission controls-oxidation catalyst.
- Proposed BACT controls for the fluidized bed boiler are good combustion practices.

B.7. BACT Analysis for Mercury

- Establish fuel specifications that will result in the removal of the majority of contaminants and non-burnables and conduct on-site source separation that will remove potential sources of mercury in the fuel (such as thermostats or light ballasts).
- Partial control of mercury emissions from solid fuel fired boilers may be accomplished using the controls for PM and SO_2.
- A specific post combustion mercury control technology is the use of activated carbon injection, typically used on coal-fired utility boilers or municipal solid waste incinerators.
- Proposed BACT controls for mercury include activated carbon injection for the removal of mercury.

B.8. Summary of BACT Analysis

- Use of low emission combustion technology including, multicyclone, dry scrubber, and fabric filter.
- BACT for NOx includes overfire air, low excess air, and SNCR.
- BACT for ammonia emissions will be 10 ppm ammonia slip.
- BACT for acid gases includes injection of limestone and the use of a dry scrubber.
- BACT analysis for CO and VOC indicates that combustor design and good combustion practices meet BACT and add-on control equipment (an oxidation catalyst) is unjustified.
- Mercury emissions will be controlled through fuel specifications, source separation, and activated carbon injection, as necessary.