Biomass Boiler Regulation in New Hampshire

An Overview of ASME and EN 303-5 Biomass Boiler Standards

PRS Policy Brief 0910-03
March 10, 2010

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This report was written by undergraduate students at Dartmouth College under the direction of professors in the Rockefeller Center. Support for the Policy Research Shop is provided by the Ford Foundation.

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EXECUTIVE SUMMARY

New Hampshire has the stated goal of expanding its renewable energy portfolio. An option for New Hampshire to achieve that goal is through the use of biomass fuel. The state's vast reserves of potential biomass fuel make it particularly well suited to this source of renewable energy.

New Hampshire is considering a proposal that would allow European boilers that are approved by the European Committee of Standardization (CEN), EN 303-5, "Heating boilers for solid fuels, hand and automatically stoked, normal heat output up to 300 kW". This report will refer to this code as the "European" code. Currently, New Hampshire only allows boilers that are approved by the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME) Section IV, "Rules for Construction of Heating Boilers". This document will refer to this code as the "American" code. Boilers built to one code are not compatible with the other code. The safety record for boilers built to each of the codes is comparable.

Boilers built to the European standard generally have superior efficiency ratings and lower emissions, although some boilers built to the current American standard have comparable efficiency and emissions. Allowing the European boilers in New Hampshire would substantially increase consumer choice for high efficiency, low emission boilers.

There are important obstacles to allowing European biomass boilers into New Hampshire. It is unclear if insurance companies will be willing to cover the European boilers. Boiler inspectors in New Hampshire will be unfamiliar with the boilers, their manuals, and maintenance. The building and fire codes must also be updated across the state.

The State of Oregon decided in 2009 to allow European biomass boilers. However, as of February 2010, no European boilers had been installed in the state and the impact of the change is unknown. The Commonwealth of Massachusetts considered adopting the European code, but decided against it, because Massachusetts did not see the codes as comparable.

It is likely that the reason for the superior efficiency of European boilers is not from their safety code, but from more stringent emissions standards for boilers across most European countries. New Hampshire could seek to emulate these countries, which would encourage innovation in boiler market and might give consumers more choice in the boiler market without adopting a new safety code.

The United States Environment Protection Agency (EPA) is considering changes to its emissions standards for smaller commercial and institutional boilers. These new standards are currently slated to be unveiled in December of 2010. The new rule is likely to have a significant impact on the biomass boiler market across the country.

1. RENEWABLE ENERGY IN NEW HAMPSHIRE

New Hampshire has prioritized investment in renewable energy initiatives. For example, the Renewable Portfolio Standards requires that New Hampshire Electric Utilities obtain 25 percent

of their electricity from renewable sources by 2025. This is known as the 25 x 25 initiative. The left chart in Figure 1 shows that in 2006, only seven percent of New Hampshire's total energy usage came from renewable sources. The right chart in Figure 1 shows that of that seven percent, 43 percent came from hydroelectric sources and 57 percent from biomass sources. (Electrical imports, solar, geothermal, and wind made up less than one percent.) Biomass sources include wood, ethanol, biogenic municipal solid waste, and landfill gas. Biomass can play a pivotal role in helping New Hampshire achieve its 25 x 25 goal.

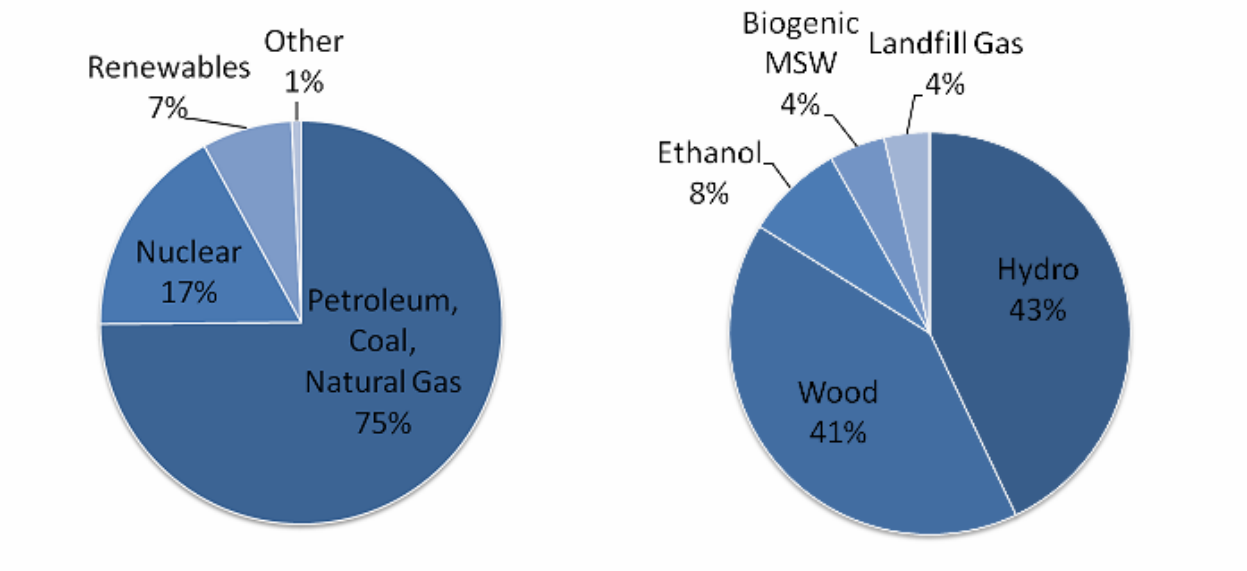


Figure 1. New Hampshire Total Energy Usage and Gross Renewable Energy Sources, 2006[1]
Less than 1% of Renewable Energy: electrical imports, solar, geothermal, biodiesel

1.1 Biomass Overview

Biomass energy is the conversion of biological materials into an energy source. Common biomass sources are wood (pellets, chips, pulp), alcohol fuels (crops), and waste (garbage, landfill gas).

Biomass has several advantages over other energy sources. It reduces reliance on nonrenewable sources such as fossil fuels. This decreases our exposure to price volatility in foreign markets. Additionally, biomass fuel prices are historically lower than fossil fuel prices. Appendix IV provides a cost efficiency comparison of several fuel types. It shows that the biomass fuels most often used in New Hampshire (woodchips and wood pellets) are more cost effective than other sources. (Appendix VII provides a breakdown of other potential costs associated with biomass boilers.)

Another advantage is that biomass is theoretically carbon neutral. Biomass energy releases black carbon that is already trapped within the source; the carbon it introduces to the atmosphere is not created and is equal to the amount of carbon that would be released if the tree were to rot naturally. It is argued, however, that mature forests sequester carbon dioxide much more effectively than cut over areas. Additionally, introducing carbon to the atmosphere quickly, as

biomass does, contributes to global warming more than introducing the carbon gradually over time, as a rotting tree does. The sustainability of biomass is also debated. Harvesters must be careful with their re-growth efforts to ensure a constant energy supply. A disadvantage of biomass is that it releases particulate matter that can be harmful to one's health. The air pollution caused by biomass can be similar to that caused by fossil fuels.

1.2 Biomass Viability in New Hampshire

Biomass is a viable renewable energy source for New Hampshire. According to the USDA Forest Service, New Hampshire has a higher density of forest biomass relative to most states. New Hampshire also has significant viability in overall biomass. Appendices II and III show the potential for forest biomass in the U.S. and the potential for all biomass in New England. These maps show that New Hampshire has greater opportunity to harness local biomass than neighboring states.

Wood comprises over 70 percent of the biomass sources currently used in New Hampshire, so it is important to consider the details of harnessing wood potential. Appendix VIII provides a breakdown of forest ownership in New Hampshire. Appendix VII shows the wood harvest by county in New Hampshire for an average year.

An increased focus on biomass in New Hampshire could create jobs and support local forest and agriculture development. Furthermore, it has the potential to help residents and commercial businesses realize energy savings. Appendix I provides two examples of New Hampshire businesses that have effectively implemented biomass, resulting in economic savings. Biomass has the potential to help New Hampshire's economy and to help the state achieve its 25 x 25 goal.

2. BIOMASS BOILER OVERVIEW

Biomass boilers are used to combust biomass and utilize its heat energy. The two most popular boilers designs in the United States are direct-burn and two-chamber boilers. Figure 2 diagrams each of these boilers designs.

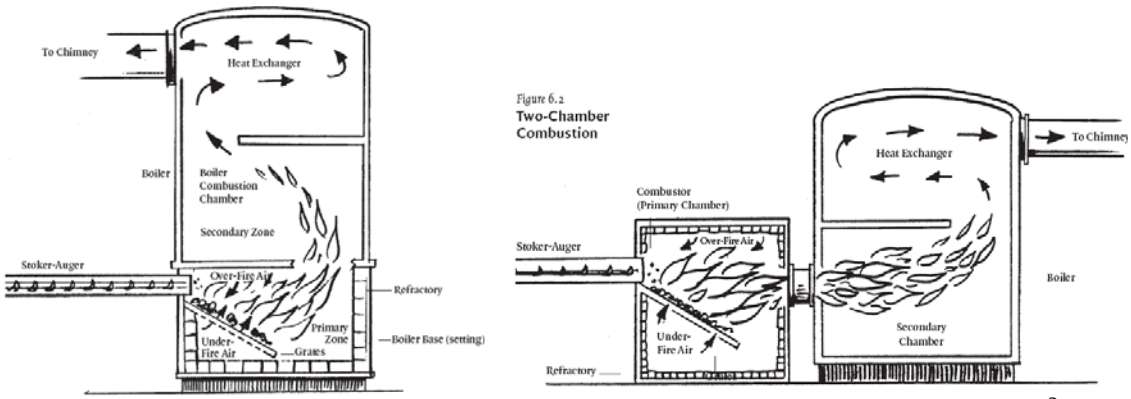


Figure 2. Direct-Burn Wood Boiler System and Two-Chamber Wood Boiler System[2]

In a direct-burn wood boiler system, air is injected into the primary zone, where the wood is being burned. The hot air then rises into the combustion chamber to continue the combustion of solid particles. The hot exhaust then passes through the heat exchanger and into the chimney. Direct-burn systems are simpler and cost less than two-chamber systems.[3]

A two-chamber wood boiler system separates the primary chamber from the secondary chamber with a blast tube, which increases boiler efficiency and decreases particulate matter emissions. Two-chamber boilers have longer flame paths, more turbulence, and longer retention times of high-temperature gases, all of which increase the rate of combustion. This also decreases particulate matter emission because the longer burn time allows for small particulate matter to be fully combusted.[4]

Figure 3 shows how a biomass boiler can be integrated into a full system.

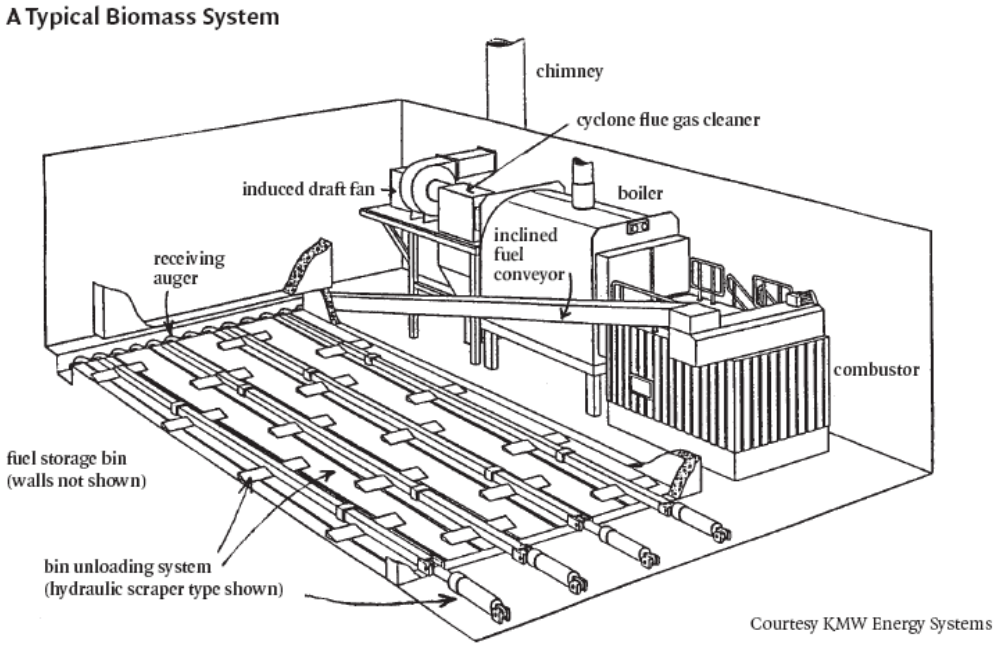


Figure 3. A Typical Biomass System[5]

3. U.S. AND EUROPEAN BIOMASS BOILER COMPARISON

New Hampshire's RSA 157-A:2 currently requires that all boilers and pressure vessels conform to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Section IV, "Rules for Construction of Heating Boilers"). Exempt boilers include those with less than 200,000 BTU per hour output, less than 15 psig working pressure, and less than 210 degrees Fahrenheit water temperature.[6] Boilers and pressure vessels that do not meet ASME standards can be operated if the commissioner approves and if the boiler/vessel is inspected annually by a qualified person. Although it is not federally mandated, most states require that boilers adhere to ASME standards. A summary of the standards for northeast states is included in Appendix IX.

Alternatively, many European countries adhere to standards defined by the European Committee for Standardization, EN 303-5 (CEN, "Heating boilers for solid fuels, hand and automatically stoked, normal heat output of up to 300 kW").[7] Countries that utilize testing standards of EN 303-5 include: Finland, Austria, Denmark, Germany, and Great Britain.[8] The CEN adopted EN 303-5 in 1998. These standards apply for boilers up to 300 kilowatts of heat output (about equal to 1,000,000 BTU per hour).[9]

The slight differences between American and European standards disallow each type of boiler from being approved by the other set of standards. European boilers are not approved by the American code and vice versa. Even though European boilers are not currently approved for use in New Hampshire, there could be advantages to allowing them in the state. This would improve consumer choice by increasing the size of the boiler market. Second, European boilers must adhere to stricter efficiency and emissions standards.

3.1 Efficiency Differences

Efficiency ratings measure the percentage of energy in the fuel that is converted into heat. In general, biomass is a less efficient energy source than others (natural gas, propane, coal). Appendix V diagrams how a boiler might lose energy. Efficiency for new European boilers, however, is comparable to these other sources, at 90 percent efficiency. Comparatively, boilers in the US are only about 70 to 80 percent efficient.

American standards do not specify an efficiency rating that approved boilers must achieve.[10] European standards, on the other hand, specify efficiency ratings for different boiler classes. For example, the minimum efficiency of a Class 3, 20 kilowatt boiler is 74.8 percent.[11] Although it is possible for American boilers to be just as efficient as European boilers, the European efficiency requirements promote innovation in ways that are not done in the United States.

3.2 Emissions Differences

Wood combustion is a source of pollution, including particulate matter (PM), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and hazardous air pollutants (HAPs: benzene, mercury and dioxins).[12] In some areas, wood combustion is the cause of more than 80 percent of particulate matter pollution.[13] Particulate matter affects the respiratory system, and can aggravate asthma and bronchitis. It has been linked to being a cause of premature death for persons with heart and lung diseases.[14] In 2007, installation of biomass boilers in several schools in Scotland came to a standstill due to worries about air quality and particulate matter.[15]

Boilers in the United States must currently adhere to emission standards set by the EPA. Compared to the standards set by the CEN, the emission limits in the United States are lenient. Figure 4 shows that particulate emission limits in Europe are currently 0.054 pounds PM emission per million British thermal units (MMBtu). Comparatively, emission limits in New Hampshire are 0.3 pounds PM emission per MMBtu. (Limits in New York and Massachusetts are 0.6 and 0.1, respectively.)

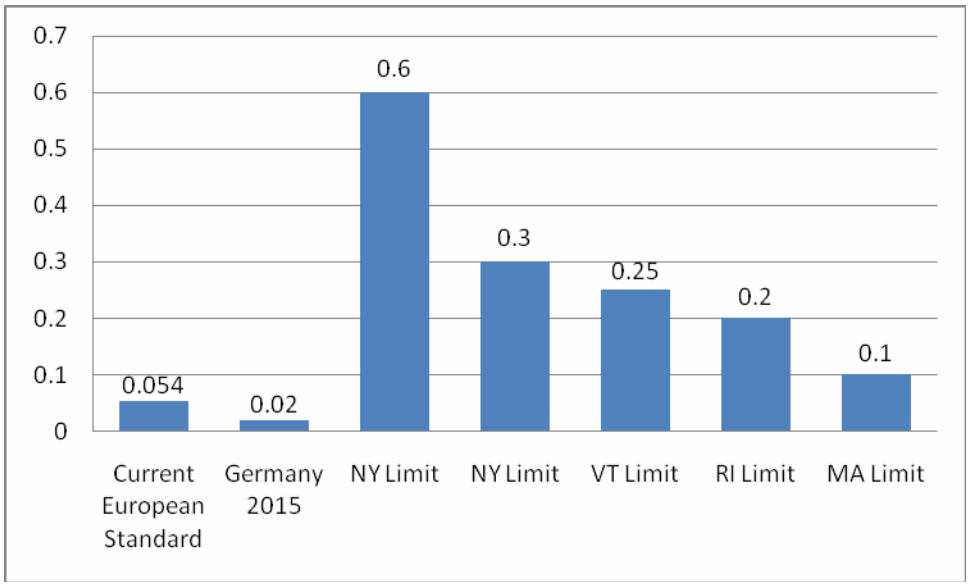


Figure 4. Comparison of Particulate Emission Limits for Units Sized from 1 to 10 Million Btu (lb PM emission/MMBtu)[16]

European boilers must adhere to more stringent emission limits than American boilers. Although American boilers do not inherently emit more PM and $PM_{2.5}$ than their European counterparts, the European standards force all European boilers to emit low amounts of pollution. These lower standards encourage innovation in the European market for low emissions boilers. This fuels innovation in ways that are not done for American boilers. Allowing European boilers in New Hampshire would broaden the boiler market for consumers, and would increase the options of boilers that emit less particulate matter.

3.3 Safety Differences

A study conducted by the United States National Board of Boiler Inspectors determined that ASME safety standards are just as safe as European safety standards.[17] Both models of biomass boilers are equipped with a wide variety of safety features. Most wood-burning boilers feature a temperature sensor to detect burn back, a water-releasing device to put out fire, and an automatic system that shuts down the boiler in case of burn back. In addition, biomass boilers are low-pressure vessels, which are generally safer than regular, high-pressure boilers.[18]

There are a few key safety differences between European boilers and American boilers. European inspectors pressure test each vessel whereas American inspectors test only one boiler from the manufacturer and then visually inspect the others. In addition, unlike Europeans boilers, pressure stays in American boilers penetrate the firebox walls. This could potentially lead to the corrosion of this important boiler part. Non-penetrating stays used in European boilers are therefore safer than their ASME counterparts.[19]

According to Steve Nichols, owner of BioheatUSA,[1] a New Hampshire based provider of biomass, there have been no deaths associated with European boilers to date and not a single boiler has failed in their 35-year history.[20]

3.4 Testing Differences

American and European biomass boiler regulations follow different testing measures. American boilers tests follow EPA Test Method 28 and European boiler tests are outlined by the CEN. The tests of boiler performance differ in firing rates, particulate matter sampling, and fuel used. The following table summarizes these differences.[21]

	US EPA Test Method 28	CEN Test Methods
Firing rates	Four burn rates: 15%, 15 – 30% 30 – 50% maximum capacity	Two rates: nominal load 30%
Particulate matter sampling methods	Dilution tunnel sampling	Hot filter sampling techniques
Pollutants measured	Total particulate matter	Continuous emission monitoring of: CO_2, O_2, Co, Organic carbon, VOC, NOx
Fuel used	Crib (dimensional lumber)	Cordwood (random moisture content)
Inspector	Authorized Inspector	Notified Body evaluated by TUV or DNV

Table 1. Comparison of EPA and CEN Biomass Testing Methods

The difference in burn rates is significant because the European test does not require biomass boilers to be tested at low burn rates (below 30 percent). Without doing this, it is difficult to assess the performance of European boilers at low levels of operation.[22]

Other significant testing differences are the particulate matter sampling methods and the difference in pollutants measured. The EPA dictates that dilution tunnel sampling be used to measure emissions, rather than hot filter sampling techniques. Dilution tunnel sampling captures all particulate matter (including filterable and condensable portions), and hot filter sampling captures only the filterable portion of the particulate matter. This creates a significant difference in the particulate matter measured for each boiler.[23]

[1] From their website, www.woodboilers.com: "BioHeatUSA, formerly TARM USA, is a third-generation, family owned business that has pioneered the sales and service of European residential central heating equipment to North America for over 30 years. BioHeatUSA's primary objective is to offer European innovation in home heating solutions, paired with a significant commitment to consumer education and environmental awareness. Exclusive partnerships with ISO 9001 certified manufacturers allow BioHeatUSA to offer products with operational reliability, exceptional efficiency, and to promote the clean burning of carbon-cycle biomass that is critical to the lowering of net greenhouse gas emissions."

The different fuel requirement for EPA and CEN tests is significant because of the varying moisture content in the different fuels. Moisture content impacts the efficiency and emissions of boilers; high moisture content fuel can lead to incomplete combustion (decreased efficiency) and increases in PM emissions.[24] The crib fuel used for EPA tests has a specified moisture content. Comparatively, the cordwood used for CEN tests has a random moisture content.[25] This could affect the accuracy of emission and efficiency measures for European boilers.

Finally, different inspectors are required to enforce each of the tests. The EPA uses an Authorized Inspector, whereas the CEN uses a Notified Body evaluated by TUV Rheinland or DNV. These inspectors are not interchangeable; ASME inspectors are not authorized to inspect and approve European boilers.[26]

4. ADDITIONAL CONSIDERATIONS

4.1 Obstacles to Implementation

There are obstacles to the approval of and demand for European biomass boilers in New Hampshire. First, technologies that improve efficiency and emission functioning add to the boilers' construction costs. For this reason, American boilers are more attractive to the consumer than European boilers because they are cheaper, despite the fact that they are less efficient and more polluting. Even if European boilers are allowed in New Hampshire, consumers may not demand them.[27]

The New Hampshire Department of Labor and the Chief Boiler Inspector oppose the introduction of European biomass boilers into the state. Many insurance companies, risk averse by nature, express concerns about inspection and repairs of these foreign machines. For example, foreign vessels often differ from domestic models in welding style and materials, thus requiring special equipment and training for mechanics. They also require specialized and regular maintenance.[28] Foreign and unfamiliar language, procedures, measurements, and standards within manufacturer manuals may also pose problems for state inspectors and repairmen.

4.2 EPA Status

In 2004, the EPA began the process of creating emissions standards for boilers classified as "area sources," under the Clean Air Act (CAA), using both biomass and other fuel types.[29] Section 112 of the CAA mandates that the EPA regulate the emissions of area sources for hazardous air pollutants, such as particulate matter and mercury.[30] Boilers classified as area sources under the CAA are industrial, commercial and institutional boilers that emit less than 10 tons annually of a single hazardous air pollutant, and less than 25 tons annually of all hazardous air pollutant.[31] For biomass boilers, those with output less than 20 million Btus per hour (MMBtu/hr) will likely fall under the new regulation.[32] Boilers affected will include many of those in schools, churches, small businesses, apartment buildings, hotels, restaurants, and municipal buildings.[33]

The regulation will likely increase the costs of installing, operating, and maintaining wood boilers that fall under the area source category.[34] For most pollutants, the EPA will probably be

creating standards based on generally available control technology (GACT).[35] For mercury and polycyclic organic matter, the EPA is required to base its standards on the more stringent maximum available control technology (MACT), and will likely include the use of fabric filters.[36]

The rule has faced numerous legal challenges, which have delayed its implementation.[37] Under its current schedule, the rule will reach notice of proposed rulemaking (NPRM) in April 2010, to be followed by a public comment period.[38] The final rule is due to be issued in December 2010. Compliance will not be required immediately, but it is likely that current boilers will be required to comply with the new standards..[39] The regulation may significantly impact the market for smaller commercial and institutional biomass boilers across the country.

5. STATE CASE STUDIES

Massachusetts and Oregon have considered allowing European boilers in their states. Massachusetts did not approve this legislation, while Oregon did.

5.1 Massachusetts

In 2009, Massachusetts considered accepting European standards, but the state did not change its standards. Repairs of European boilers would not have been in compliance with National Boiler and Pressure Vessel Inspection Code. The state did not consider the two standards to be equivalent.[40] Furthermore, the state questioned the sustainability of biomass in terms of forest management and greenhouse gases. In June 2009, Massachusetts amended its Renewable Portfolio Standard (RPS) to require sustainable biomass energy for RPS qualification. In December 2009, Governor Deval Patrick suspended all biomass projects in Massachusetts until research proved it to be sustainable.[41]

5.2 Oregon

Oregon has been a pioneer state in the field of biomass energy. In 2005, the Oregon Biomass Coordinating Group (OBCG) formed to develop the biomass market according to the state's Renewable Energy Action Plan (REAP). This plan aims to promote alternative energy and economic development within the state.[42] Most notably, Oregon changed its administrative rules to enable the installation of European boils on January 1, 2009, provided that the boilers have been tested and meet EN 303-5 standards. The new standards also stipulate that non-AMSE boilers must have comparable safety standards to ASME boilers. Despite the rule change, Oregon has not seen an increase in the installation of European boilers in the state.[43]

6. POLICY OPTIONS

6.1 Reduce Maximum Allowable Particulate Emissions for Biomass Boilers

The efficiency and emissions differences between American and European boilers are likely due to the stricter emissions and efficiency requirements for boilers in place in many of the European countries that use the European code.[44] If New Hampshire adopted similarly strict emissions standards, it may push the boiler industry to expand consumer choice for high efficiency, low emission boilers, without adopting European boilers. Figure 4 shows that New Hampshire currently allows three times as many emissions as Massachusetts. Cleaner ASME approved boilers would be available if New Hampshire lowered its emission limits.

It would not directly cost the state of New Hampshire to reduce particulate emission limits. The burden of these costs would fall on the consumer. Appendix VI outlines various costs that could be associated with reducing particulate emissions for biomass boilers. These range from $7,000 for a cyclone that would remove an additional zero to ten percent of the particulate matter, to $175,000 for an electrostatic precipitator which would remove 90 percent of additional particulate matter.[45]

6.2 Allow EN 303-5 Boilers in New Hampshire

Although there are high efficiency, low emissions biomass boilers currently being built to the ASME code, allowing those built according to the EN 303-5 code in New Hampshire would significantly increase their availability, thereby increasing consumer choice.[46] Hopefully with increased choice, New Hampshire choice residents would opt for the higher performing boilers more frequently. However, if European boilers were allowed in New Hampshire, European documents and measurements would need to be translated to English or converted to the American system. In addition, it would be helpful to create an EN 303-5 Training and Development program in New Hampshire similar to the ASME education programs throughout Europe.

6.3 Await the EPA's Upcoming Rule on Boiler Emissions

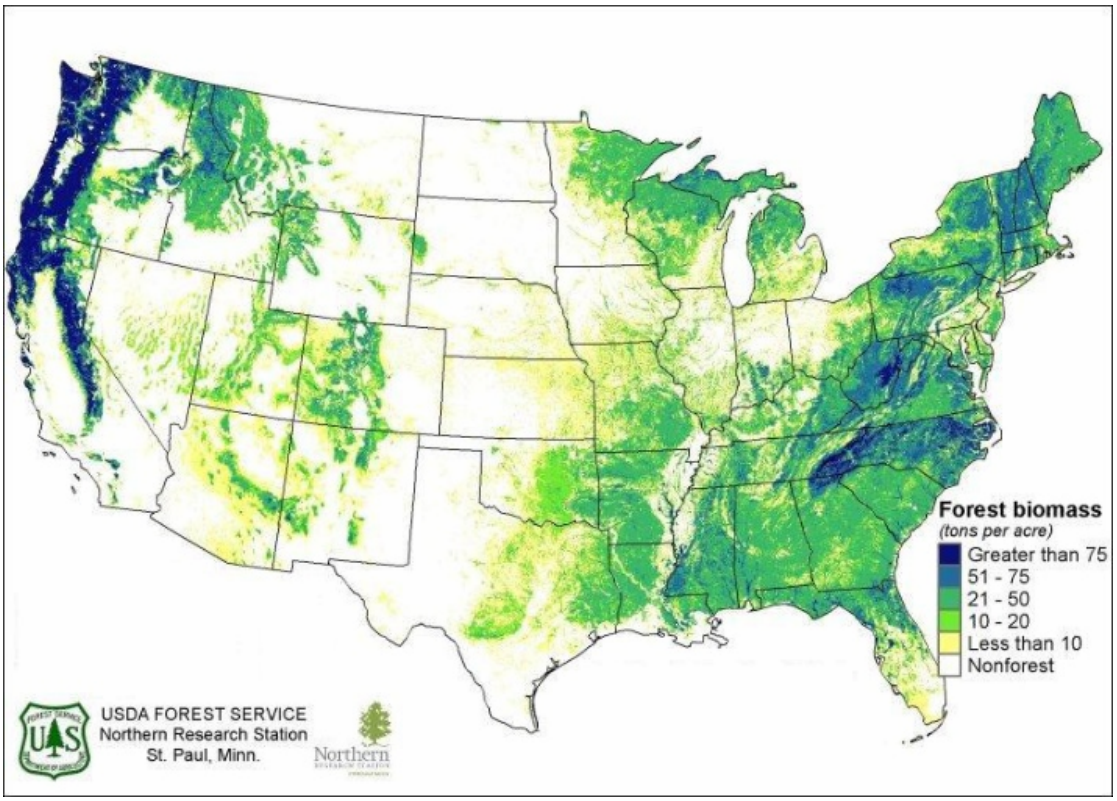
The EPA's new regulation on boiler emissions may radically alter the market for smaller institutional biomass boilers across the United States. Both new and old boilers will come under regulation, and the impact will be impossible to know until the rule is officially issued. New Hampshire could wait until after the promulgation of this rule before changing its policy on biomass boilers.

Appendix I. Biomass in New Hampshire

Harris Conservation Center in Hancock, New Hampshire: The Harris Conservation Center was the first public building in New Hampshire to use a wood pellet boiler. The boiler, a multi-heat variable output boiler rated at 146,700 Btu, has been a cost-effective investment; in 2005 fuel for the boiler cost $1,700 a year, 40 percent less than the cost would have been with fuel oil ($4,200). Furthermore, the boiler has burned at 90 percent efficiency while heating the 10,000 square foot facility.

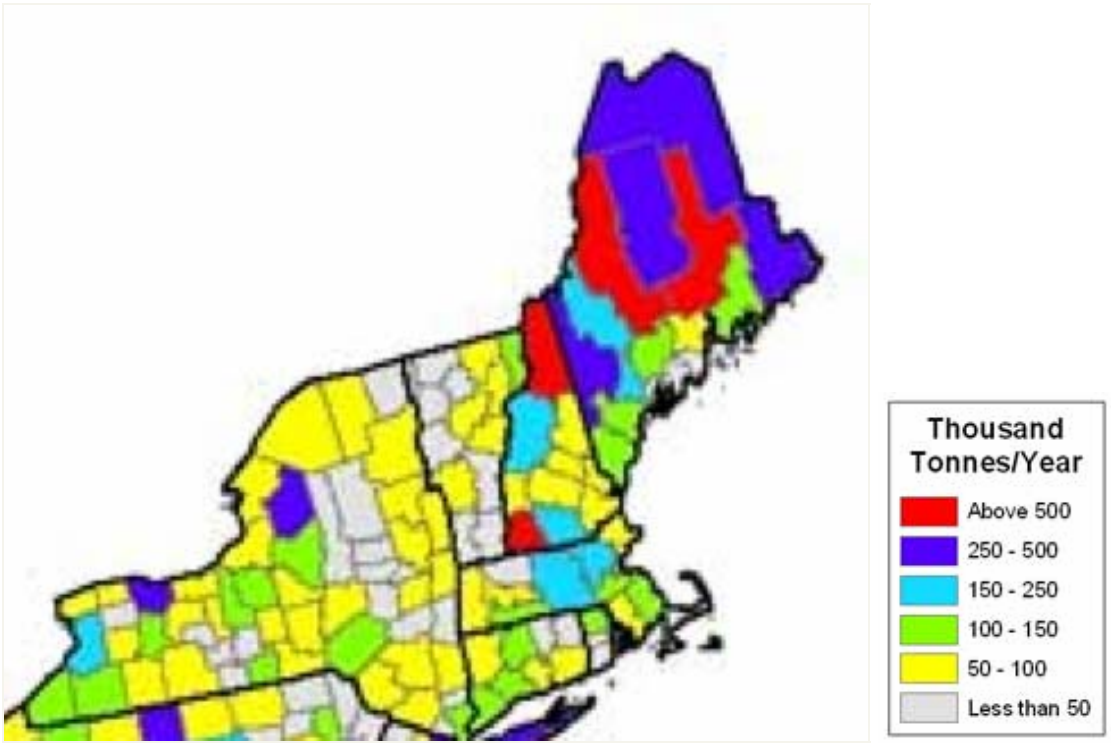
Crotched Mountain Rehabilitation Center in Greenfield, New Hampshire: In 2007 the Center installed a 12MMBtu dual wood boiler to heat and supply hot water (and also chilled water in the summer) to approximately 250,000 square feet of space. The center has also successfully lowered particulate matter emissions by using a two stage system to capture particulates: a cyclone separator removes larger fly ash while a baghouse removes the smallest particulates. Furthermore, the two boilers have different sizes, and thus have "the capacity for modulated burning," which increases the overall efficiency of their operation. The Center realized total savings of $250,000 in fuel costs during its first heating season (2007-2008).

Appendix II. Biomass Viability in the U.S.



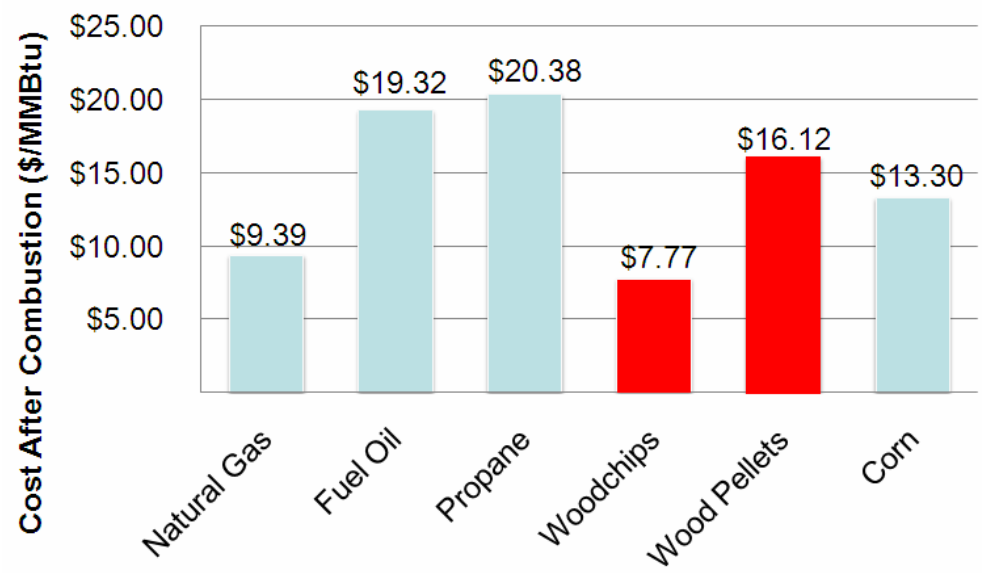
Source: USDA Forest Service

Appendix III. Biomass Viability in the Northeast



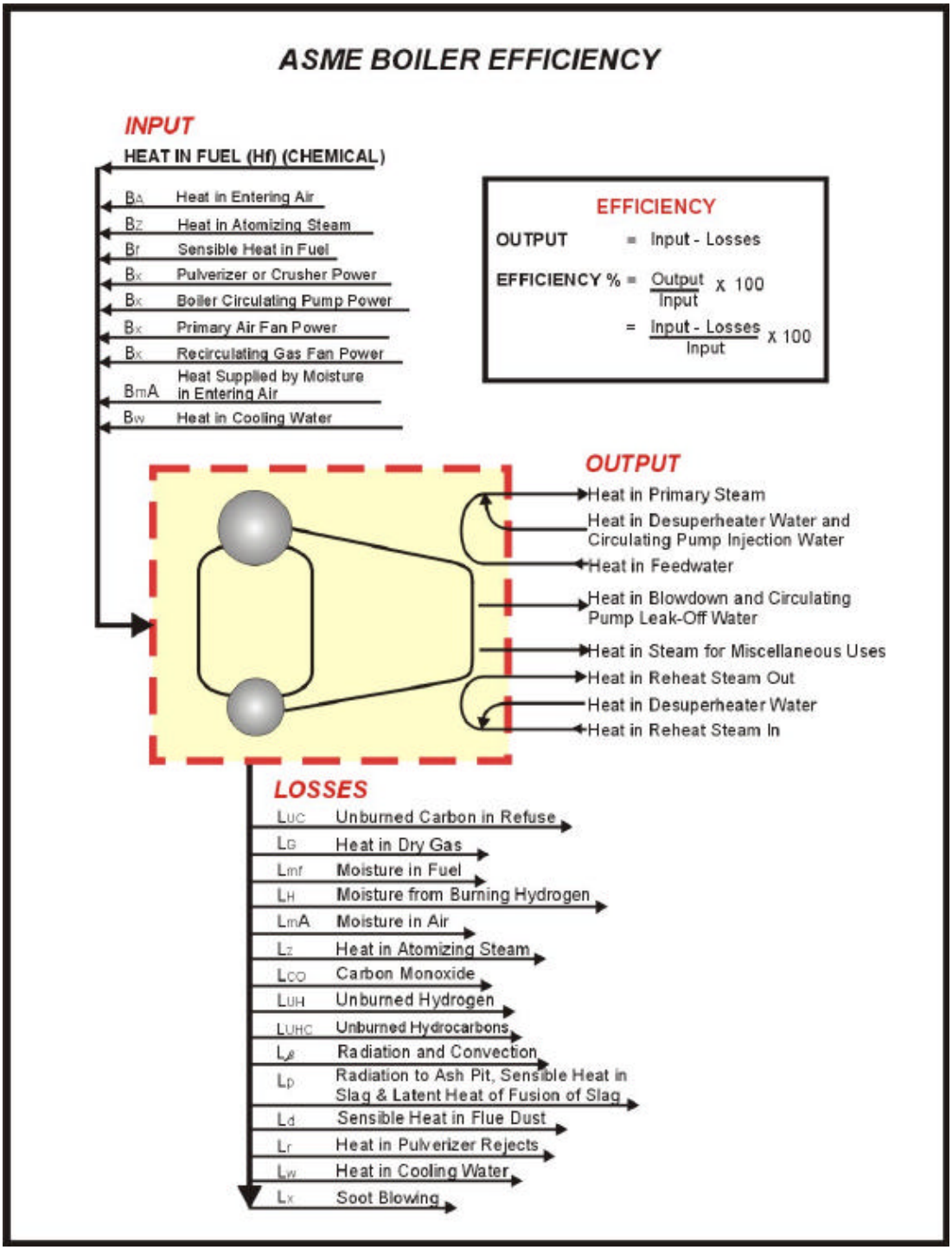
Included: agriculture residues, wood residues, municipal discards, and dedicated energy crops
Source: National Renewable Energy Laboratory

Appendix IV. Fuel Cost Comparison



Source: Biomass Energy Resource Center, March 2008

Appendix V. Boiler Efficiency Overview



Source: USDA Forest Service

Appendix VI. Costs and Efficiencies of Particulate Matter Control Devices

Control	*Removal Effectiveness*	*Cost ($)*	*Comments*
Cyclone	PM_{10} - Moderate control efficiency ~50 percent $PM_{2.5}$ – 0 to 10%	Installation *7-10K* Maintenance *minimal*	• Inexpensive • Ineffective at removing fine PM • Ineffective at removing gas phase PM (condensable PM)
Multicyclone	PM_{10} - Moderate control efficiency ~75 percent $PM_{2.5}$ – 0 to 10%	Installation *10-16K* Maintenance *minimal*	• Inexpensive • Ineffective at removing fine PM • Ineffective at removing gas phase PM (condensable PM)
Core Separator	PM_{10} – 98 percent and higher $PM_{2.5}$ – 98 percent and higher	Installation *83-130K* Maintenance *Unknown*	• Questions about availability • Questions regarding effectiveness
Baghouse / fabric filter	PM_{10} – 98 percent and higher $PM_{2.5}$ – 98 percent and higher	Installation *100K* Maintenance *10K*	• Higher cost • Highly effective at removing fine PM • Able to capture condensable PM
Electrostatic Precipitator	PM_{10} – 90 percent and higher $PM_{2.5}$ – 90 percent and higher	Installation *90-175K* Maintenance *1-2K*	• Higher cost • Highly effective at removing fine PM • Ineffective at removing gas phase PM (condensable PM)

Source: USDA Forest Service

Appendix VII. Costs Associated with Biomass

Cost Estimates and Fuel Usage

	Cost (Installed including Fuel Storage and Delivery Systems)	Annual Fuel Consumption (Tons)	Fuel	Equivlent Oil (Gallons)	Current Fuel Cost/ton
Residential Pellet Boiler	$16,000	8.0	Pellets	1,000	$265
Pellet Stove	$3,200	3.0	Pellets	375	$265
Qualifying Wood Stove	$2,500	8.6	Cord Wood	600	$90
Qualifying Outdoor Wood Boiler	$5,000	17.1	Cord Wood	1,200	$90
Commercial/Industrial Pellet Boiler (100-500 kw)	$200,000	253	Pellets	31,666	$265
Commercial/Industrial Pellet Boiler (500-1000 kw)	$350,000	633	Pellets	79,165	$265
Commercial/Industrial Pellet Boiler (1000-5000 kw)	$1,750,000	2533	Pellets	316,659	$265
Commercial/Industrial **Chip** Boiler (100-500 kw)	$280,000	405	Dry Chips	31,666	$65
Commercial/Industrial **Chip** Boiler (500-1000 kw)	$490,000	1013	Dry Chips	79,165	$65
Commercial/Industrial **Chip** Boiler (1000-5000 kw)	$2,450,000	4053	Dry Chips	316,659	$65

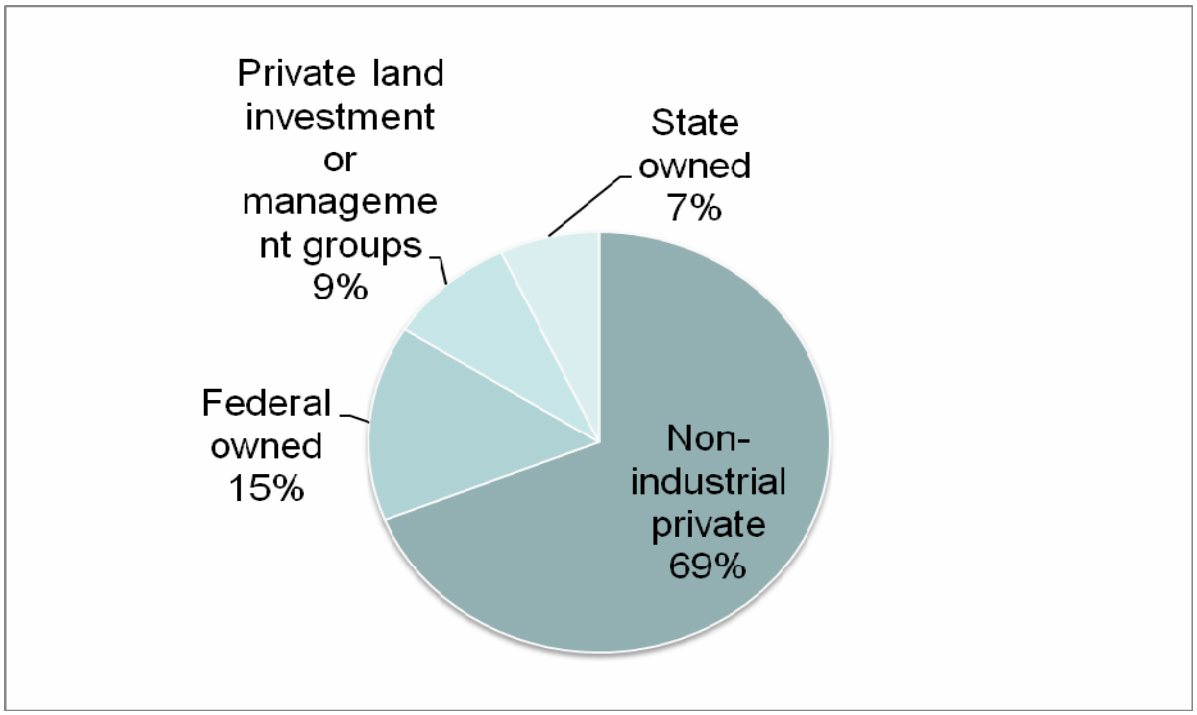
Source: Maine Energy Council, August 2009

Appendix VIII. New Hampshire Wood Harvests, 4/2005 – 3/2006

County	Harvest #	Whole Tree Chips Tons	Pulpwood Tons	Fuelwood Tons	Sawlogs 1000 board ft.
Belknap	202	48,872	37,795	2,457	10,815
Carroll	372	72,542	100,156	2,609	19,980
Cheshire	339	49,529	60,179	8,247	23,240
Coos	367	125,757	503,534	4,980	47,535
Grafton	597	170,425	190,079	5,985	33,982
Hillsboro	377	117,150	42,970	8,334	27,051
Merrimack	494	142,571	69,653	6,882	31,413
Rockingham	251	60,823	24,429	5,137	12,437
Strafford	145	38,871	17,474	3,486	9,413
Sullivan	283	35,890	30,413	3,907	13,717
Totals	**3427**	**862,430**	**1,076,682**	**52,024**	**229,583**

Source: NH Division of Forests and Lands

Appendix VIII. New Hampshire Forest Ownership, 2002



Source: USDA Forest Service, 2002

Appendix IX. Biomass Codes in the Northeast States

Source: Coneg Report

Appendix F

SAFETY REGULATIONS FOR BIOMASS SYSTEMS NORTHEAST STATES

State	Safety Codes	Significant Exceptions	Variances
Connecticut[1] Connecticut Department of Public Safety Division of Fire, Emergency and Building Services Office of State Building Inspector Bureau of Boilers	The Commissioner of Public Safety shall formulate regulations for the design, construction, installation, repair, use and operation of boilers in Connecticut. Such regulations shall conform as nearly as possible to the Boiler Code of the American Society of Mechanical Engineers, and the National Board Inspection Code, both as amended, and shall prescribe requirements as to the construction, installation, repair, use and inspection of boilers in the interest of public safety.	Relevant exempt boilers include: (1) Boilers under federal control; (2) portable boilers used in pumping, heating, steaming and drilling in the open field; (3) portable boilers used solely for agricultural purposes; (4) steam heating boilers, hot water heaters and hot water heating boilers, when used in private homes or apartment houses of not more than five families; and (5) hot water heaters approved by a nationally recognized testing agency that are equipped with adequate safety devices including a temperature and pressure relief valve, having a nominal water capacity of not more than one hundred twenty gallons and a heat input of not more than two hundred thousand British thermal units per hour and used solely for hot water supply carrying a pressure of not more than one hundred sixty pounds per square inch and operating at temperatures of not more than two hundred ten degrees Fahrenheit, provided such heaters are not installed in schools, day care centers, public or private hospitals, nursing or boarding homes, churches or public buildings.	A person may apply to the State Building Inspector to grant variations or exemptions from, or approve equivalent or alternate compliance with, standards incorporated in the regulations… and the State Building Inspector or a designee may approve such variations, exemptions, or equivalent or alternate compliance where strict compliance with such provisions would cause practical difficulty or unnecessary hardship.
Maine[2] Maine Department of Professional and Financial Regulation Office of Licensing & Registration	Unless otherwise exempt, all new boilers and pressure vessels to be installed must be inspected during construction by an inspector authorized to inspect boilers in this State, or, if constructed outside the State, by an inspector holding a license from this State or an inspector who holds a certificate of inspection issued by the National Board of Boiler and Pressure Vessel Inspectors, or its successor or other organization approved by the board.	Relevant exempt boilers include: Boilers that are under federal control; Boilers used for agricultural purposes only; Steam heating boilers, hot water heating boilers and hot water supply boilers, except boilers located in schoolhouses or boilers owned by municipalities, constructed and installed in accordance with the rules adopted by the board;	A person who is or will be aggrieved by the application of any law, code or rule relating to the installation or alteration of boilers and pressure vessels may file a petition for a variance, if the enforcement of any law, code or rule relating to boilers or pressure vessels would do manifest injustice or cause substantial hardship, financial or otherwise, to the petitioner or would be unreasonable under the circumstances as long as desirable relief may be granted without substantial detriment to the public good and without nullifying or substantially derogating from the intent or purpose of that law, code or rule. In granting a variance under this section, the chief inspector may impose limitations both of time and of use, and a continuation of the use permitted may be conditioned upon compliance with rules made and amended from time to time.

Compiled by: Rick Handley

[1] http://www.cga.ct.gov/2008/sup/chap540.htm
[2] http://www.mainelegislature.org/legis/statutes/32/title32ch131sec0.html

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Massachusetts[3] Department of public safety division of inspection	In accordance with the provisions of M.G.L. c. 146,s 2, the Board of Boiler Rules herewith adopts by reference the 1998 A.S.M.E. Boiler and Pressure vessel Code section I, Power Boilers with 1999 addenda	Relevant exempt boilers include: Boilers under the jurisdiction of the United State; Boilers used exclusively for horticultural or agricultural purposes; Steam Heating Boilers. Having a capacity of more than 207 pounds of steam per hour output and not in excess of 15 p.s.i.; Hot water heating Boilers, not exceeding 30 psig operating pressure; or 250°F operating temperature, or having a capacity of more than 200,000 BTU output of the boiler nozzle; Hot Water Supply Boilers and Other Liquid Heat Storage Sources Not Exceeding,160 psig operating pressure, 250°F operating temperature, provided that they not exceed, A heat input of 200,000 BTU per hour, a water temperature of 200°F, or a nominal water containing capacity of 120 gallons.	When a person or a corporation desires to manufacture a special type of boiler, the design of which is not covered by the rules formulated by the board or by the current section one, four or eight of the ASME Code, specifications and drawings shall be submitted through the chief of inspections to the board which, if it approves, shall permit the construction thereof.
New Hampshire[4] The Department of Labor	Boilers and pressure vessels, as defined in RSA 157-A: 2, shall conform to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code.	Relevant exempt boilers include: boilers under federal control, or United States Coast Guard control; Boilers with less than 200,000 BTU/HR output in apartment houses; Pressure vessels operating at a working pressure not exceeding 15 psig; and Hot water boilers rated at less than (a) Heat input of 200,000 BTU/HR. (b) Water temperature of 210 degrees F.	Any boiler or pressure vessel that does not conform to the standards established under RSA 157-A:3 (ASME) may be operated under the following conditions: An inspection of such boiler or vessel shall be conducted annually by a person qualified under RSA 157-A:7 and in accordance with rules adopted by the commissioner, and such boiler or vessel shall conform to any conditions or restrictions established by the commissioner

[3] http://www.mass.gov/Eeops/docs/dps/inf/522_cmr_1.00_14.00_board_of_boiler_rules.pdf
[4] http://www.gencourt.state.nh.us/rules/lab1200.html

State	Safety Codes	Significant Exceptions	Variances
New Jersey[5] New Jersey Department of Labor & Workforce Development - Labor Standards & Safety Enforcement - Bureau of Boiler and Pressure Vessel Compliance	All boilers shall be constructed and installed in accordance with the applicable sections of the ASME Boiler and Pressure Vessel Code and The National Board Inspection Code	Relevant exempt boilers include: Steam boilers operating at a pressure not greater than 15 psig when such boilers serve dwellings of less than six family units or other dwellings with accommodations for less than 25 persons; Hot water boilers at a pressure not greater than 160 psig and hot water boilers limited to temperatures not exceeding 250 degrees Fahrenheit when such boilers serve dwellings of less than six family units or other dwellings with accommodations for less than 25 persons; Any steam or hot water boiler having a heat input of less than 10 kilowatts or less than 40,000 BTU per hour; Any steam or hot water boiler under the jurisdiction and control of the United States Government when actively regulated by a Federal agency; and Any steam or hot water boiler used solely for the propulsion of a motor vehicle regulated by the Motor Vehicle Act, Title 39 of the Revised Statutes.	A code of construction which is a national or international standard and is recognized by regulation and by the country of origin, when applicable, shall be acceptable as an alternate code of construction under this subchapter, provided that it has been fully and finally approved and accepted as an alternate code of construction by the NBBPVI
New York[6] New York Department of Labor - Division of Safety & Health - DOSH - Boiler Safety Bureau	No boiler shall hereafter be installed in this State unless it has been constructed in accordance with the requirements of the American Society of Mechanical Engineers and the National Board of Boiler and Pressure Vessel inspectors and is so tamped and registered.	Relevant exempt boilers include: Boilers subject to inspection by DOT, boilers located on farms used solely for agriculture purposes, boilers subject to inspection by a federal agency, low-pressure boilers under 100,000 BTU/HR, steam boilers operation at 15 psi or less in dwelling occupied by fewer that 6 families	None found

[5] http://lwd.dol.state.nj.us/labor/lsse/laws/boiler_law.html#90-4.1
[6] http://www.labor.state.ny.us/workerprotection/safetyhealth/sh14.shtm#14.9.41

State	Safety Codes	Significant Exceptions	Variances
Pennsylvania[7] Pennsylvania Department of Labor & Industry - Boiler Division	Every boiler destined for use in this commonwealth shall be inspected during its construction by an individual who has a valid National Board commission to perform an inspection. Every boiler which has been so inspected shall, upon completion, have placed upon it a stamp bearing a symbol and number authorized by the department for this purpose. The department may accept comparable shop inspection and quality control standards which are equivalent to or exceed the ASME or National Board standards.	Relevant exempt boilers include: Boiler installations in a single-family residence (as long as a business is not located in the home) in apartment buildings with four (4) or fewer dwelling units, Boiler installations in agricultural buildings used for farming operations (this does not include farm buildings where sales occur or where agricultural processing may occur), Boilers or unfired pressure vessels owned and operated by the federal government, Storage water heaters and instantaneous water heaters when none of the following limitations are exceeded: • A heat input of 200,000 BTU per hr. • A water temperature of 210° F. • A nominal water-containing capacity of 120 gallons.	Any boiler or unfired pressure vessel which has not been shop-inspected as required under subsection (a) may be installed within this Commonwealth if the following requirements are met: (1) Submission of a request to install the equipment, in a form prescribed by the department, to the department. (2) Furnishing of mill test reports of material to show compliance with the ASME Code or another code accepted by the department. (3) Furnishing of calculations and stress analyses showing the maximum allowable working pressure under the ASME Code or another code accepted by the department. These stress analyses shall be certified by a registered professional engineer. (4) If equipment is of welded construction, all seams that are required to be X-rayed by the ASME Code or another code accepted by the department shall be X-rayed. (5) Establishment that welding meets requirements of the ASME Code or another code accepted by the department. (6) Subjection of equipment to nondestructive examination or test that verifies structural integrity. (7) All tests shall be made under the supervision of a Commonwealth-commissioned inspector or an individual holding a valid national board commission. (8) Submission of a data sheet comparable to the appropriate ASME data report form and certified by a national board-commissioned inspector. (9) If mill test reports, names of welders or other required information cannot be produced, the department may, in its discretion, accept other documentation. (10) Payment of a special equipment application fee. (11) Compliance with the requirements outlined under section 7.

[7] http://www.dli.state.pa.us/landi/CWP/view.asp?a=185&Q=70059

State	Safety Codes	Significant Exceptions	Variances
Rhode Island[8] Rhode Island Department of Labor & Training - Division of Occupational Safety - Boiler Unit	Codes adopted and enforced shall be the standard code of rules as published and enunciated by the American Society of Mechanical Engineers and the National Board of Boiler and Pressure Vessel Inspectors and any amendments to them, as were in effect as of January 1, 2007.	Relevant exempt boilers include: Boilers and pressure vessels under federal control, Pressure vessels having an internal or external working pressure not exceeding fifteen (15) psig, with no limit on size, Steam boilers used for heating purposes carrying a pressure of not more than fifteen (15) pounds per square inch gauge, and which are located in private residences or in apartment houses of less than six (6) family units provided the boiler heat input does not exceed four hundred thousand (400,000) BTU per hour, Hot water heating boilers which are located in private residences or in apartment houses of less than six (6) family units provided the boiler heat input does not exceed four hundred thousand (400,000) BTU per hour, and) Hot water boilers and hot water heaters operated at pressure not exceeding one hundred sixty (160) pounds per square inch gauge, or temperatures not exceeding two hundred fifty degrees (250°) F. which are located in private residences or in apartment houses of less than six (6) family units provided the boiler or hot water heater is not in a place of public assembly.	Any person, who believes the rules and regulations promulgated under 28-25 of the General Laws impose an undue burden upon the owner or user, may request a variation from such rule or regulation. The request for variation shall be made to the Administrator of Occupational Safety in writing and shall specify how equivalent safety is to be maintained. The Administrator, after investigation and such hearing as it may direct, may grant such variation from the terms of any rule or regulation provided such special conditions as may be specified are maintained in order to provide equivalent safety.
Vermont[9] Vermont Department of Public Safety - Division of Fire Safety - Boiler & Pressure Vessel Safety Program	All boilers and pressure vessels shall be manufactured, constructed and assembled in accordance with the appropriate American Society of Mechanical Engineers (ASME) standards, or equivalent standard recognized by the National Board of Boiler & Pressure Vessel Inspectors.	Relevant exempt boilers include: Boilers under federal control and subject to regulations under the Surface Transportation Board, Department of Transportation, Federal Railroad Administration or Nuclear Regulatory Commission. Hot water heaters and portable water storage tanks with a heat input of less than 200,000 BTU/HR, water temperature less than 210 degrees (F) and less than 120 gallons aggregate water capacity.	The Commissioner may grant a variance approving a different solution to compliance that meets the intent of this code, or may exempt a portion of a building, or equipment including non-standard boilers and pressure vessels, from the requirements of this Code.

[8] http://www.dlt.ri.gov/occusafe/boilerlaws.htm
[9] http://www.dps.state.vt.us/fire/05firecodeadopted.pdf

REFERENCES

[1] *Energy Programs, Renewable Energy Incentives*. NHOEP. Web. 4 Mar. 2010. <http://www.nh.gov/oep/programs/energy/RenewableEnergyIncentives.htm>.
[2] *Information on Air Pollution Control Technology For Woody Biomass Boilers*. Forests and Rangelands. Web. 4 Mar. 2010. <http://www.forestsandrangelands.gov/Woody_Biomass/documents/bioenergy/woody_biomass_control_technology_032509.pdf>.
[3] *Information on Air Pollution Control Technology For Woody Biomass Boilers*. Forests and Rangelands. Web. 4 Mar. 2010. <http://www.forestsandrangelands.gov/Woody_Biomass/documents/bioenergy/woody_biomass_control_technology_032509.pdf>.
[4] *Information on Air Pollution Control Technology For Woody Biomass Boilers*. Forests and Rangelands. Web. 4 Mar. 2010. <http://www.forestsandrangelands.gov/Woody_Biomass/documents/bioenergy/woody_biomass_control_technology_032509.pdf>.
[5] *Information on Air Pollution Control Technology For Woody Biomass Boilers*. Forests and Rangelands. Web. 4 Mar. 2010. <http://www.forestsandrangelands.gov/Woody_Biomass/documents/bioenergy/woody_biomass_control_technology_032509.pdf>.
[6] *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>, F-2.
[7] Oravainen, Heikki. *Testing Methods and Emission Requirements for Small Boilers*. Rep. Helsinki: Motiva, 2000, 12.
[8] *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>, 8.
[9] Oravainen, Heikki. *Testing Methods and Emission Requirements for Small Boilers*. Rep. Helsinki: Motiva, 2000, 12.
[10] *Measuring Boiler Efficiency*. Energy Solutions Center. Web. 4 Mar. 2010. <http://www.energysolutionscenter.org/BoilerBurner/Resources/Primer/Primer_App1.pdf>.
[11] Oravainen, Heikki. *Testing Methods and Emission Requirements for Small Boilers*. Rep. Helsinki: Motiva, 2000, 13.
[12] Roberts, Catherine. *Woody Biomass Boilers: Emissions and Control Technology*. 2 Dec. 2009. Web. 4 Mar. 2010. <http://www.cdphe.state.co.us/ap/toxics/woodybiomassemissions.pdf>.
[13] *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>, 1.
[14] "Air Pollution – Particulate Matter Brochure." California Environmental Protection Agency. Web. 4 Mar. 2010. <http://www.arb.ca.gov/html/brochure/pm10.htm>.
[15] Fraser, Gemma. "Safety Clearance Sparks Biomass Boilers for Schools Row." *The Scotsman*. 2 Mar. 2009. Web. <http://news.scotsman.com/education/Safety-clearance--sparks-biomass.5027987.jp>.
[16] *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>.
[17] Committee to Study State Regulations Governing Installation of Boilers, Pressure Vessels, and Related High Performance HVAC Equipment. (n.d.). SB 98, Chapter 251:1, Laws of 2009.

[18] Committee to Study State Regulations Governing Installation of Boilers, Pressure Vessels, and Related High Performance HVAC Equipment. (n.d.). SB 98, Chapter 251:1, Laws of 2009.
[19] Reedy, Roger, and Rick Swayne. *Solid-Fuel Heating Boilers Constructed to the Provisions of EN 303-5*. Rep. no. KKAI Report No. 090304-1 Rev 1. Prepared for BioHeatUSA. Kevin Kennedy Associates, 28 Apr. 2009. Web. 4 Mar. 2010. <http://www.woodboilers.com/admin/uploads/public/090428%20KKAI%20Final%20Report%20Revision%201%20for%20BioHeat%20USA.PDF>.
[20] Committee to Study State Regulations Governing Installation of Boilers, Pressure Vessels, and Related High Performance HVAC Equipment. (n.d.). SB 98, Chapter 251:1, Laws of 2009.
[21] *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>, E-4.
[22] *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>, E-5.
[23] *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>, E-4.
[24] *Information on Air Pollution Control Technology For Woody Biomass Boilers*. Forests and Rangelands. Web. 4 Mar. 2010. <http://www.forestsandrangelands.gov/Woody_Biomass/documents/bioenergy/woody_biomass_control_technology_032509.pdf>.
[25] *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>, E-5.
[26] *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>.
[27] *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>.
[28] Committee to Study State Regulations Governing Installation of Boilers, Pressure Vessels, and Related High Performance HVAC Equipment. (n.d.). SB 98, Chapter 251:1, Laws of 2009.
[29] Eddinger, Jim. "Small Biomass Boilers and Air Quality: New Regulations Being Developed by the Environmental Protection Agency." Speech. Webinar: Presentation by EPA and USDA Forest Service. 3 Apr. 2009. *Western Forestry Leadership Coalition*. Web. 4 Mar. 2010. <http://www.wflccenter.org/ts_dynamic/edu_outreach/52_file.pdf>.
[30] Eddinger, Jim. "Small Biomass Boilers and Air Quality: New Regulations Being Developed by the Environmental Protection Agency." Webinar: Presentation by EPA and USDA Forest Service. 3 Apr. 2009. *Western Forestry Leadership Coalition*. Web. 4 Mar. 2010. <http://www.wflccenter.org/ts_dynamic/edu_outreach/52_file.pdf>.
[31] Eddinger, Jim. "Small Biomass Boilers and Air Quality: New Regulations Being Developed by the Environmental Protection Agency." Webinar: Presentation by EPA and USDA Forest Service. 3 Apr. 2009. *Western Forestry Leadership Coalition*. Web. 4 Mar. 2010. <http://www.wflccenter.org/ts_dynamic/edu_outreach/52_file.pdf>.

[32] Eddinger, Jim. "Small Biomass Boilers and Air Quality: New Regulations Being Developed by the Environmental Protection Agency." Webinar: Presentation by EPA and USDA Forest Service. 3 Apr. 2009. *Western Forestry Leadership Coalition*. Web. 4 Mar. 2010. <http://www.wflccenter.org/ts_dynamic/edu_outreach/52_file.pdf>.
[33] Eddinger, Jim. "Status Update on EPA's Rulemakings Affecting Small Biomass-Fired Boilers." SmallWood 2008. Madison, WI. 14 May 2008. Forest Products Society. 4 Mar. 2010. <http://www.forestprod.org/smallwood08eddinger.pdf>.
[34] Eddinger, Jim. "Small Biomass Boilers and Air Quality: New Regulations Being Developed by the Environmental Protection Agency." Speech. Webinar: Presentation by EPA and USDA Forest Service. 3 Apr. 2009. *Western Forestry Leadership Coalition*. Web. 4 Mar. 2010. <http://www.wflccenter.org/ts_dynamic/edu_outreach/52_file.pdf>.
[35] Eddinger, Jim. "Small Biomass Boilers and Air Quality: New Regulations Being Developed by the Environmental Protection Agency." Speech. Webinar: Presentation by EPA and USDA Forest Service. 3 Apr. 2009. *Western Forestry Leadership Coalition*. Web. 4 Mar. 2010. <http://www.wflccenter.org/ts_dynamic/edu_outreach/52_file.pdf>.
[36] Eddinger, Jim. "Small Biomass Boilers and Air Quality: New Regulations Being Developed by the Environmental Protection Agency." Speech. Webinar: Presentation by EPA and USDA Forest Service. 3 Apr. 2009. *Western Forestry Leadership Coalition*. Web. 4 Mar. 2010. <http://www.wflccenter.org/ts_dynamic/edu_outreach/52_file.pdf>.
[37] Eddinger, Jim. "Status Update on EPA's Rulemakings Affecting Small Biomass-Fired Boilers." Speech. SmallWood 2008. Madison, WI. 14 May 2008. Forest Products Society. 4 Mar. 2010. <http://www.forestprod.org/smallwood08eddinger.pdf>.
[38] "Combined Rulemaking for Industrial, Commercial, and Institutional Boilers and Process Heaters at Major Sources of HAP and Industrial, Commercial, and Institutional Boilers at Area Sources." United States General Services Administration. Web. 4 Mar. 2010. <http://www.reginfo.gov/public/do/eAgendaViewRule?pubId=200910&RIN=2060-AM44>.
[39] "Combined Rulemaking for Industrial, Commercial, and Institutional Boilers and Process Heaters at Major Sources of HAP and Industrial, Commercial, and Institutional Boilers at Area Sources." United States General Services Administration. Web. 4 Mar. 2010. <http://www.reginfo.gov/public/do/eAgendaViewRule?pubId=200910&RIN=2060-AM44>.
[40] *Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>.
[41] Giudice, Philip. Letter to Massachusetts Biomass Energy Stakeholders. 3 Dec. 2009. Department of Energy Resources. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs//doer/rps/Mass%20Biomass%20Energy%20Stakeholders.pdf>.
[42] *Oregon Biomass Coordinating Group*. Oregon Department of Energy. Web. 4 Mar. 2010. <http://www.oregon.gov/ENERGY/RENEW/Biomass/OBCG.shtml>.
[43] "Phone Interview with Oregon Boiler Inspector." Telephone interview. Jan. 2010.
[44]*Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency*. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>.
[45] *Controlling Emissions from Wood Boilers*. Rep. Northeast States for Coordinated Air Use Management, 9 Oct. 2008. Web. 4 Mar. 2010. <http://www.nescaum.org/documents/controlling_emissions_from_wood_boilers.pdf>.
[46]Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>.

BIBLIOGRAPHY

"Air Pollution – Particulate Matter Brochure." California Environmental Protection Agency. Web. 4 Mar. 2010. <http://www.arb.ca.gov/html/brochure/pm10.htm>.

Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States Evaluation and Options for Regional Consistency. CONEG Policy Research Center, Inc., June 2009. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/DOER%20Biomass%20Emissions%20&%20Safety%20Regulations.pdf>.

"Combined Rulemaking for Industrial, Commercial, and Institutional Boilers and Process Heaters at Major Sources of HAP and Industrial, Commercial, and Institutional Boilers at Area Sources." United States General Services Administration. Web. 4 Mar. 2010. <http://www.reginfo.gov/public/do/eAgendaViewRule?pubId=200910&RIN=2060-AM44>.

Committee to Study State Regulations Governing Installation of Boilers, Pressure Vessels, and Related High Performance HVAC Equipment. (n.d.). SB 98, Chapter 251:1, Laws of 2009.

Controlling Emissions from Wood Boilers. Rep. Northeast States for Coordinated Air Use Management, 9 Oct. 2008. Web. 4 Mar. 2010. <http://www.nescaum.org/documents/controlling_emissions_from_wood_boilers.pdf/>.

Doshi, Kamalesh, comp. *Why a Wood Heating System? Part of the New Hampshire Wood Biomass Heating Project*. Rep. Biomass Energy Resource Center, 2008.

Eddinger, Jim. "Small Biomass Boilers and Air Quality: New Regulations Being Developed by the Environmental Protection Agency." Webinar: Presentation by EPA and USDA Forest Service. 3 Apr. 2009. *Western Forestry Leadership Coalition.* Web. 4 Mar. 2010. <http://www.wflccenter.org/ts_dynamic/edu_outreach/52_file.pdf>.

Eddinger, Jim. "Status Update on EPA's Rulemakings Affecting Small Biomass-Fired Boilers." Speech. SmallWood 2008. Madison, WI. 14 May 2008. Forest Products Society. 4 Mar. 2010. <http://www.forestprod.org/smallwood08eddinger.pdf>.

Energy Programs, Renewable Energy Incentives. NHOEP. Web. 4 Mar. 2010. <http://www.nh.gov/oep/programs/energy/RenewableEnergyIncentives.htm>.

Fraser, Gemma. "Safety Clearance Sparks Biomass Boilers for Schools Row." *The Scotsman.* 2 Mar. 2009. Web. <http://news.scotsman.com/education/Safety-clearance--sparks-biomass.5027987.jp>.

Giudice, Philip. Letter to Massachusetts Biomass Energy Stakeholders. 3 Dec. 2009. Department

of Energy Resources. Web. 4 Mar. 2010. <http://www.mass.gov/Eoeea/docs//doer/rps/Mass%20Biomass%20Energy%20Stakeholders.pdf>.

Heating the Northeast with Biothermal Fuel. Dr. William Strauss, 5 Aug. 2009. Web. 4 Mar. 2010. <http://www.forestprod.org/biomass09strauss.pdf>.

Information on Air Pollution Control Technology For Woody Biomass Boilers. Forests and Rangelands. Web. 4 Mar. 2010. <http://www.forestsandrangelands.gov/Woody_Biomass/documents/bioenergy/woody_biomass_control_technology_032509.pdf>.

Measuring Boiler Efficiency. Energy Solutions Center. Web. 4 Mar. 2010. <http://www.energysolutionscenter.org/BoilerBurner/Resources/Primer/Primer_App1.pdf>.

Niebling, Charlie. *Thermal Renewable Energy in New Hampshire: Issues and Opportunities*. Rep. New England Wood Pellet, 2008.

Office of the Governor. *Gov. Lynch: New Hampshire Must Act to Help Secure Its Energy Future*. 29 Aug. 2006. Web. 19 Feb. 2010. <http://www.governor.nh.gov/news/2006/082906energy.htm>.

Oravainen, Heikki. *Testing Methods and Emission Requirements for Small Boilers.* Rep. Helsinki: Motiva, 2000.

Oregon Biomass Coordinating Group. Oregon Department of Energy. Web. 4 Mar. 2010. <http://www.oregon.gov/ENERGY/RENEW/Biomass/OBCG.shtml>.

Our Carbon, Our Communities. Hubbard Brook Research Foundation, 19 Oct. 2009. Web. 4 Mar. 2010. <http://www.actbioenergy.com/brochure/HBRF%20Our%20Carbon%20Our%20Communities.pdf>.

"Phone Interview with Oregon Boiler Inspector." Telephone interview. Jan. 2010.

Reedy, Roger, and Rick Swayne. *Solid-Fuel Heating Boilers Constructed to the Provisions of EN 303-5*. Rep. no. KKAI Report No. 090304-1 Rev 1. Prepared for BioHeatUSA. Kevin Kennedy Associates, 28 Apr. 2009. Web. 4 Mar. 2010. <http://www.woodboilers.com/admin/uploads/public/090428%20KKAI%20Final%20Report%20Revision%201%20for%20BioHeat%20USA.PDF>.

Roberts, Catherine. *Woody Biomass Boilers: Emissions and Control Technology.* 2 Dec. 2009. Web. 4 Mar. 2010. <http://www.cdphe.state.co.us/ap/toxics/woodybiomassemissions.pdf>.

Status Update on EPA's Rulemakings Affecting Small Biomass-Fired Boilers. SmallWood, 14 May 2008. Web. 4 Mar. 2010. <http://www.forestprod.org/smallwood08eddinger.pdf>.

Strauss, William. *Heating the Northeast with Biothermal Fuel*. 5 Aug. 2009. Web. 4 Mar. 2010. <http://www.forestprod.org/biomass09strauss.pdf>.