Maryland Wood Energy Coalition

College of Agriculture & Natural Resources - University of Maryland Extension & MD Ag. Exp. Stat., Jonathan Kays
Maryland Department of Natural Resources Forest Service, Daniel Rider
Maryland Energy Administration, Chris Rice
Alliance for Green Heat, John Ackerly
The Pinchot Institute for Conservation, Brian Kittler
American Wood Fiber, Inc., Steven Faehner
Maryland/Delaware Society of American Foresters, Mike Schofield
Maryland Forestry Board Foundation, Gary Allen
Harry R. Hughes Center for Agro-Ecology, Nancy Nunn
Maryland Forests Association, John Jastrzembski

February 2, 2012

For Maryland Policy & Decision Makers and Citizens:

A Prospectus For Advancing Biomass Thermal Energy In Maryland Developed By the Maryland Wood Energy Coalition

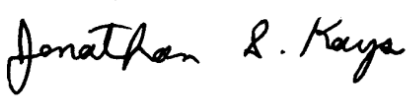
The Maryland Wood Energy Coalition was organized by the University of Maryland Extension and the Department of Natural Resources Forest Service in April 2010 with the goal to increase the use of woody biomass for high-efficiency wood energy technologies. Woody biomass is an overlooked renewable energy source that produces green jobs locally, is sustainable, has low emissions due to new technological advances, and is affordable and price stable. The efforts of all those involved has resulted in the Prospectus that can serve as a concise research-based information source and roadmap for decision makers.

The attached prospectus provides research-based information and policy recommendations (Pages 2 & 3) that will increase the adoption of advanced wood energy technology, and help Maryland reach targets for the Renewable Portfolio Standards (RPS).

Wood is the fastest growing residential heating fuel in Maryland, increasing 33% between 2000 and 2010. Residential and institutional applications will reduce fossil fuel and electric use. Best of all, using woody biomass from forests and urban sources is truly renewable and sustainable, while providing green jobs locally. Advances in wood burning technology have created a well-deserved image of woody biomass as a low emission renewable fuel. Finally, woody biomass has proven to be affordable and price stable, with significant fuel saving compared to fossil fuels and electricity.

For more information about the Coalition and/or the Prospectus please contact Jonathan Kays at 301-432-2767 x323 or by Email: jkays@umd.edu, or contact others listed in the letterhead. The prospectus will be available for download at the Harry R. Hughes Center For Agro-Ecology (www.agroecol.umd.edu) and the University of Maryland Extension Forest Stewardship Education (www.naturalresources.umd.edu).

Sincerely,



Jonathan S. Kays
Natural Resource Extension Specialist
Chair, Maryland Wood Energy Coalition

MARYLAND WOOD ENERGY COALITION

A Prospectus for Advancing Bio-thermal Energy in Maryland

THE MARYLAND WOOD ENERGY COALITION IS COMPRISED OF REPRESENTATIVES FROM STATE AGENCIES, UNIVERSITY EXTENSION, NON-PROFITS, AND PRIVATE BUSINESSES COMMITTED TO INCREASING THE ADOPTION OF HIGH-EFFICIENCY WOOD ENERGY TECHNOLOGIES THAT MEET MARYLAND AIR QUALITY STANDARDS. THE COALITION BELIEVES THIS CAN BEST BE ACHIEVED THROUGH SMALL TO MEDIUM-SIZED ADVANCED WOOD ENERGY TECHNOLOGIES IN RESIDENTIAL, COMMERCIAL, AND INSTITUTIONAL SETTINGS.

PREFACE

Wood is an underutilized renewable energy source in Maryland. What are Maryland's best options to promote development of sustainable forms of wood energy? What is the appropriate role of public policy in advancing wood energy in a responsible manner? This document is both an educational resource and a prospectus of policy options for advancing biomass thermal energy.

WHERE IS MARYLAND NOW?

- 40% of all energy consumed in Maryland is thermal energy in the form of heating and cooling for buildings and industrial processes.

- Maryland overwhelmingly relies on fossil energy—propane (3%), natural gas (47%), number 2 heating oil (11%), and electricity (39%) mostly from coal and nuclear—for heating and cooling.

- Maryland has one wood energy facility—a 4 MW plant providing the heat and electricity for a prison in Somerset County.

- Advanced, clean and efficient wood energy technologies are readily available. Other states have pursued these, but Maryland has yet to seize such opportunities.

This wood-based 4 MW CHP plant on the Lower Eastern Shore has operated since the 1980s providing heat and electricity to the ECI correctional institution.

- Existing policies such as Maryland's Renewable Portfolio Standard (RPS) provide incentives to produce electricity from wood. The RPS qualifies wood with preferential treatment as a Tier 1 fuels source, but this incentive has yet to be utilized.

Recommendations for Advancing Thermal Biomass in Maryland

- Well designed incentives can make renewable thermal more competitive with nonrenewable sources of thermal energy. Policy tools are critical to overcoming initial costs of adoption. Parity is needed; existing programs that support solar and wind should explicitly support thermal biomass as well.

- A small portion of The Strategic Energy Investment Fund (SEIF) could be allocated to underwrite a revolving loan fund to local and municipal governments for design and construction of biomass energy systems.

- Institutional scale wood chip boiler projects are Maryland's low hanging fruit; the state should select a few pilots and see these through from start to finish. If successful, a "Fuels for Schools and Beyond" program would be a natural progression, as it has been for Pennsylvania, Vermont, Maine, Missouri, North Dakota, Montana, Wyoming, Idaho, Utah, and Nevada.

- Maryland's net metering and interconnection policies should be evaluated by the Public Service Commission to remove barriers impeding the development of combined heat and power (CHP) projects.

- Renewable thermal energy from CHP and straight thermal biomass technologies do not currently qualify to generate renewable energy credits (RECs) under Maryland's renewable portfolio standard (RPS). The RPS should be modified to include certain specified types of renewable thermal biomass energy production as Tier 1 qualified resources as was done for solar thermal in the 2011 legislative session with Senate Bill 717. Another option would be to create an entirely new renewable thermal energy standard, separate from the current state renewable portfolio standard.

- A 1972 Maryland air quality regulation prohibit permitting of boilers under 35 MMBtu/hr in urban areas and 13 MMBtu/hr in Western Maryland and the Lower Eastern Shore. Proposed boilers under 13 MMbtu/hr can be granted an exception to this rule if air quality standards can be met. Small wood boiler projects are new for the state and specific guidance for meeting this exemption (i.e. Best Available Control Technology) must be made clear in Maryland Department of Environment Guidance if unwarranted uncertainty for boiler project financiers is to be avoided. Emission controls and boiler technologies have evolved significantly since this regulation was established, allowing small boilers to meet air quality standards.

- Maryland's solid waste disposal regulations currently require any tree trimmings that are separately collected at a disposal site be mulched or composted. Because of this, the majority of wood residues that could be used for energy are directed to the mulch market.

This should be revisited to clearly identify sources of biomass that are acceptable for energy. Undesirable wood residues (e.g. pressure treated wood and painted wood) can be identified as unacceptable.

- All new construction or retrofits of heating and cooling systems of state buildings should evaluate wood as a fuel alongside traditional fossil fuels.

- Explicitly target displacement of electric heating with appropriate biomass heating technologies as a core strategy of achieving the EMPOWER Maryland Goals. This concept could be piloted in renovations to low income housing units using the district heating model with a centralized biomass thermal heating plant.

- Major state informational outlets (i.e. the websites of Maryland Energy Administration and the Maryland Clean Energy Center) should be updated to include information about renewable thermal energy, including biomass thermal.

- Maryland should implement a number of programs to support residential scale thermal biomass:
    - Establish programs to accelerate the transition from older technologies to efficient and clean technologies. Continue to support the Maryland Department of Environment's $100,000 effort to change out older outdoor wood boilers. A well designed air quality/renewable energy program could effectively swap out older non-certified conventional wood stoves and give homeowners credit towards upgrading, several states, especially Oregon have designed effective programs to do this.
    - Extend residential renewable energy property tax breaks for solar and wind to advanced residential wood combustion.
    - Energy Performance Contracting (EPC) should include evaluation of biomass for heating and cooling systems.
    - Expand focus on wood appliances in home energy audits, weatherization programs, and energy assistance programs. Maryland home energy auditors and contractors should be trained to better assess wood stoves or fireplaces for energy efficiency, contribution to the energy needs of the home, and safety. Weatherization and energy assistance programs should classify very old stoves as health and safety risk.
    - Low interest loans or outright grants for biomass appliance assistance for homeowners. This program could provide a scaled financing system favoring low- income consumers. Envisioned is a rebate program or tax incentive for installing EPA certified wood or pellet stoves.

SO, JUST WHAT IS WOOD BIOMASS?

Wood biomass is a renewable fuel that can be used in a number of energy applications at various scales from residential firewood and wood pellet stoves to utility scale electric power plants. Maryland's sources of wood biomass include: urban wood wastes, byproducts of forest management activities, residues produced by industries utilizing Maryland's wood supply, and purpose-grown short rotation wood crops. Energy wood from forest management comes from low value wood not sold for a higher value product than energy and includes, logging slash, small-diameter trees, limbs and tops, poorly formed trees, and other woody materials.

DOES MARYLAND HAVE A SUSTAINABLE SUPPLY OF WOOD BIOMASS?

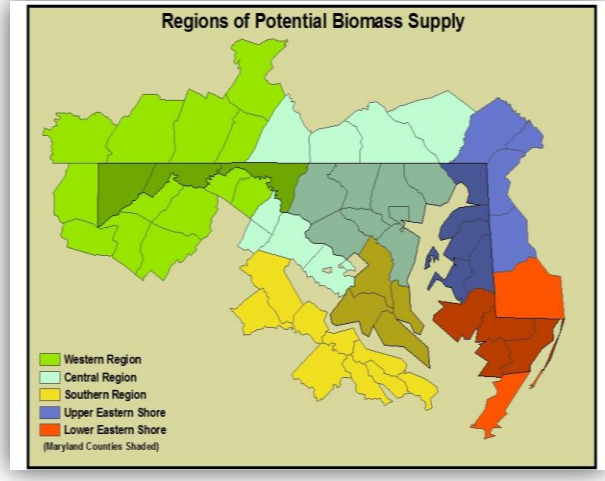
Is there enough biomass to sustain new energy facilities in Maryland? Where is this biomass located? How much does wood fuel cost compared to fossil fuels? Is removing biomass from Maryland's forests sustainable? Can developing biomass supply chains also develop jobs? These and other questions are central to developing a sustainable wood energy economy in Maryland, and this document addresses each of these questions.

Sources of Wood Biomass

- According to the Pinchot Institute analysis[1] there may be as much as 780,000 dry tons[2] of wood biomass available annually distributed across the five subregions (see map below) at a delivered cost of ~$30/ton.

- Wood chips from forest management (e.g. thinnings and final harvests) are available in rural communities with logging capacity, particularly in the western region and on the Delmarva Peninsula.

- Urban wood waste, Maryland's largest potential source of wood biomass, is available statewide, with the greatest concentration occurring in the central region where over half of the state's 35 Natural Wood Waste Recycling (NWWR) facilities operate.



Source: Chapter 1 - Potential Availability of Wood Biomass Resources in Maryland. Pinchot Institute for Conservation, 2010.

[1] For a detailed analysis of Maryland's wood biomass supply see chapter 1 of *The Potential for Sustainable Wood-based Bioenergy in Maryland*.

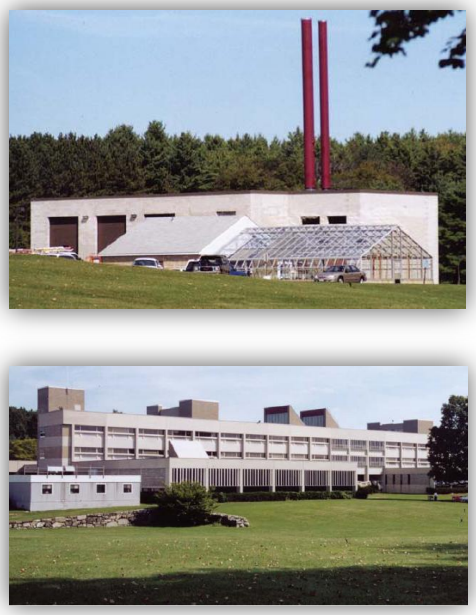
[2] 1 dry ton of wood has the heating value of approximately 2 green tons.

- Wood pellets are available at retail outlets throughout Maryland but no pellet manufacturers currently exist in state. In recent years, neighboring states have significantly increased wood pellet production, with several pellet mills coming online in Pennsylvania and Virginia.

- Researchers at the University of Maryland are determining the most advantageous locations for growing short rotation wood crops for energy. The cost of production notwithstanding, more than 600,000 green tons of wood could be available from short rotation wood energy crops cultivated on Maryland's idle lands annually. Environmental co-benefits, such as improved water quality in Chesapeake Bay, could result.

- Maryland's firewood market is significant, with more than 260 firewood contractors and many more landowners harvesting cordwood for local consumption. An estimated 18% of Maryland homes have at least one wood combustion appliance, consuming an estimated 340,000 tons of wood in aggregate each year.

- If the portion of Maryland's wood supply that presently serves as feedstock for the region's pulp and paper mills and the mulch market was diverted to feed a utility scale electricity-only power plant, the maximum capacity of such a facility would be just under 100 megawatts (MW), or enough to power 75,000 – 100,000 homes.[3] Siting a facility of this scale should carefully consider resource availability and potential impacts to existing wood industries.



8 MMBtu/hr biomass heating system at Mount Wachusett Community College, Massachusetts with a separate boiler house (top) heats a main college building and a fitness center with pool (bottom). The system uses advanced emissions control equipment to meet Massachusetts' stringent air quality standards. The project won a climate award from the National Wildlife Federation.

IS REMOVING BIOMASS FROM MARYLAND'S FORESTS SUSTAINABLE?

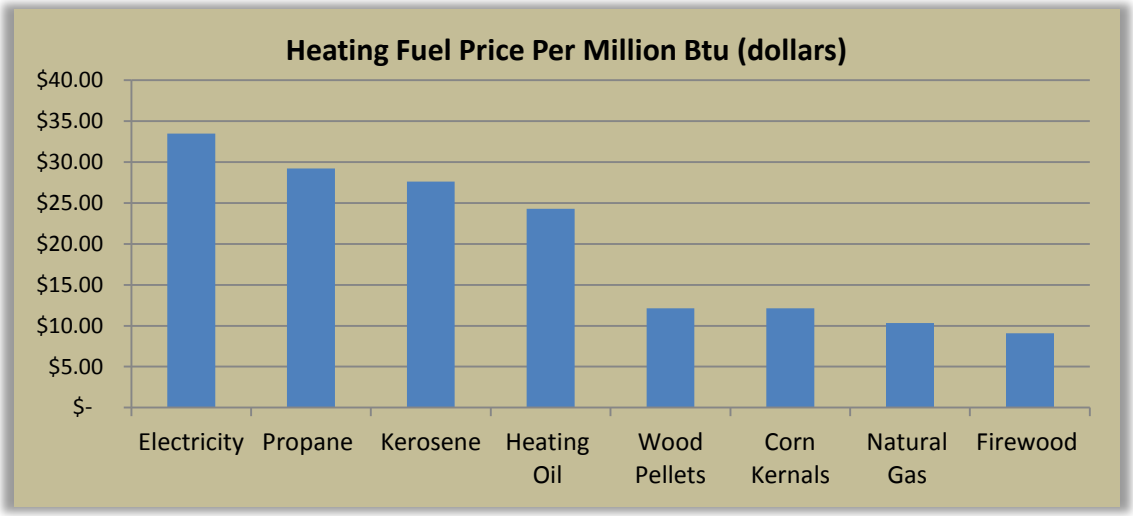
Strong markets for sustainably produced forest products are a main strategy for conserving Maryland's forests for future generations. Biomass harvests can be a valuable tool to meet multiple forest management objectives when forest management planning and careful harvests are undertaken. Maryland's 2008 Climate Action Plan states that, "*all biomass products will be sustainably harvested without depriving soils of important organic components for reducing erosion and maintaining soil nutrients and structure, nor depleting wildlife habitat or jeopardizing future feedstocks in quantity and quality*."

[3] Electrical energy is measured in kilowatt-hours (kWh). One kWh is the amount of energy a 100-watt light bulb uses every 10 hours or a 1,500-watt blow-dryer uses in 40 minutes. A typical house uses around 700 kWh in a month. A 1 megawatt (MW) power plant can power about 750 – 1,000 homes.

To address this charge, a multi-stakeholder working group led by the Department of Natural Resources Forest Service developed *Maryland's Forest Biomass Harvesting and Retention Guidelines* to educate Maryland's logging industry about their opportunities to harvest biomass in an ecologically responsible manner. Biomass markets can provide an incentive for forest landowners to manage their forests sustainably, encouraging a balanced approach to forest management. Markets for low grade wood are vital to keeping Maryland's forests healthy and energy markets represent the largest new potential market of this kind. University of Maryland Forestry Extension, Maryland's Master Logger Training Program and other outreach mechanisms are helping stakeholders understand the opportunities and responsibilities involved with biomass removal.

WHAT ARE THE ADVANTAGES OF THERMAL BIOMASS?

- **Thermal biomass is cost-effective.** Wood fuel can help keep the cost of heating low as the cost of fossil fuels continues to escalate. For instance, paying $200 for a ton of wood pellets is equivalent to paying $1.67 per gallon of heating oil (currently, in September 2011, at a national average price around $3.37 per gallon) or $1.10 per gallon of propane (currently at a national average price around $2.67). Heating with wood chips in institutional and commercial settings and heating homes with firewood exhibits even greater savings.



Source: Heating Fuel Comparison Calculator - *www.eia.gov/neic/experts/**heat**calc.xls*

- **Heating with wood insulates from price volatility.** Regions that have heated with wood for a long time demonstrate wood fuel's historical record of price stability, whereas fossil fuels continue to demonstrate price volatility each year. Low income families and individuals are especially vulnerable to high heating fuel costs. Wood fuel can reduce the demand for heating assistance by ratepayers, and reduce pressure on programs such as the Maryland Low Income Energy Assistance Program. In rural western Maryland as many as 10% of homeowners heat primarily with wood.

- **Wood fuel is local fuel.** Biomass typically cannot be transported over long distances cost-effectively so Wood fuel typically comes from within 50 – 75 miles. Thus, when people heat with

biomass it keeps energy dollars circulating within communities that are close proximity to the point of consumption, keeping benefits and energy dollars local.

- **Thermal biomass energy can reduce electricity consumption.** A portion of the nearly one third of Maryland households currently using electric heat, which is one of the least-efficient and most-costly options for household space and water heating, could switch to biomass. Likewise a portion of the electricity consumed in heating and cooling in Maryland's industries could be offset by biomass, reducing demand for electricity and helping to achieve the goals of the EMPOWER Maryland Act of 2008

- **Thermal biomass strengthens the local economy.** The northeast uses ~84% of the nation's heating oil, with Maryland being the 5th largest consumer nationwide. As much as 11% of Maryland's residential thermal energy is currently supplied by heating oil. A recent study found that shifting roughly 18.5% of northeast's thermal energy demand to biomass by 2025 would inject $4.5 billion annually into the regional economy, retain $1.6 billion dollars, and create 140,000 permanent jobs.[4]

- **Each link in the biomass supply chain retains and creates local green jobs.** Maryland's wood products industry provides 27,610 jobs and $3 billion in economic output annually. At present ~2,500 – 5,000 of these jobs depend greatly on wood harvested in Maryland, while about 9,000 – 10,000 of these jobs depend on wood imported from nearby states. Building local biomass supply chains for thermal energy systems will build jobs that harness Maryland's resources. Supply chain jobs will come from tree care crews, arborists, land clearing companies, public works agencies, and municipal waste recycling operations, licensed loggers, and biomass aggregators. Creating green jobs in rural communities can be significantly more important to the economy at large than adding service jobs to the more densely populated areas.

- **Jobs created during project construction.** According to figures cited by contractors developing wood energy projects under the American Recovery and Reinvestment Act, at least one job is created for every $92,000 spent in wood energy project development.

Job Creation in the Supply Chain Assumptions per every 50,000 tons per year of pellets equivalent or 100,000 dry tons of biomass per year		
Chipping and Grinding Jobs		8
Pellet Mill Jobs		12
Logging and Cultivation Jobs		111
Trucking Jobs (Logs and Chips)		38
Trucking Jobs (Pellets to Retailer)		2
	Total Direct Jobs	171
Other assumptions		
Tons of dry biomass to make a ton of pellets		1
Tons per truckload of biomass and pellets		15
Annual tons of wood per logger		900
Trucks per day (365 days/year) to mill		5
Average trips per day for logging trucks		0.2

Source: Heating the Northeast with Renewable Biomass: A Vision for 2025

[4] *Heating the Northeast with Renewable Biomass: A Vision for 2025.* Presented by the Biomass Thermal Energy Council, Alliance for Green Heat, Maine Pellet Fuels Association, New York Biomass Energy Alliance, and the Pellet Fuels Institute. April 28, 2010.

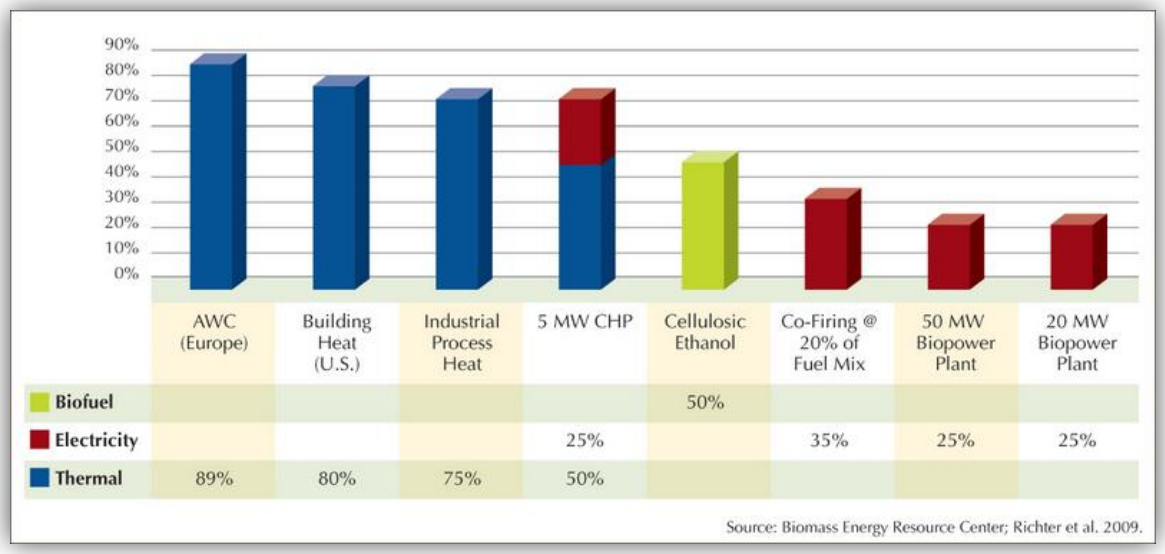
- **Thermal biomass is more likely to supplement, *not* supplant, other industries.** Distributed and appropriately scaled projects are less likely to result in competitive economics that may negatively affect existing wood users. In fact, pellet production and biomass thermal can positively influence the existing forest products industry if scaled appropriately.

A Maryland logger demonstrates how biomass destined for energy markets is sorted next to roundwood for higher value markets. Unlike other renewable energy technologies, wood thermal energy projects are dependent on local jobs in a wood fuel supply chain.

- **Thermal biomass can help reduce greenhouse gas emissions.** Biomass thermal has the lowest life-cycle greenhouse gas emissions of all biomass energy options and as a result the greenhouse gas reduction benefits of using biomass are achieved fastest through thermal technologies.

- **Thermal biomass is the most efficient use of wood fuel.** Energy efficiency is a comparison of fuel input to usable energy output. Modern and commercially viable biomass heating, cooling, and combined heat and power (CHP) technologies can reach efficiencies of up to 80 – 90%, while electric power plants only reach 25 – 30%, releasing three quarters of the energy produced into the air and/or surrounding water bodies.

Relative Efficiencies of Various Bioenergy Conversion Options



WHAT ARE THE MOST APPROPRIATE WOOD ENERGY TECHNOLOGIES FOR MARYLAND?

With support from the University of Maryland Harry R. Hughes Center for Agro-Ecology and Maryland Department of Natural Resources, the Pinchot Institute for Conservation completed a comprehensive analysis of wood energy market potential that pairs biomass procurement cost limitations of various energy technologies with data on Maryland's available wood biomass resources. [5] This analysis includes a regional breakdown to depict the type and scale of energy technologies that may best be paired with the locally available wood biomass supply. Important highlights about Maryland's wood supply and wood energy market potential include:

- New wood energy capacity may prop up the existing forest products industry, and other wood using industries (e.g. poultry production), retaining and creating jobs in the process, if new wood energy infrastructure is "scaled appropriately."

- Only 6.5% of Maryland's electricity generating capacity is currently using combined heat and power (CHP) technologies, despite the fact that Maryland has an estimated ~3,000 opportunities to produce both usable heat and electricity in one fuel efficient process. Biomass could fuel a number of such CHP plants in each region of the state producing more electricity in aggregate than a centralized biopower facility while providing marketable heat and economic benefits to adjacent industries and communities.

Successful wood chip heat for single buildings

- ✓ Typically 1.5 to 5 MMBtu/hour in scale
- ✓ Displaces high cost fossil fuels
- ✓ Use ~150 to ~1,000 green tons of chips per year
- ✓ Payback of 5 to 20 years in fuel savings

- If 100% of Maryland's biomass resources (excluding wood going to other industries) were utilized in CHP systems, more than 50 MW of usable electricity and nearly 1.5 billion BTUs[6] of usable heat could be generated, all while minimizing unnecessary air emissions that would occur if this heat and electricity were generated in separate processes.

[5] This report, *The Potential for Sustainable Wood-Based Bioenergy in Maryland*, is available at: http://www.pinchot.org/gp/Maryland_Biomass. The market analysis presented in chapters one and two details the scale and type of energy facilities with the most potential for different areas of Maryland.

[6] A Btu (British Thermal Unit) is a common measurement of heat. About 1 Btu of heat is released by a single match. An MMBtu, is a million Btus. Home furnaces are typically 25,000 to 100,000 Btu/hr.

- Utility scale electric power plants and cofiring, as well as commercial scale advanced liquid biofuel production for transportation appear to be less feasible in Maryland, although some opportunities for larger scale projects may yet exist. Small to moderate-scale distributed bioenergy options can clearly be sustained throughout Maryland.

- Commercial/institutional scale projects (e.g. "Fuels for Schools" type projects) hold significant promise to maximize the energy output of Maryland's biomass supply. If all of Maryland's biomass resources (excluding wood going to the region's wood using industries) were utilized in small wood chip fired advanced wood combustion systems distributed across the state, over 6 billion BTUs of useful thermal energy could be produced. Some communities in Maryland like Baltimore County are advancing institutional wood heating projects.

- Residential scale technologies hold great promise. In Europe, both pellet and firewood equipment is equally incentivized with solar and geothermal. If all of Maryland's available biomass resources (excluding wood going to other industries) were compressed into wood pellets and subsequently combusted in the clean burning wood pellet stoves of Maryland's homeowners, over 7 billion BTUs of thermal energy would be produced. As many as 270 small businesses participate in local firewood markets across Maryland.

Project Types and Scales that Make Sense for Maryland

Building Type and size[7]	Fuel/Technology Type	Heat Output	Average Biomass Consumption
Space Heat in Homes ~1,000 – 2,000 square feet	EPA certified firewood stoves and pellet stoves	~0.1 - ~0.3 MMBtu/hr	~1 - 5 dry tons/year
Small Office Building ~2,500 square feet	Pellet boilers and modular chip boilers	~0.5 MMBtu/hr	~10 dry tons/year
Small Campuses (Institutional/Commercial) ~7,100 – ~25,000 square feet	Modular chip boilers pellet boilers	~1 - 3 MMBtu/hr	~100 - 1,000 dry tons/year
Large Campuses (Institutional/Commercial) and industrial CHP ~ 215,000 square feet	Chip boilers for thermal and CHP	~30 MMBtu/hr	~10,000 dry tons/year

Institutional/commercial thermal biomass projects

Institutional scale wood chip boiler (typically around 1 – 10 MMBtu/hr) projects should be a top priority for Maryland, as these involve well established technologies and business models. The main hurdle for these projects is upfront capital costs which are often higher than comparable fossil fuel systems because these systems are less familiar to engineers and may require more costly emission control technologies. Investments in biomass are typically viewed as affordable when fuel savings,

[7] Assumes 140 Btus of heat per square foot.

as compared to fossil fuel alternatives, occur over a relatively short timeframe (e.g. 5 – 20 years). Investments in wood energy systems are quickly recovered through fuel savings derived from using locally produced wood chips, which are much cheaper than expensive fossil fuels imported from outside our region. This has proven to be the case for ten states (ME, VT, PA, MO, ND, MT, WY, ID, UT, NV) that have moved ahead with programs to provide upfront financial and technical assistance to schools, government buildings, hospitals, and other commercial/institutional settings where wood works well.

Advanced European wood combustion technology. This 500kW (1.7 MMBtu/hr) biomass boiler produces minimal particulate emissions (0.01 lbs/MMBTU) and operates with an efficiency of nearly 90%.

More than 30% of the students in Vermont go to schools that are heated by wood chip or pellet boilers. According to Vermont Fuels for Schools program managers, each year these schools displace about 1.4 million barrels of heating oil equivalent collectively saving $1.7 million in fuel costs annually (during the 2009 – 2010 heating season), a significant win for rural school districts operating on tight budgets. Vermont Fuels for Schools projects predictably break even in eight to twelve years, justifying state financing programs that cover up to 30% of initial capital costs.

In the 20 year history of Vermont's program the price of wood chips has remained stable and below the price of heating oil, which has fluctuated dramatically. As fossil fuel prices rise, this payback occurs in a much shorter timeframe.

Just north of Maryland, a boiler conversion program in Pennsylvania has led to big savings. For instance, the Elk Regional Health Center utilizes 2,785-tons of clean wood chips from local forests at around $89,000 annually. By converting from natural gas to biomass in 2008, the Health Center saved more than $94,000 in fuel costs in its first 6 months of operation. Even with the price of natural gas falling significantly, biomass projects like this can still pencil out economically.

Maryland's warm climate does not make biomass thermal any less attractive as biomass boilers can also include an air conditioning technologies using adsorption chillers, running during the cooling season as well. While this application has been used sparingly, some biomass cooling projects have been completed or are moving ahead in places like Florida and Missouri.

WHO IS POISED TO UNDERTAKE INSTITUTIONAL SCALE BIOMASS PROJECTS IN MARYLAND?

Hospitals, schools, colleges and universities, downtown areas, municipal buildings such as libraries and government service buildings all present opportunities for conversion to wood chip boilers. Wood biomass could potentially fit in agricultural areas where propane and heating oil are used to heat buildings and in food processing.

For instance, the dry heat offered by wood pellets or dry wood chips could reduce ammonia levels in poultry houses when compared to the wet heat from propane. This promotes flock health and productivity.

The approximately 5,100 poultry houses on Delmarva would need an estimated supply of over 200,000 tons of wood chips or 163,200 tons of wood pellets annually. This collective fuel switching would represent a savings of more than $49 million annually to the Delmarva poultry industry and a reduction of over 175,000 metric tons of fossil-based CO2 annually, not to mention a reduction in ammonia emissions, an additional win for the region's air and water quality.

This assumes that:

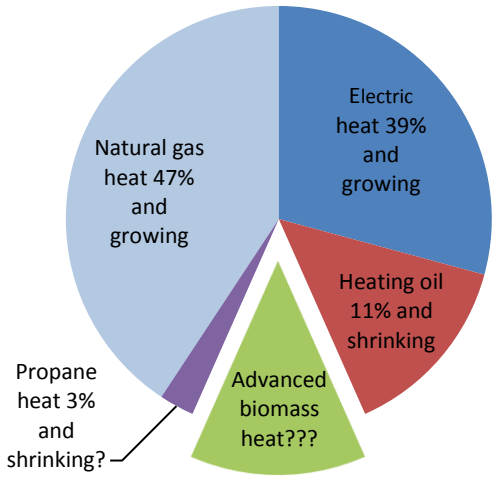
- The average poultry house consumes 6,000 gallons of propane per year at a cost of $2.67/gallon = $16,020 per year
- It takes 40 tons of wood chips[8] or 32 tons of pellets to offset 6,000 gallons of propane
- Energy grade semi-dry wood chips cost ~$60/ton and bulk pellets cost ~$200/ton = $6,400 per year – a fuel savings of $9,620 per year over propane

Residential Wood Combustion

Wood is the fastest growing source of heat in America. A $2,000 EPA certified wood or pellet stove can provide 50% to 100% of the heat of an average sized home in Maryland, and can reduce fossil fuels by the same amount as a $20,000 array of solar PV Panels.[9]

- If the 832,013 (39%) Maryland homes heating with electricity were to switch to wood pellet furnaces for space and water heating needs, the state would realize roughly a 1 million MWh savings annually, conceivably offsetting enough electricity to power more than 85,000 standard new homes.

How many Maryland homes can advanced biomass combustion heat in the future?



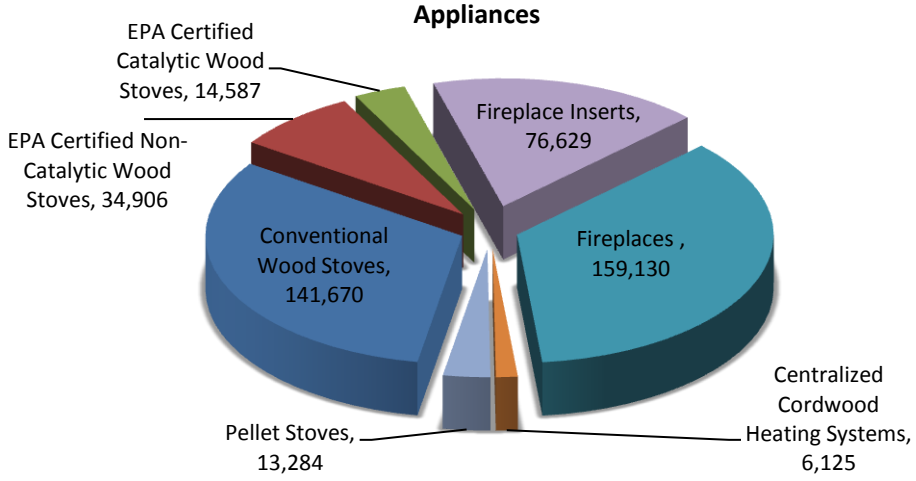
[8] Assumes a 20% moisture content of semi-dry wood chips and en energy content of 12.8 MMBtu/ton and assumes an energy content of 16 MMBtu/ton of wood pellets.

[9] Alliance for Green Heat

- If the 240,788 Maryland residences (11%) with heating oil switch to wood pellet furnaces for space and water heating, Maryland's annual fuel oil consumption could decrease by as much as 210 million gallons, or as much as 19% of Maryland's annual total oil consumption.[10]

Approximately 18% of Maryland's households have at least one wood burning appliance, accounting for ~366,710 total installed appliances and around 344,341 dry tons of wood combusted every year (Houck and Eagle, 2006). The majority of these appliances are older and less efficient than modern technologies, such as wood pellet appliances and EPA certified firewood stoves.

Number and Type of Wood Combustion Appliances in Maryland Homes as a Percentage of Total Residential Wood Combustion Appliances



Source: Houck and Eagle 2006; 2010 US Census.

WHAT ABOUT AIR EMISSIONS?

Negative perceptions about biomass boiler technologies are often unwarranted and inaccurate. Particulate matter (PM) emissions are really the only area in which fossil fuel boilers often outperform biomass. Still, wood energy systems with strong emissions controls can do quite well in controlling particulates to meet air quality standards, although such control technologies can be costly for small biomass boilers. Particulates and other emissions from biomass boilers can be minimized with good combustion practices, routine maintenance, and use of high quality fuels (i.e. low moisture and bark content). Recognizing this, the US EPA ruled in 2011 that routine tune ups is their preferred approach to regulating small institutional/commercial scale boilers (<10 MMBtu/hr or roughly ≤4 MW).

[10] Based on the 4 billion gallons of oil Maryland consumed in 2009 in the form of distillate fuel oil, jet fuel, LPG, gasoline, and residual fuels oil.

Overview of air pollutants

- **Particulates.** Institutional/commercial scale wood energy systems emit virtually no visible smoke although a small plume of water vapor can be visible on cold days. Per unit fuel, institutional/commercial wood energy systems emit ~7% the particulates of the average residential wood stove. Over the course of a heating season, a large wood-heated school (~150,000 - ~200,000 square feet) has about the same particulate emissions as 4 houses heated with EPA certified wood stoves. Particulates from the exhaust of idling school buses pose a larger health risk than emissions from such systems (BERC 2008).

- **Other pollutants.** Institutional/commercial scale wood heating systems produce less sulfur dioxide (SO_2) and carbon monoxide (CO) than oil systems, while emissions of nitrogen oxide (NOx) are roughly equivalent for both fuels.[11] Natural gas systems generally outperform biomass systems, although high-efficiency biomass gasification units with advanced emission controls can be nearly as clean. Combustion of both wood fuel and fossil fuel produce Volatile Organic Compounds (VOCs) that contribute to smog—some VOCs are higher with wood and some are higher with fossil fuels.

- **Greenhouse gases.** Life cycle greenhouse gas (GHG) emissions are less with sustainably harvested biomass than all fossil energy systems. Biomass boilers do emit carbon dioxide and other GHGs, but when biomass is produced from sustainably managed forests, bioenergy yields GHG reduction benefits relative to burning fossil fuels over time as GHGs from combustion of biomass are reabsorbed in new forest growth. A number of recent studies have found that because of comparably higher efficiencies, thermal and CHP technologies generally achieve GHG reduction benefits over a much shorter time horizon than electricity only power plants.

HOW ARE EMISSIONS FROM RESIDENTIAL WOOD HEATING ADDRESSED?

New installations of residential wood stove and boilers tend to be relatively clean burning compared to the stoves made prior to EPA regulations in 1990. Emissions from residential wood heating appliances can be a concern if they are not EPA certified, or in the case of outdoor boilers, EPA qualified. In Maryland, the biggest problems have been outdoor hydronic heaters installed before Maryland required that only EPA Phase II qualified boilers could be installed.

Maryland adheres to the federal EPA standards that limit new wood stoves to no more than 7.5 grams of particulates per hour and outdoor hydronic heaters to no more than 0.32 lbs/MMBtu. Currently, the EPA is working to make residential emission limits stricter and mandatory for all classes of products, including pellet stoves that are presently exempt because of their high efficiency. Wood and pellet

[11] Note that biomass emissions of NOx, SO_2, CO, and other harmful pollutants are less than coal because wood contains less of the constituent molecules that form these compounds than coal.

stoves are likely to be held to a 4.5 gram/hour emissions performance standard, a target that can be reached with EPA certified products.

From an air quality management perspective, adding new EPA certified residential appliances is a much smaller air quality concern than addressing the continued use, sale, and installation of older technologies and second hand stoves. Old uncertified stoves can emit 30 – 40 grams of particulates per hour. Air quality programs in several states are tackling this problem by banning the installation of all pre-1990 non-EPA certified stoves and by requiring that old stoves be removed and destroyed upon the sale of a home. These states often accompany such phase out programs with incentives for homeowners to upgrade their wood heating appliances to new EPA certified wood heating appliances. Maryland has had plans for such a program with outdoor boilers and may consider a similar approach for old uncertified wood stoves.

WHAT ARE THE EMISSION CONTROLS OF INSTITUTIONAL BIOMASS ENERGY SYSTEMS?

A recent study evaluated 24 stack emission test reports for wood chip and wood pellet heating systems in the US (RSG and BERC 2010).[12] This report focuses on: (1) development of work practice standards for controlling particulates in institutional/commercial scale boilers, (2) comparisons between US and European emission control practices, and (3) outlining the cost-effectiveness of common emission control technologies.[13] The cost-effectiveness analysis included in the study evaluated eight commonly used emission control options for small boilers.

Small institutional/commercial scale biomass boilers (≤10 MMBtu/hr) can use the most advanced particulate control technologies available (electrostatic precipitators) for around ~$110,000 - ~$140,000. Even baghouses paired with cyclones, a popular and less costly emission control technology (~$50,000 - ~$140,000) than electrostatic precipitators, have particulate control efficiencies over 99%, even for very small particles (<1 micrometer) (Resource Systems Group, 2010).

Average Efficiency of Particulate Control Technologies

PM Control Technology	PM 2.5 Control Efficiency	PM10 Control Efficiency
Baghouse + Cyclone	99%	99%
Electrostatic Precipitator (ESP)	90%	95%
Core separator	72-94%	29-56%
Multi-cyclone	10%	75%
Single Cyclone	5%	50%

Source: Emission Control Technologies for Small Wood-fired Boilers, Resource Systems Group, Inc. May 6, 2010.

[12] This report (available at http://www.biomasscenter.org/images/stories/emissions_rpt.pdf

[13] Pollution control technologies evaluated in this study include cyclones, multi-cyclones, high-efficiency multi-cyclones, core separators, dry electrostatic precipitators (ESPs), and baghouses, all of which are used in wood energy heating systems throughout the northeast and Europe.

How will EPA regulation of GHG emissions impact biomass boilers?

The US EPA has the authority to regulate GHG emissions at industrial facilities under the Clean Air Act. As such, the EPA's new Tailoring Rule sets GHG emissions thresholds for new and existing industrial facilities under the New Source Review and Title V Operating Permit programs.[14] The Tailoring Rule establishes emissions thresholds for "new" stationary sources that annually emit more than 75,000 tons of CO_2 equivalent or "existing" facilities that emit more than 100,000 tons of CO_2 equivalent annually. By 2016, EPA may expand this rule to include requirements for facilities that emit as low as 50,000 tons of CO_2 equivalent annually. The Tailoring Rule covers all fuels, but biomass facilities are currently exempt from this rule. Moreover, the type and scale of technologies outlined in the table on page 10 titled "Project Types and Scales that Make Sense for Maryland" fall well below these thresholds, with the largest technology identified in this table emitting just over 11,000 tons of CO_2 annually.[15]

In July 2011, EPA officially began a three-year deferral period that examines the effects of greenhouse gas emissions from biomass energy systems, and how they should be treated under Clean Air Act permitting. During this three-year deferral period EPA has sought further independent scientific analysis of the lifecycle effects of greenhouse gas emissions from biomass. Following this period EPA is expected to release a final rule on how GHG emissions from major biomass sources should be treated.[16] Under the Tailoring Rule, EPA will require the use of Best Available Control Technology (BACT) as a means to stay within GHG thresholds. EPA currently considers the use of biomass fuel to be BACT for bioenergy facilities.[17]

How are biomass emissions currently regulated?

The EPA has developed standards for a number of pollutants. Geographic areas that meet standards for these pollutants are classified as "attainment areas," whereas geographic areas that do not meet standards are classified as "nonattainment areas." The urban and suburban core of central Maryland contains the bulk of the state's nonattainment areas, whereas Western Maryland and much of the eastern shore are in attainment. A map of these areas is available at this website: http://www.mde.state.md.us/programs/Air/AirQualityPlanning/Documents/NAAQS.swf

In nonattainment areas, the Maryland Department of Environment works with local air planning programs to specify which pollution reduction measures are to be adopted. Air permitting programs include the New Source Review (NSR) program, the Prevention of Significant Deterioration (PSD) permitting program, and the Title V Operating Permit program; all administered by the Maryland Department of the Environment.

[14] http://www.epa.gov/nsr/documents/20100413fs.pdf
[15] Assumes a six month operating period annually, 30 MMBtu/hr capacity, and an emissions rate of 195 lbs CO_2/hr.
[16] http://yosemite.epa.gov/opa/admpress.nsf/0/4369C709163915B485257816005971BB
[17] http://www.epa.gov/nsr/ghgdocs/bioenergyguidance.pdf

In an effort to ensure continuous improvement in air quality in Maryland, the state placed restrictions on the size of new boilers in 1972 because at the time the vast majority of small boilers could not meet air quality standards. This policy is still in effect and under this policy, smaller projects are viewed as being less efficient and less apt to adopt expensive emission control technologies, and are therefore judged to be unable to meet particulate matter and visible emission standards.

This policy requires that projects in eastern and western Maryland be at least 13 MMBtu/hr and projects in central Maryland be at least 35 MMBtu/hr. This regulation includes a process administered by the Maryland Department of the Environment in which a proposed boiler under 13 MMbtu/hr can be granted exemption to receive a permit if the project can demonstrate that it can meet air quality standards.

Several northeastern states with air quality policies that operate on a case-by-case exemption process similar to Maryland have addressed the uncertainty caused by such exemption processes by identifying Best Available Control Technology for biomass boilers of a certain size, usually under 10 MMBtu/hr (Rick Handley and Associates and NESCAUM, 2009).[18] This clarity has encouraged biomass projects to move ahead while ensuring air quality.

Adding to this state permit processed, the US EPA established new Maximum Achievable Control Technology (MACT) standards for all boilers, including biomass boilers in 2011:[19]

- ***Large boilers.*** Under the new boiler MACT rule EPA defines large boilers ($\geq$10 MMBtu/hr or roughly $\geq$ 4 MW) as "major sources" of pollutants. The new rule established numeric emission limits for five pollutants (mercury, dioxin, hydrochloric acid, PM, CO) for major sources with the potential to emit 10 or more tons annually of any single air toxic or 25 tons or more annually of any mix of toxics. Under this rule, major sources are subject to: a onetime energy assessment, an initial and annual stack test, a need to adopt sophisticated emission control technologies, and state air permitting programs. For new large energy facilities an energy assessment is not necessary.

- ***Small boilers.*** For existing small institutional/commercial scale boilers ($\leq$10 MMBtu/hr or less than 4 MW in size) regulated under the area source rule there are no numeric emission limits, but such facilities must complete a onetime energy assessment and require a tune up every other year to maintain optimum boiler operation and combustion efficiency. Numeric limits and an energy assessment are not required for new boilers <10 MMBTU/hour, but a tune up is required every other year. Small boilers

[18] The report finds that, "*in the northeast states, the size thresholds vary from 1 to 10 MMBtu. Many of these standards were adopted in the early 1970s and need to be updated as states move forward with their PM2.5, State Implementation Plans (SIPs) and other particulate matter reduction activities. NESCAUM is developing a model rule to assist states in updating their state regulations for small to medium sized biomass boilers.*"

[19] For more information on the new EPA rules see www.epa.gov/airquality/combustion

that must comply with the boiler area source rule are those that have the potential to emit less than 10 tons/year of any single hazardous air pollutant or less than 25 tons per year of a mix of these pollutants.

CONCLUSIONS ON AIR EMISSIONS

Projects in eastern and western Maryland are currently required to be at least 13 MMBtu/hr and projects in central Maryland are required to be at least 35 MMBtu/hr. While a logical approach, the regulatory exemption process to allow small boilers under 13 MMBtu/hr to be permitted has proven to be difficult to navigate for biomass proponents. Moreover, the process signals significant uncertainty to financiers, which affects project development. Virtually every other state in the northeast has proactively dealt with air permitting issues by clearly identifying Best Available Control Technology for large and small boilers. As discussed in this section, emission control technologies for biomass boilers exist that are capable of meeting both Maryland and federal air quality standards. If renewable bioenergy projects are to proceed, the state should clearly define acceptable emissions control technologies for biomass projects.

GIVEN ALL OF THIS, WHERE DO WE WANT MARYLAND TO BE IN 10 YEARS?

- Maryland has clearly articulated its position on biomass and air quality and is encouraging modern high-efficiency biomass energy systems to develop at a scale that is appropriate for Maryland, and with appropriate emission control technologies.

- Wood energy is growing in the Mid-Atlantic region, and Maryland is leading the way with policy innovations that promote cost-effective renewable thermal energy technologies.

- Maryland has enabled thousands of residents to reduce their fossil carbon footprint by switching from electricity, oil, and propane to modern wood heat systems. Maryland also has cleaner air because it has assisted homeowners with upgrading their old wood heating appliances to modern, cleaner burning options.

- A number of advanced wood combustion (AWC) systems are up and running, providing social, economic, and environmental benefits to Maryland communities.

Maryland can emulate advanced wood gasification technologies. This 9MW (30 MMBtu/hr) unit produces much of the heat and electricity consumed on the campus of Middlebury College in Vermont. Middlebury's system consumes ~20,000 green tons of wood chips annually (2 – 3 truckloads daily at 20 tons /truck) sourced from within 75 miles of the College.

- Advanced and clean burning residential wood heating systems have replaced older uncertified wood burning appliances in Maryland homes.

- At least one Maryland community is heating multiple buildings in a downtown thermal energy grid.

- Thermal biomass energy is a significant contributor to Maryland's climate and energy goals, including the EMPOWER Maryland 2008 goals to reduce electricity consumption.

- Maryland's biomass resources are being efficiently utilized and regional wood chip, firewood, and wood pellet markets have all grown, adding green jobs in the process.

- A number of Maryland's local governments have utilized local urban wood resources to produce thermal energy.

- Maryland's private forest landowners, forestry professionals, and loggers are all benefiting from enhanced markets for wood for energy.

References

BERC 2008. Air Emissions from Modern Wood Energy Systems. Biomass Energy Resource Center. Montpelier, Vermont 05601

BERC 2011a. Particulate Matter Emissions-Control Options for Wood Boiler Systems. Biomass Energy Resource Center, Montpelier, Vermont.
This report reviews the basics of particulate emission control practices and technologies for wood-biomass boiler systems.

BERC 2011b.Woodchip Heating Fuel Specifications in the Northeastern United States.
This report details the types of biomass fuel, their fuel characteristics, and their implications for air quality.

BTEC 2010. Heating the Northeast with Renewable Biomass: A Vision for 2025. Presented by: Biomass Thermal Energy Council, Alliance for Green Heat, Maine Pellet Fuels Association, New York Biomass Energy Alliance, Pellet Fuels Institute. April 28, 2010.

Colorado State Forest Service 2008. Where Wood Works: Harnessing the Energy of Woody Biomass in Colorado. Colorado State Forest Service. Download at: http://csfs.colostate.edu/pdfs/Where-Wood-Works-2011.pdf

Houck, J.E., and Eagle B.N. 2006. Control Analysis and Documentation for Residential Wood Combustion in the MANE-VU Region. Baltimore, MD: Mid-Atlantic Regional Air Management Association, Inc. (MARAMA). Download at: http://www.marama.org/publications_folder/ResWoodCombustion/RWC_FinalReport_121906.pdf

Hinckley, J.A. Approaches to Permitting Wood-Fired Boilers in Vermont and New Hampshire Paper # 158. Resource Systems Group, Inc., 55 Railroad Row, White River Junction, VT 05001
This report describes the approaches to permitting wood fired boilers in Vermont and New Hampshire according to the following categories: (1) permit applicability thresholds, (2) emission limits, (3) emission controls, (4) air toxics evaluation thresholds, (5) ambient air quality impact evaluation thresholds and (6) record keeping requirements. This report focuses on wood-fired boilers ranging in size from two to less than 30 MMBtu/hr, the scale of projects deemed most appropriate in Maryland by the Maryland Wood Energy Coalition. The report includes permit conditions addressing Best Available Control Technology (BACT), fuel specifications, monitoring requirements and operation and maintenance requirements.

Partridge and Jamieson 2011. Forest Biomass and Air Emissions. Washington State Department of Natural Resources.

Pinchot 2010. The Potential for Sustainable Wood-based Bioenergy in Maryland. Pinchot Institute for Conservation.

Richter, D., Jenkins, D., Karakash, J., Knight, J., McCreery, L., and Nemestothy, K. 2009. Wood Energy in America. Science, Vol. 323, pp. 1432-1433 (March 13, 2009)

Rick Handley and Associates and NESCAUM 2009. Biomass Boiler & Furnace Emissions and Safety Regulations in the Northeast States: Evaluation and options for Regional Consistency. Submitted to Massachusetts Department of Energy Resources by CONEG Policy Research Center, Inc.
This report is a concise, objective analysis on whether the northeast states' air emissions regulations and safety certifications for residential and institutional-scale biomass boilers and furnaces pose a barrier to creation of a viable northeast market for domestic and non-U.S. biomass heaters and boilers; and if so, various strategic actions that could be taken to reduce such barriers and create a more attractive regional market for high performance biomass boilers – either developed domestically or abroad. The report and its findings are intended to provide public officials, state policy makers in the northeast and mid-Atlantic states, and the regional and international biomass industry with information on the role that regionally compatible air emissions and safety standards and certification can play in supporting an expanded northeast market for renewable biomass consistent with maintaining safety and the environment. The report examines the U.S. federal, northeast states, and European emissions and safety regulatory requirements that shape the current technologies and markets for residential and commercial biomass-based heating and power systems. It draws upon surveys of the relevant emissions and safety regulations, analysis of research reports, and interviews with public regulatory officials and representatives of U.S. and European. For more information see: http://www.nescaum.org/topics/wood-biomass-combustion

RSG 2001. An Evaluation of Air Pollution Control Technologies for Small Wood-Fired Boilers. Prepared for: Vermont Department of Public Service, Vermont Department of Environmental Conservation, Air Pollution Control Division, New Hampshire Governor's Office of Energy Resources and Community Services Massachusetts Division of Energy Resources. Revised September 2001

RSG and BERC 2010. Emission Controls for Small Wood-Fired Boilers. Prepared for the USDA Forest Service and the Western Forestry Leadership Coalition.
This report provides perhaps the most in depth overview of emission control technologies for small wood-fired boilers such as those recommended by the Maryland Wood Energy Coalition.