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EXECUTIVE SUMMARY

Wood Biomass for Heat & Power

Addressing Public Health Impacts

SUMMARY OF A 2011 SYMPOSIUM



Polly Hoppin, ScD
Molly Jacobs, MPH

Lowell Center for
Sustainable Production

About this Report

This Executive Summary provides highlights of the information and discussion at a day-long science policy symposium, “Wood Biomass for Heat and Power: Addressing Public Health Impacts,” held November 7, 2011 at the Massachusetts Medical Society in Waltham, Massachusetts. The full report is available at www.sustainableproduction.org/WoodBiomass.php.

In addition to summaries of conclusions from the scientific presentations, the Executive Summary includes recommendations for broad policy and program changes, developed by the Lowell Center for Sustainable Production to align with action steps generated by Symposium participants. The recommendations and action steps reflect collaborative work by representatives of the range of organizations across the Northeast states engaged in decisions about wood biomass combustion at the industrial, commercial, institutional and electricity generating scales.

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The authors have made every effort to accurately describe the content of the Symposium in this Executive Summary. However, the views expressed are opinions of the authors, presenters and other Symposium participants and do not necessarily reflect the position of the organizations that provided financial support for the meeting.*

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Cover: Ellen Burkhard, New York State Energy Research and Development Authority
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*Please see full report for full disclaimer: www.sustainableproduction.org/WoodBiomass.php.

Executive Summary

Background and Symposium Goals

Growing support for renewable energy—as a strategy for reducing environmental impacts and dependence on foreign oil—has stimulated interest in the use of biomass as a fuel source. The U.S. Department of Energy estimates that with aggressive action, biomass energy could replace 30% of current demand for petroleum-based fuels nationwide by 2030.¹ In addition, organizations promoting biomass, including trade associations, have established a collaborative vision calling for 25% of all thermal energy requirements in the Northeast and New York to be met with renewable resources by 2025, 74% of which is to be derived from biomass, including wood and crops such as switch grass.² Consistent with these goals, and driven by subsidies tied to the purchase of capital equipment and the relatively low cost of wood, the combustion of wood biomass to heat buildings and generate electricity is proliferating across the Northeast.

Increased wood-burning carries public health risks. Most industrial, commercial and institutional (ICI) and electricity generating units (EGUs) that burn wood emit higher concentrations of hazardous pollutants—such as fine particulate matter, volatile organic compounds, and carbon monoxide—than do boilers burning other fuels, including oil and natural gas.³ Extensive evidence from air pollution studies, as well as research on woodsmoke specifically, suggests that fine particulates in emissions from wood combustion harm respiratory health and contribute to other health conditions.⁴ Gaps in information and inconsistent state requirements for limiting emissions hamper efforts both to characterize risks from ICI/EGU sources and to protect public health. Moreover, public policies do not routinely promote the installation of cleanest-burning units which are widely used in European countries and increasingly available in the U.S. thermal market. These smaller-scale units can dramatically reduce concentrations of pollutants, particularly if state-of-the-art control technologies are used.

“Wood Biomass for Heat & Power: Addressing Public Health Impacts,” was held on November 7, 2011 at the Massachusetts Medical Society’s headquarters in Waltham, Massachusetts. With guidance from a planning committee, the Lowell Center for Sustainable Production (Lowell Center), based at the University of Massachusetts Lowell, convened and facilitated the Symposium. Representatives from the range of agencies responsible for biomass-related decisions participated, including state and federal departments of health, environment, education, energy and forestry. Other attendees included health

¹ U.S. Department of Energy. *U.S. Billion Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry*. Department of Energy. RD Perlack and BJ Stokes (leads), ORNL/TM-2011/224. Oak Ridge National Laboratory, Oak Ridge, TN. August 2011. Available at: http://www1.eere.energy.gov/biomass/pdfs/billion_ton_update.pdf. Accessed: September 15, 2012.

² *Heating the Northeast with Renewable Biomass: A Vision for 2025*. Biomass Thermal Energy Council, Alliance for Green Heat, Maine Pellet Fuels Association, New York Biomass Energy Alliance, Pellet Fuels Institute. April 28, 2010. Available at: https://www.biomassthermal.org/resource/pdfs/heatne_vision_full.pdf. Accessed: September 15, 2012.

³ Environmental Protection Agency. *AP 42, Fifth Edition*. Available at: <http://www.epa.gov/ttnchie1/ap42/>. Accessed: September 15, 2012.

⁴ Naeher LP, Brauer M, Lipsett M, et al. Woodsmoke health effects: A review, *Inhal Toxicol*. 2007;19(1):67-106.

professionals, scientists, and representatives from the biomass industry and health advocacy organizations. All nine northeast states were represented.

The Symposium Planning Committee set two goals for the meeting:

1. Exchange information about the state of the science regarding health effects from emissions associated with wood biomass combustion, with a focus on industrial, commercial and institutional uses.
2. Discuss policy and program changes that hold promise for enhancing public health protection from non-residential wood combustion.

Following opening remarks, Polly Hoppin, Research Professor and Program Director at the University of Massachusetts, Lowell, introduced Terry Miller, the U.S. Department of Agriculture, Forest Service Director's Field Representative, and Betsy Rosenfeld, Deputy Regional Health Administrator of the U.S. Department of Health and Services, Region 1 (New England). Mr. Miller and Ms. Rosenfeld provided their organizational perspectives on the issue—the importance of keeping the benefits of wood biomass for local economies, energy independence and forest health in mind while also addressing health concerns (Mr. Miller), and the opportunities the Symposium provided for working with diverse partners on complex issues, and for preventing detrimental impacts on public health (Ms. Rosenfeld). The three introductory speakers set a tone for the day of constructive collaboration and identification of common ground.

State of the Science on Woodsmoke Emissions and Health

The first morning session featured presentations by Dr. Doug Dockery (Harvard University School of Public Health), Dr. Michael Brauer (University of British Columbia) and Dr. Anette Kocbach Bølling (Norwegian Institute of Public Health). Their presentations provided an overview of what is known about risks to human health from the primary pollutants in woodsmoke. Key conclusions follow.

Dr. Doug Dockery, “Particulate Matter, Air Toxics & Health: The Big Picture”

- The size of pollutant particles matters. Evidence from epidemiological studies demonstrates that fine particulate air pollution (PM_{2.5}), a pollutant generated by combustion of wood and other fuels, is associated with significant health effects. These include a shortening of life expectancy, as well as increases in specific health conditions such as asthma attacks, heart attacks, chronic obstructive pulmonary disease, and a range of other conditions.
- Improved air quality leads to measurable improvements in public health.
- All levels of reductions in air pollution improve public health, even in communities that are already in compliance with the current PM_{2.5} air quality standards established by the Environmental Protection Agency (EPA). (The current annual standard is 15 ug/m³ and the current 24-hour standard is 35 ug/m³.)

- EPA is expected to tighten the PM_{2.5} standards in 2012.⁵

Dr. Michael Brauer, “Biomass Emissions, Exposure and Health Effects”

- Location matters. Distributed energy sources, such as boilers in institutions or commercial establishments, create high potential for exposure to emissions. To protect public health, it is important to benchmark any new pollution source against the cleanest technology in the region and to ensure that the siting of new sources takes into consideration proximity to populations.
- There is consistent scientific evidence that biomass combustion emissions contribute to respiratory disease, and growing evidence that these exposures are also associated with systemic inflammation. The primary knowledge gap regarding the health effects of exposure to biomass emissions is cardiovascular impacts. This evidence is minimal, and mixed.

Dr. Anette Kocbach Bølling, “The Toxicity of Woodsmoke Particles Generated Under Different Combustion Conditions”

- Toxicological research suggests that improved combustion conditions reduce health impacts, both because of lower emissions and also lower toxicity due to more complete combustion.
- The toxicity of particles in woodsmoke depends not only on the number or mass of particles emitted, but also on their physicochemical properties.
- The inorganic ash particles emitted from complete combustion conditions appear to be less harmful than the particles generated under conditions of incomplete combustion.
- Knowledge about the relative toxicity of organic carbon and soot particles that result from incomplete combustion is insufficient.
- Small-scale units installed in schools and hospitals are of particular concern. They have variable technologies and limited emission controls, and may expose potentially vulnerable populations, such as students and medical patients.

ICI Wood Burning in the Northeast

The second morning session featured presentations by Mr. Steve Snook (Vermont Department of Environmental Conservation), Dr. Ellen Burkhard (New York State Energy Research and Development Authority (NYSERDA)), and Dr. Phil Hopke (Clarkson University). These presentations provided a bridge between information on the public health hazards of PM_{2.5} and woodsmoke—the focus of the first session—and information on exposures from non-residential wood combustion. Two discussants, Ms. Lisa Rector (Northeast States for Coordinated Air Use Management) and Dr. Mark Utell (University of Rochester Medical Center), reflected on the lessons for medical and policy decision-making from all five morning presentations. Key conclusions follow.

⁵ In June 2012, U.S. EPA issued its proposed revisions to the PM_{2.5} standard. The proposed rule changes the annual standard from 15 ug/m³ to 12-13 ug/m³ and keeps the 24-hour standard the same at 35 ug/m³.

Mr. Steve Snook, “Air Emissions and Permitting: ICI Biomass Boilers”

- Emissions of pollutants from wood-fueled combustion systems vary widely. Policies should include monitoring or other requirements to ensure that a given unit emits what is promised based on the manufacturer’s specifications.
- Air permits are based on regulatory thresholds, and these vary across the Northeast states. As a consequence, smaller institutional units in some Northeast states will not require a permit. Moreover, new systems may be designed to avoid exceeding a regulatory threshold. Consistent stringent permit requirements across the Northeast states could provide greater assurance that the emissions from biomass-fueled boilers will pose fewer risks to health than under current regulations.
- The majority of ICI boiler permits may not require air dispersion modeling (which estimates concentrations of pollutants at certain distances from the combustion source). The main exception is in New Hampshire where air dispersion modeling is required for any unit over 2 MMBtu/hr (heat input). Yet even where modeling is a component of the permit process, it is designed to determine whether or not the facility will exceed the National Ambient Air Quality Standards, which do not address short-term impacts of PM_{2.5} (i.e. high emission events lasting less than 24 hrs).

Dr. Ellen Burkhard, “Energy & Emissions Performance of Commercial Wood Boilers”

- NYSERDA’s Research and Development Program demonstrates that advanced wood boilers can achieve:
 - the same combustion efficiency as oil-fired boilers;
 - lower PM_{2.5} emissions than direct-fired wood chip combustion technology, with particles composed primarily of inorganic salts;
 - PM_{2.5} levels that are similar to oil-fired boilers if post-combustion controls with electrostatic precipitators (ESPs) are used.

Dr. Phil Hopke, “Estimating Public Health Impacts: Air Receptor Modeling & Measurement”

- Prior to April 2011, the U.S. Environmental Protection Agency’s AERMOD system for conducting air dispersion modeling may have underestimated the building downwash effect, resulting in underestimations of pollutant concentrations in the vicinity of wood boilers with short stacks, such as those found at schools.
- Receptor modeling has shown that woodsmoke in winter represents a significant source of PM_{2.5}.
- Exposures to PM_{2.5} in woodsmoke can be significantly higher in localized areas than they are across the entire community or region.

Ms. Lisa Rector, Discussant

- There is significant lack of understanding of emissions from wood boilers as they are actually operating. Available data on emissions from ICI boilers are from tests taken when emissions are

likely the lowest (e.g., at peak load); these data may underestimate more typical levels of emissions.

- State regulation of wood combustion units will impact the type of technology installed. However, few regulatory incentives are in place to encourage the use of the most advanced and clean technologies for institutional-scale boilers.
- In addition to promoting the installation of advanced boiler technology and the use of the most effective emission control technologies, states also need to address the issue of fuel type, as the choice of fuels impacts emissions.

Dr. Mark Utell, Discussant

- Not only do children spend more time outside, where particles are prevalent, but like adults, exercise results in increased deposition of particles in their lungs. If there is woodsmoke pollution in the school yard when children are playing and exercising outside, the deposition of ultra-fine particles in their lungs can be very high.
- It is important to expand beyond what the body of research implies for susceptible populations to also address impacts on the general population.
- The bulk of toxicology research on woodsmoke focuses primarily on respiratory effects, yet it also important to keep in mind potential impacts on the cardiovascular system.

Panel and Roundtable Discussions

The afternoon session began with a panel of representatives from a health advocacy organization, the biomass industry, and those state agencies responsible for policies and programs on biomass energy that have implications for public health: health, environment, energy, and education. Panelists described their organizations' roles with regard to wood biomass combustion, and gave their perspectives on constraints and opportunities for protecting public health.

Several panelists characterized the air quality permitting process as a primary constraint in protecting public health from wood biomass combustion. Smaller scale boilers fly under the regulatory radar in some states. Limited resources can undermine government capacity to ensure compliance and to conduct detailed long-term monitoring studies of environmental and public health impacts in multiple regions of a state. Panelists also noted that the air quality permit process does not include the authority to specify types of fuels or where facilities should be sited, both of which affect air quality. The air quality permitting process also fails to engage the public in discussion of health concerns early enough to influence the design of the project.

Finally, panelists noted inconsistencies in policies within and between states, highlighting the missed opportunities for the promotion of cleanest-burning units by renewable energy initiatives. One panelist challenged government programs to support the development of innovations that have the potential to provide ground-breaking technological advances through reward-based initiatives such as design competitions.

The lack of structures for coordination among agencies with expertise and responsibilities for wood biomass also impede public health protection. In some states, energy agencies are just beginning to systematically invite input by government health experts in their planning processes. Historically, there have been no mechanisms for identifying and weighing tradeoffs among the societal goals pursued by different agencies. Laws that agencies are obligated to implement do not require or otherwise encourage the establishment of common agendas. As a consequence, input by health agencies in energy policy or project decisions comes at the eleventh hour, if at all. Lack of structured opportunities for input and, in the case of health professionals, severe and increasing overload in clinical responsibilities, are responsible for delayed and sometimes unconstructive engagement by the public.

In the context of these constraints, the panelists recommended specific opportunities for collaboration among their organizations. Some of these recommendations were revisited in roundtable discussions after the panel, which identified priority action steps to advance policy and program priorities. A survey conducted one week after the Symposium asked participants to rank the action steps in order of priority across the six roundtable topics. To derive the common goal, guiding principles and recommendations below, Lowell Center staff synthesized the comments made by presenters and panelists, and the action steps proposed in the roundtable discussions that were further prioritized by the survey.

Symposium Recommendations

Common Goal and Guiding Principles

Across the broad array of disciplines, organizations and sectors represented at the Symposium, the majority of participants concurred that policies and programs promoting wood biomass energy should prioritize the protection of public health. A goal of “healthy renewable energy” requires strategies that efficiently reduce dependence on fossil fuels, achieve carbon neutrality, and enhance local economies without increasing risks to public health.

The Lowell Center identified four principles emerging from the Symposium that can guide more specific recommendations to advance healthy renewable energy.

- It is important to fill relevant data gaps, but there is sufficient scientific information to proceed with common-sense actions to reduce exposures to woodsmoke. For example, studies are needed to evaluate the health impacts of peak emissions and emissions from non-optimal boiler operations, particularly for high risk populations. Better information about likely impacts of localized pollution on susceptible populations will inform decisions about boiler siting, choice of boiler technology, and fuel, as well as policy decisions (for example, whether or not to promote the installation of wood boilers in schools). Yet, eliminating incentives for boilers that do not meet the highest emission standards should not wait for research results.
- Though there may be disagreement about the pace of change that is needed or feasible, all policies should drive continual improvements in efficiency and reducing emissions.
- Coordination among agencies within states and across the Northeast is needed to maximize the effectiveness and efficiency of regulations, programs and other tools to protect public health.

- It is important to consider the health and environmental impacts of wood biomass technologies across the life cycle. For example, wood pellets may burn more cleanly than wood fuel, but the manufacturing process uses more energy and is itself polluting. Moreover, health risks from wood biomass energy are not limited to stack emissions from wood-burning units. Workers who make wood chips and pellets are at risk of accidental injury as well as health impacts associated with wood dust, molds and endotoxins. On the other hand, improvements in local economies associated with wood biomass activities can carry health benefits. Moreover, forestry practices can have both positive and negative implications for forest ecosystem health and climate change. An examination of the full life-cycle supports a more complete consideration of trade-offs among all of the impacts.

Recommendations and Priority Action Steps

Informed by the presentations, panel, roundtables and plenary discussions, the Lowell Center generated five broad recommendations, which align with the priority action steps proposed by the roundtables, highlighted below and described in detail in the full report.

1. Constructively engage the public in wood biomass decisions, providing opportunities for full participation in project and policy planning, including providing and considering relevant data, weighing trade-offs, and proposing solutions.
2. Prioritize public health in wood biomass decision-making across the Northeast. Public health implications need to be considered early in the energy planning process, and health maximized while still respecting other important societal goals, such as energy efficiency, carbon neutrality, sustainable forestry practices, reduced dependence on fossil fuels and economic revitalization.
3. Promote a better understanding and consideration of the health impacts on susceptible and vulnerable populations, as well as measures to prevent or reduce exposures to individuals and communities. Particular attention should be paid to both the risks from localized peak exposures and the installation of wood boilers in schools.
4. Incentivize and reward only high-efficiency, clean, wood-fired combustion, with consistent standards across the Northeast, focusing not only on technologies but also on outcomes.
5. Fill gaps in existing air quality regulation and air quality monitoring capacity, including lack of regulatory scrutiny of smaller ICI units in some states. Consider other regulatory measures to protect public health and discourage all but the cleanest-burning wood biomass units.

In roundtable discussions, Symposium participants discussed six broad topics: (1) Encouraging Cleanest-Burning Combustion Technologies; (2) Regulatory Programs, Policies and Tools for ICI Wood Combustion; (3) Guidance and Educational Materials; (4) Filling Policy-Relevant Research Gaps; (5) Public Health Engagement in Energy Decision-Making; and (6) Public Health and Large-Scale Wood Biomass Combustion. The roundtables recommended over twenty action steps. Results from the Symposium follow-up survey indicated particularly strong support for the following:

1. Formally integrate health into energy planning processes by advancing Health Impact Assessment.

2. Develop standardized Health Impact Assessment methods appropriate for the broad range of energy projects.
3. Establish regional specifications for appliances, including efficiency and emission standards.
4. Design and conduct an efficient study of the health effects (or biological markers) to address whether children are being adversely affected by woodsmoke emissions in their schools.
5. Develop a best practices guide for optimizing biomass heating combustion efficiency & performance.
6. Establish regional specification standards for wood biomass fuel (e.g., ash and moisture content etc.).
7. Provide incentives to off-set the up-front costs of new cleanest burning wood biomass heating projects.
8. Improve understanding of the emission rates and ambient air impacts of air toxics associated with large-scale wood biomass combustion, given variability in operating and load characteristics, fuel types and meteorological and topographical conditions.⁶
9. Establish a regional working group to integrate public health into the energy decision-making process.

Respondents most frequently prioritized the first two action steps, urging adoption of health impact assessment as a tool for systematically considering the health implications of energy policy and projects.

Conclusion

The reviews of the state of the science by leading researchers at the Symposium clearly established the public health hazards of the proliferation of wood combustion as a source of heat and power. Priorities identified by Symposium participants comprise an agenda for action by a range of constituencies that would fill the research gaps, and take steps now—given inherent uncertainty in the science—to prioritize the protection of public health as wood biomass and other renewable energy initiatives unfold. But beyond the content summarized in this report, the Symposium fostered communication across sectors and disciplines, enabling people who have historically not worked together to connect, identify common ground, and build relationships. In the months since the Symposium, some participating organizations have begun to capitalize on these relationships, exchanging information and strategies. With the publication of this report, the Lowell Center encourages participants and their colleagues to systematically revisit the recommendations they have the potential to advance, and to identify opportunities to work together—across agencies, across sectors and across states—to implement those recommendations that need action by multiple parties. The Lowell Center looks forward to continuing to collaborate with Northeast partners to advance policies, programs and practices that will elevate health in discussions and action on wood biomass combustion, protect public health, and more broadly, advance the common vision of healthy renewable energy.

⁶ Though the roundtable group that generated this action step was charged with focusing on large-scale biomass facilities, plenary discussion over the course of the day suggested broad support for this recommendation across all scales.



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The Lowell Center for Sustainable Production uses rigorous science, collaborative research and innovative strategies to promote communities, workplaces, and products that are healthy, humane and respectful of natural systems.

The Lowell Center is composed of faculty, staff and graduate students at the University of Massachusetts Lowell who work collaboratively with citizen groups, workers, businesses, institutions and government agencies to build healthy work environments, thriving communities and viable businesses that support a more sustainable world.

This document is available at

www.sustainableproduction.org/WoodBiomass.php



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for Sustainable
Production**

UNIVERSITY OF MASSACHUSETTS LOWELL

www.sustainableproduction.org

Lowell Center for Sustainable Production
University of Massachusetts Lowell
One University Ave
Lowell MA 01854
978-934-4943
lcsp@uml.edu