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[http://www.nyserda.org/Programs/
Research_Development/biomass.asp](http://www.nyserda.org/Programs/Research_Development/biomass.asp)

KEYWORDS

- Biomass
- Outdoor Woodboiler
- Wood Smoke

Environmental Characterization of Outdoor Wood-Fired Hydronic Heaters

PROJECT FOCUS

This project is being conducted by the U.S. Environmental Protection Agency (EPA) Office for Research and Development through a Cooperative R&D Agreement with the New York State Energy Research and Development Authority (NYSERDA). Project staff will evaluate the emissions and energy-efficiency performance of four types of residential wood boiler technologies ranging from the common

outdoor wood boiler (OWB) to a state-of-the-art, high-efficiency pellet boiler made in Austria. Measurements will include emissions of fine particulate (PM_{2.5}), elemental carbon (EC), organic carbon (OC), poly-cyclic aromatic hydrocarbons (PAHs), carbon monoxide (CO), carbon dioxide (CO₂), sulfur dioxide (SO₂), and thermal efficiency. A risk characterization of cardiopulmonary toxicity also will be performed.

CONTEXT

Inefficient (43%) outdoor wood-fired boilers have proliferated in Northern states during the last decade as oil prices have increased (Cuomo, 2008). This technology has resulted in numerous complaints to state air quality and health departments because of exceptionally high levels of smoke. Fine particles in wood smoke primarily are composed of organic carbon and contain numerous toxic compounds, including polycyclic aromatic hydrocarbons. Recent reviews of the health literature indicate that wood smoke exposure likely leads to a range of adverse health effects including increases in respiratory symptoms, lung function decreases, increases in asthma symptoms, visits to emergency rooms, and hospitalizations (Naeher et al., 2007; NYSERDA, 2008).

In contrast, high-efficiency (>85% thermal efficiency) units are common in Europe and now are being manufactured in the United States by a few companies. The improvements are due to a two-stage combustion design that results in



Outdoor wood boiler in Upstate New York

gasification of the fuel and more complete combustion. Studies performed in Europe indicate the PM_{2.5} from these units has a small organic component and consists primarily of inorganic salts.

Naeher, L.P., M. Brauer, M. Lipsett, J.T. Zelikoff, C.D. Simpson, J.Q. Koenig, and K.R. Smith. 2007. Woodsmoke Health Effects: A Review. *Inhalation Toxicology*. 19: 67-106.

(NYS OAG) New York State Office of the Attorney General. 2008. Smoke Gets in Your Lungs: Outdoor



Photo courtesy of USEPA 2009



Photo courtesy of USEPA 2009

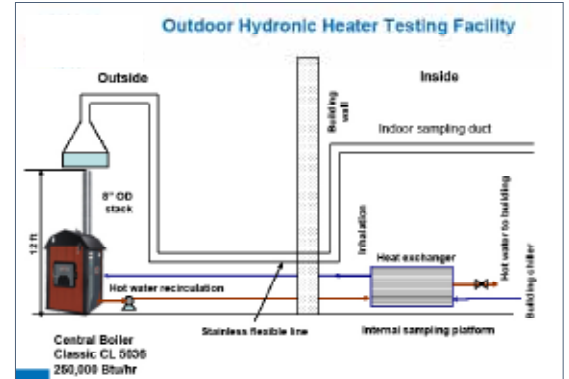
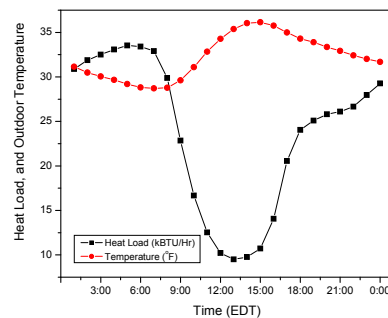
METHODS

Four wood boiler technologies will be evaluated: the Central Boiler Classic CL5036 and Central Boiler E-Classic 2300 by Central Boiler, the Econoburn by Alternative Fuel Boilers, of Dunkirk, NY and an Austrian pellet-boiler imported by Advanced Climate Technologies, of Schenectady, NY. Each boiler was evaluated and tested on the same “call for heat” diurnal load profile determined for a typical home in Syracuse, NY. The Econoburn wood boiler was operated to simulate thermal storage. This is

anticipated to be an important efficiency measure. In Europe, hot water storage is often required for cord wood boilers and recommended for pellet boilers.

Emissions will be measured by a dilution sampling method and numerous instruments to measure: total PM, PM_{2.5}, particle size, CO, CO₂, O₂, EC/OC, PAHs, semi-volatile organic compounds, aromatic gases, dioxin, furan, total hydrocarbons, NO_x, and SO₂.

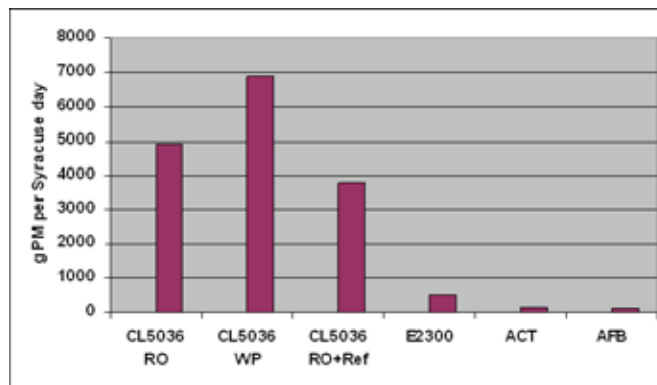
Appliance Heat Load Profile



FINDINGS TO-DATE

The graph below based on preliminary results shows that the gasification equipment emissions are a few percent of those from the standard equipment

when responding to the Syracuse heat load. Data gathered from the research is being compiled and results are forthcoming.



Grams of PM per model Syracuse heating day

- CL5036** = Central Boiler Classic 5036.
- E2300** = Central Boiler E-Classic 2300
- ACT** = automatic pellet boiler imported by Advanced Climate Technologies
- AFB** = Econoburn with simulated hot water storage
- RO** = red oak
- WP** = white pine
- RF** = refuse

Since 1975, the New York State Energy Research and Development Authority (NYSERDA) has developed and implemented innovative products and processes to enhance the State's energy efficiency, economic growth, and environmental protection.

http://www.nyserda.org/Programs/Research_Development/biomass.asp

PROJECT IMPLICATIONS

This project will provide a thorough scientific evaluation of the performance of a range of wood boiler technologies. These results will assist the U.S. EPA in updating the National Emission

Inventory to account for wood boilers and its New Source Performance Standard process. It also will provide valuable information for states as they develop renewable energy plans.