Biomass Heating Technologies, Emissions Measurements, and Observations of Wood Smoke in Rural and Urban Communities in New York State

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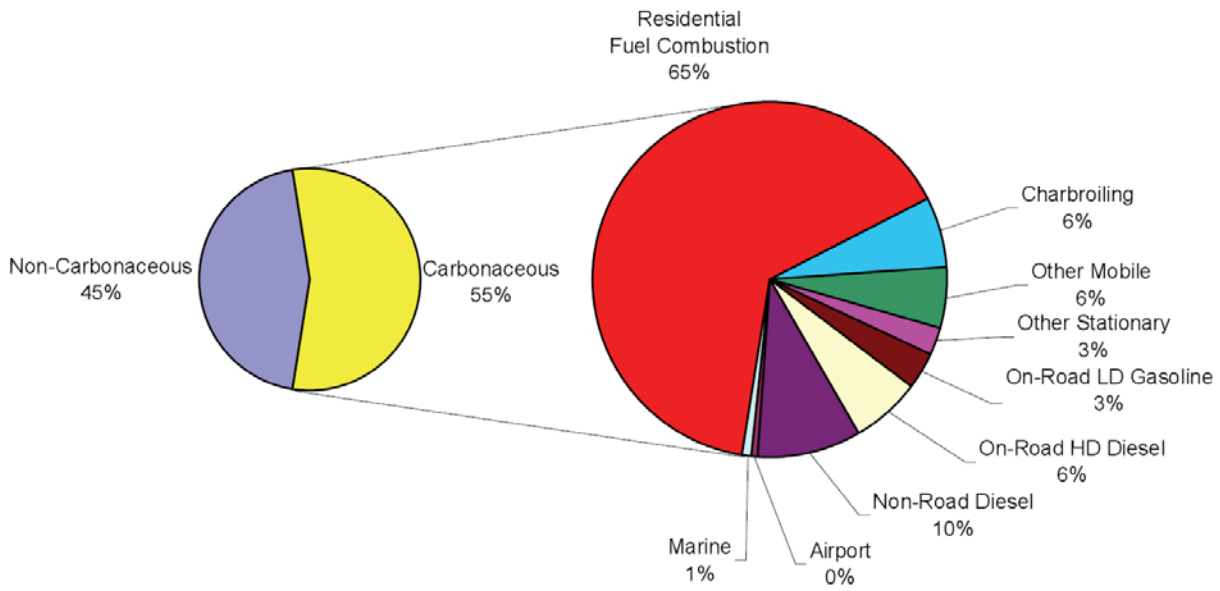
NYSERDA New York State Energy Research and Development Authority

Assessment of Carbonaceous $PM_{2.5}$ for New York and the Region

Figure ES-3. Total New York State $PM_{2.5}$ and Carbonaceous Detail (2002).



NYSERDA
Report 08-01
Executive Summary

NYSERDA 8641

March 2008

Wood smoke is an important contributor to fine particles, especially in rural areas.

Photo credit Phil Etter

Outdoor wood boiler

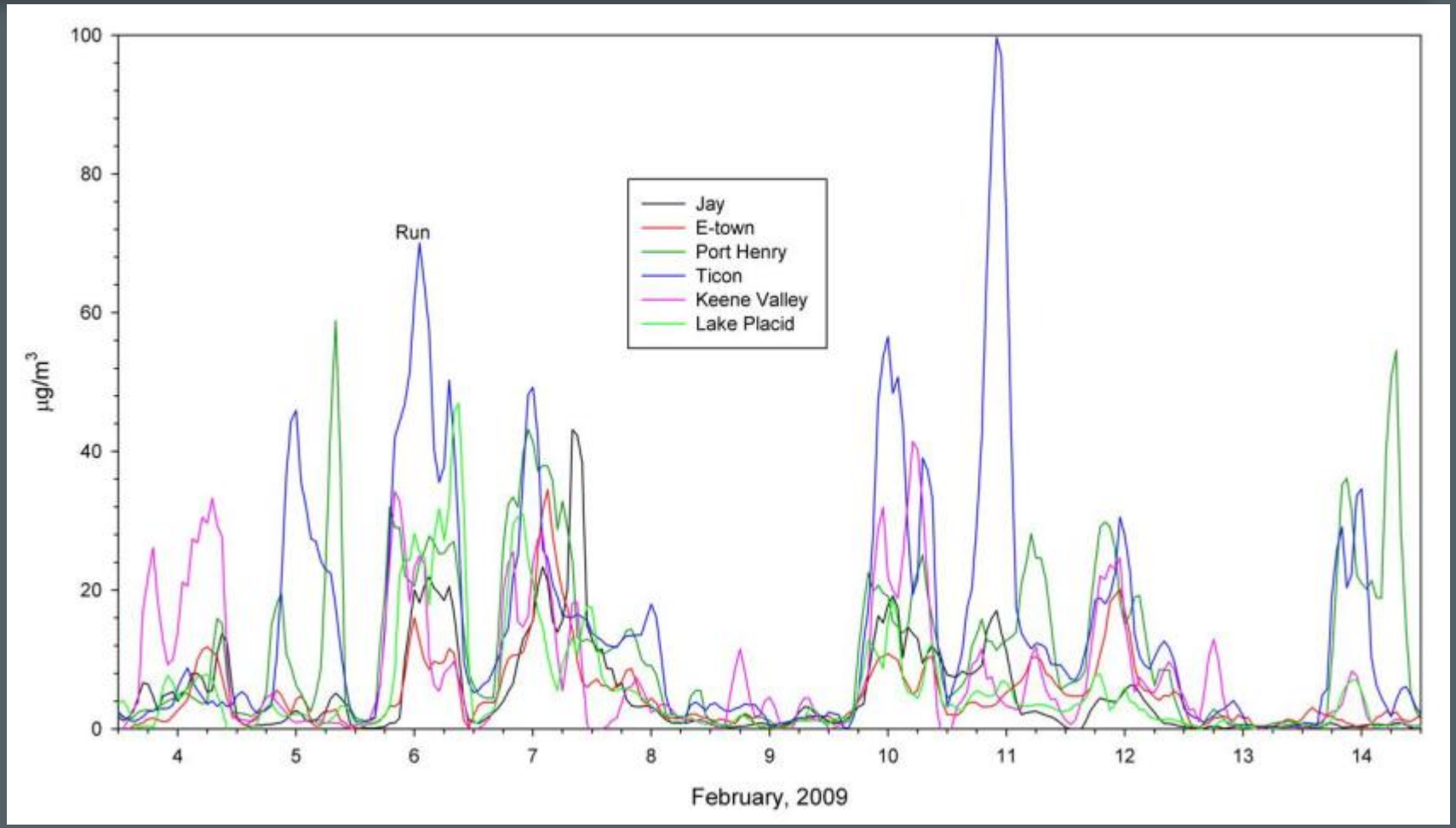
Photo credit Phil Etter

Photo credit Louis Fontain

Photo credit Gerald McDonald

"average PM" low but spikes frequently > 200 ug/m^3, several over 400

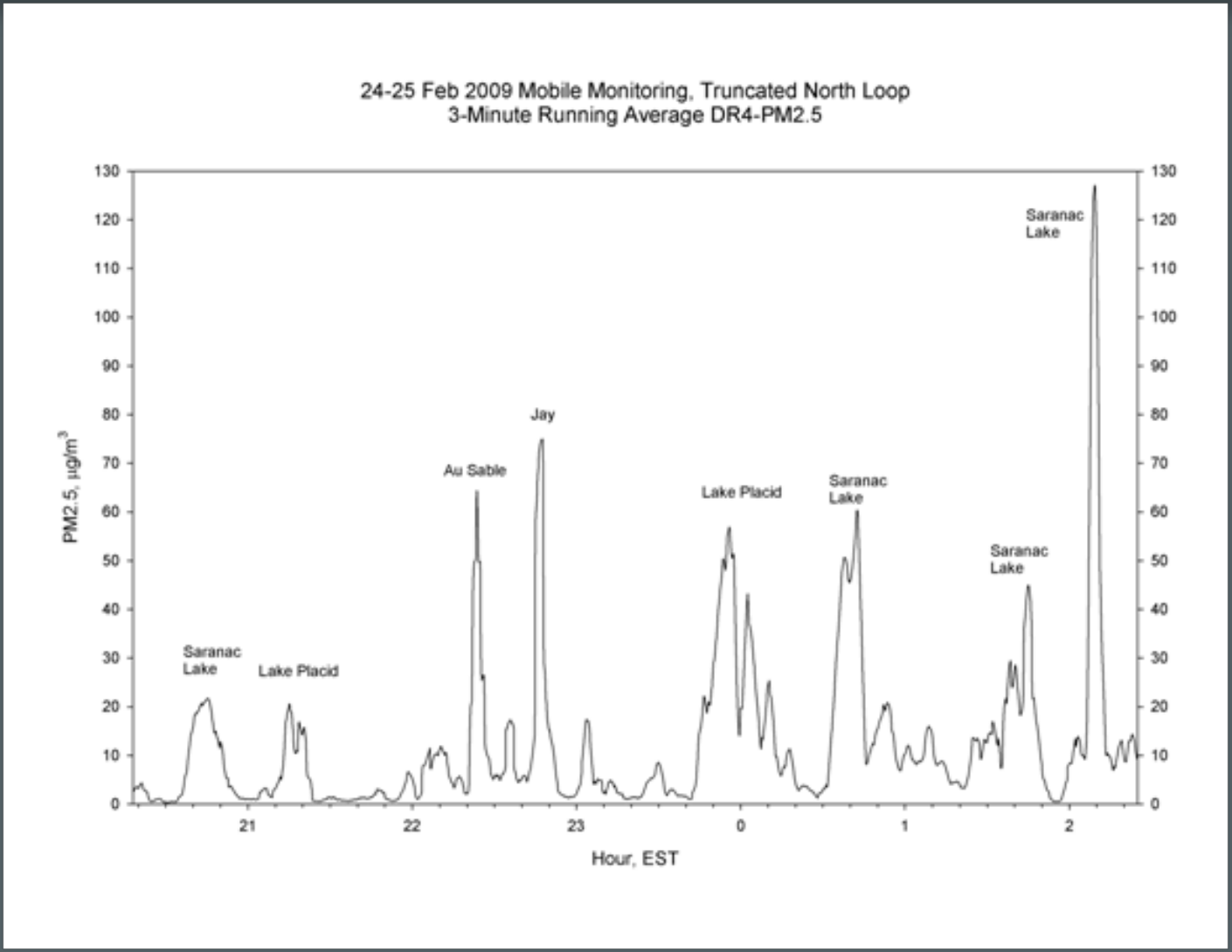
Diurnal wood smoke in the Adirondacks



NYSERDA (2010a)

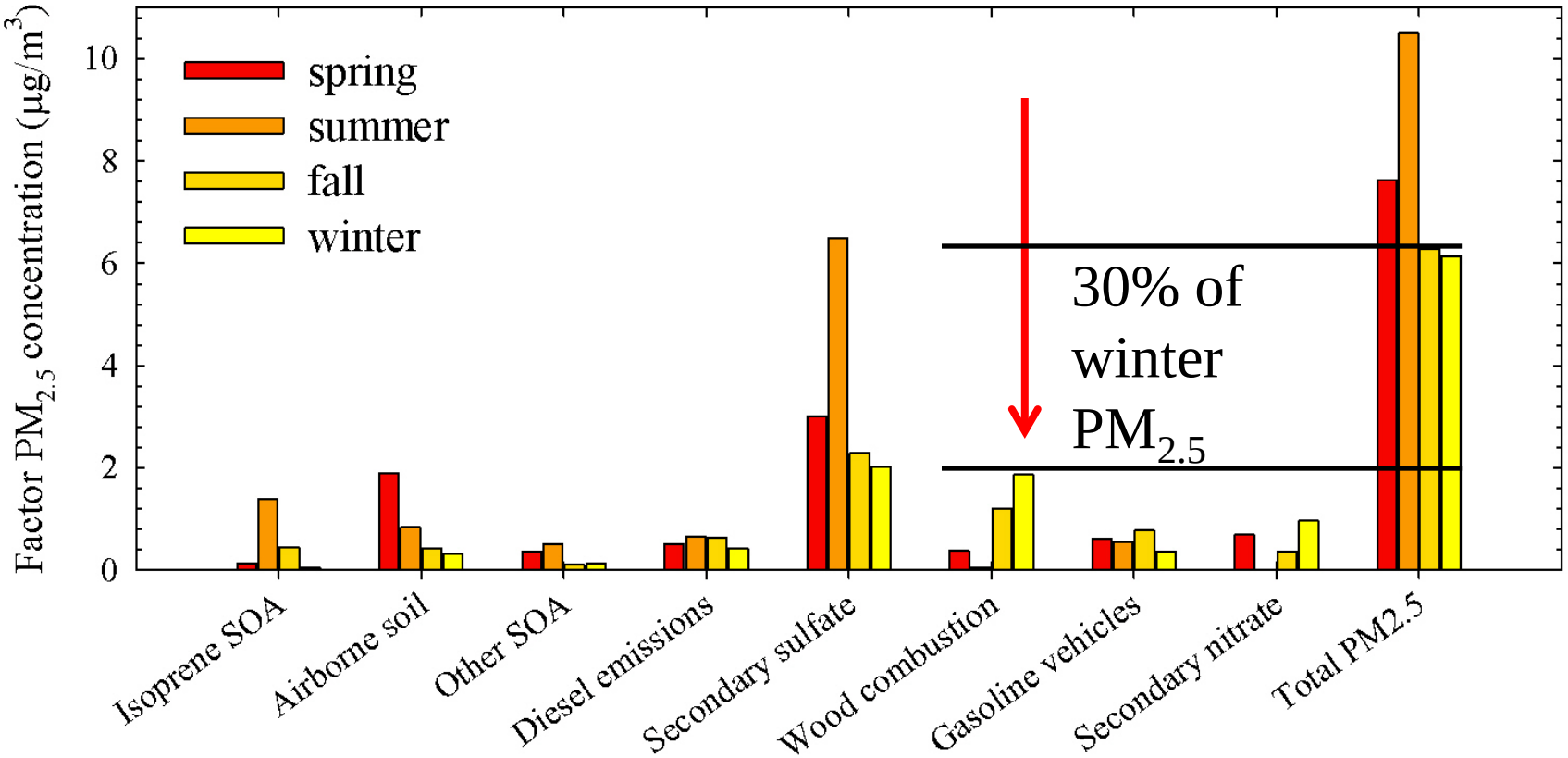
Running 3-h averages of 1-h data
Highest at night, lowest during the day

Localized high concentrations of wood smoke, “valley effect”



NYSERDA (2010a)

Wood smoke in Rochester, NY



Wang, Y. et al. (2012)

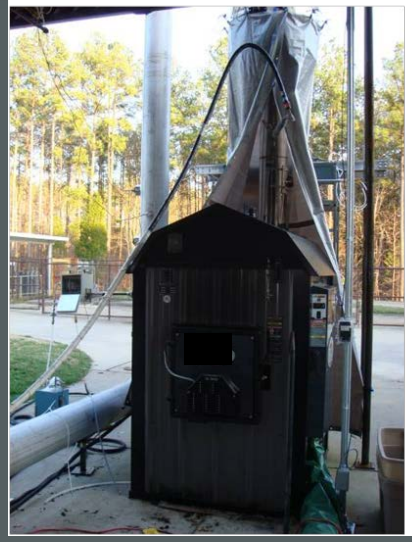
Monroe County housing unit heating systems:
Natural gas (82.5%), Electricity (11.9%), Heating oil (2.9%), Propane (1.5%), Wood (0.5%)

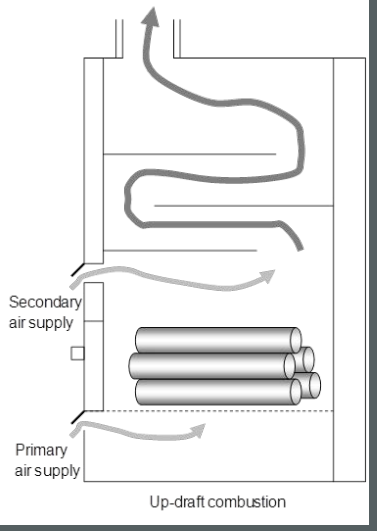
Emissions testing of 4 wood-fired hydronic heaters by EPA ORD

- Conventional outdoor wood boiler (3 fuel types)
- Advanced outdoor wood boiler (Red Oak)
- Staged combustion (gasifier) with thermal storage (Red Oak)
- European pellet boiler (hardwood pellets)
- Each tested using the same “call for heat”

Aurell et al., 2012; Kinsey et al., 2012; Hays et al., 2012, ….

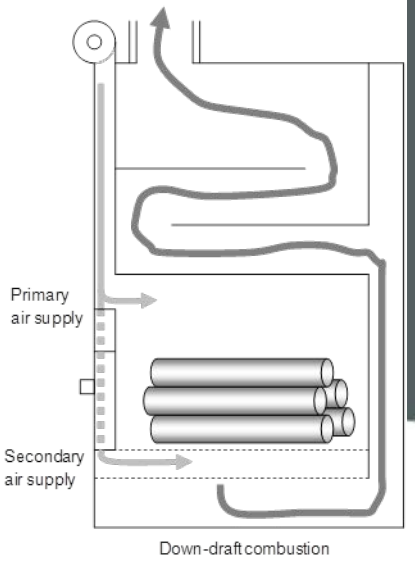
Outdoor Wood Boilers (Hydronic Heaters)





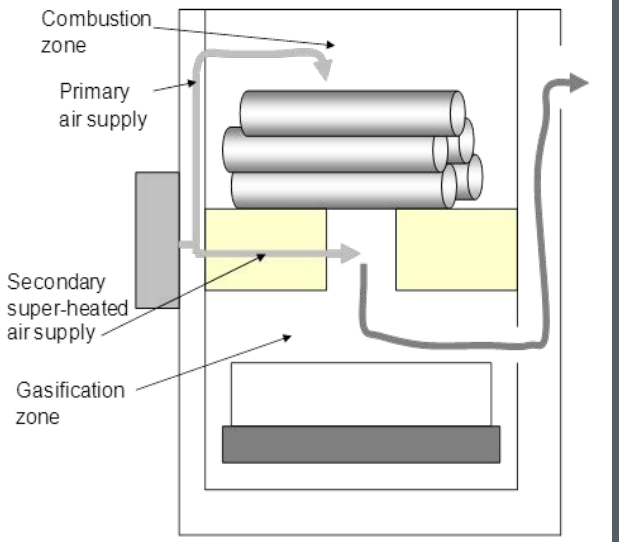
Conventional OWB
Updraft
250,000 Btu/h
196 gallons

Advanced OWB
down-draft
160,000 Btu/h
450 gallons



Btu = British Thermal Unit

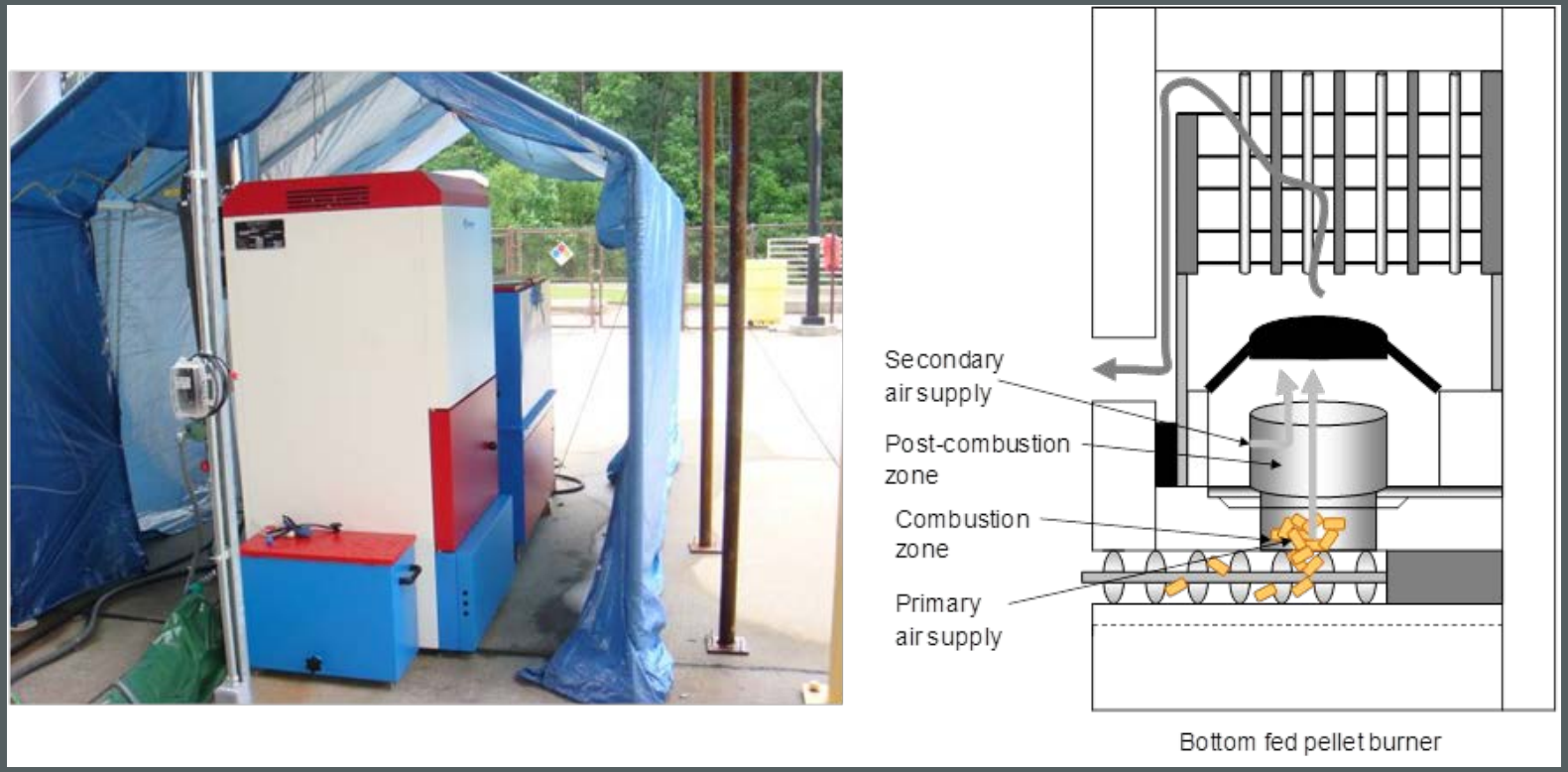
2-stage combustion (gasification) wood boiler



Combustion and gasification

downdraft
150,000 Btu/h
32 gallons

Staged combustion pellet boiler

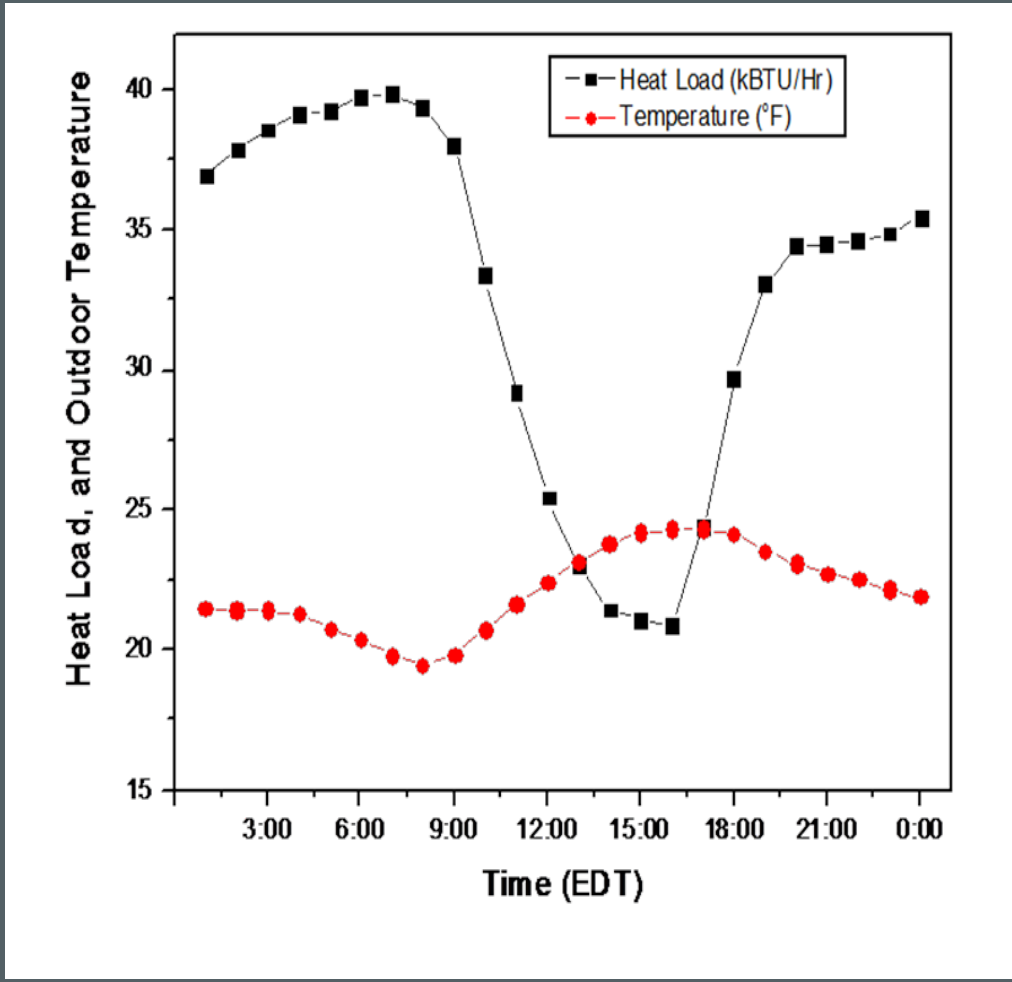


NYSERDA (2012)

Staged combustion
137,000 Btu/h
43 gallons

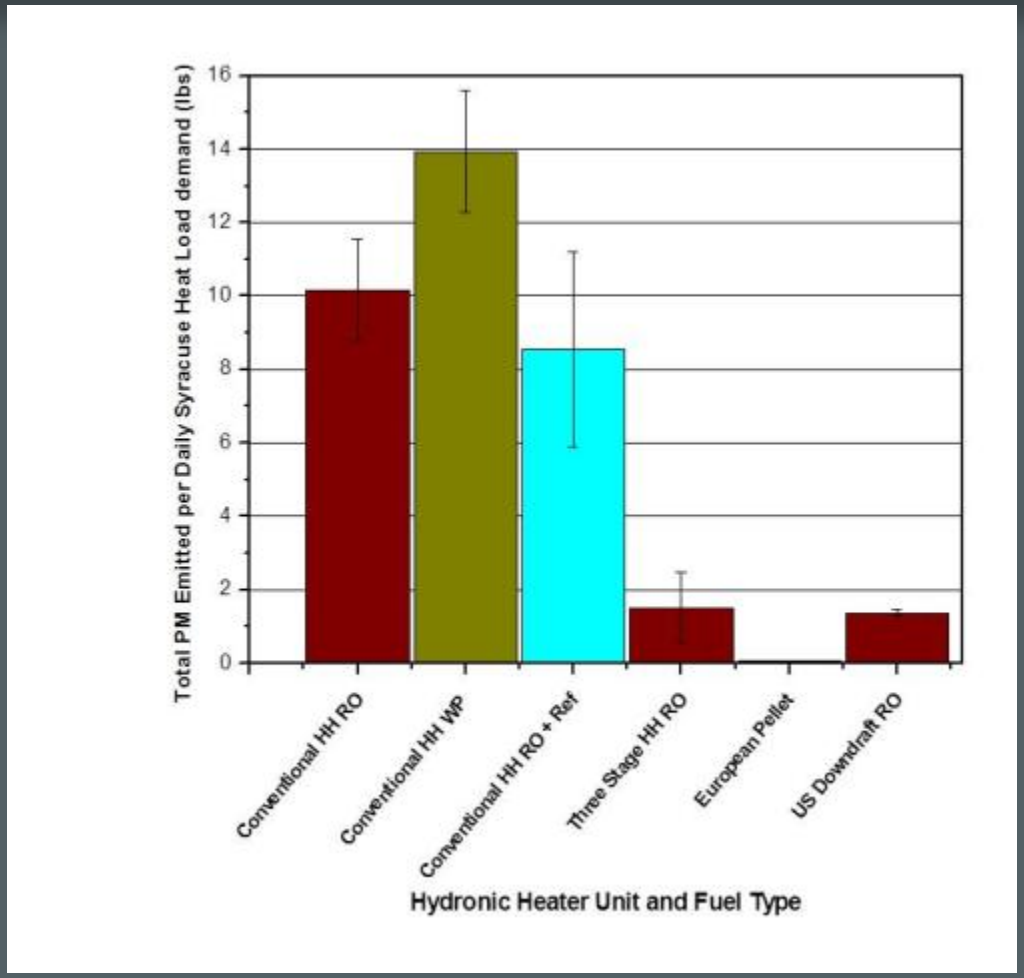
Syracuse, NY heat load

Ranch-style home,
2500 ft^2
R-13



NYSERDA (2012)

EPA-ORD residential wood boiler research



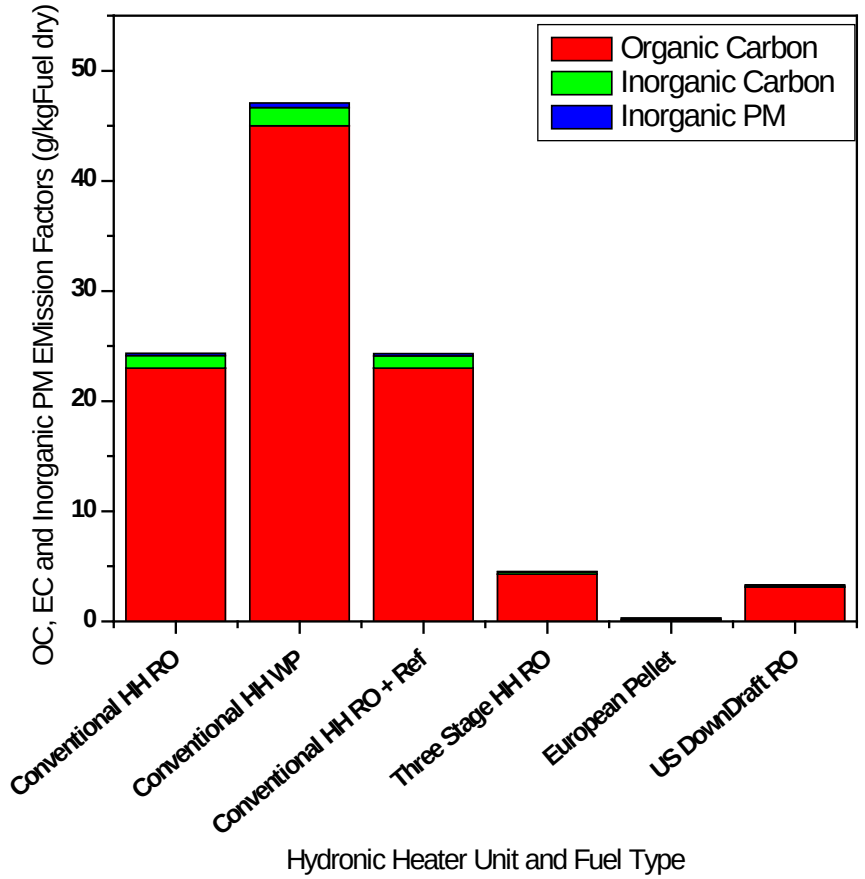
NYSERDA (2012)

PM Generated per Syracuse Day for All Six Unit/Fuel Combinations.

All units responding to the same heat load with no thermal storage except for the US downdraft

Pellet – 0.08 lb/day
Oil-fired boiler – 0.004 lb/day
ULS HHO – 0.00004 lb/day

OC, EC, inorganic PM2.5



Significant organic carbon contribution with emission factor a function of technology type and fuel.

NYSERDA (2012)

OC, EC (lb/MMBtu output), OC/EC

	OC lb/MMBtu	EC lb/MMBtu	OC/EC
Conventional, Single Stage HH Red Oak	13	0.63	20
Conventional, Single Stage HH White Pine	16	0.60	27
Three Stage HH, Red Oak	1.8	0.078	23
European Two-Stage Pellet Burner	0.039	0.046	0.82
U.S. Two Stage Downdraft Burner/ Red Oak * based on boiler efficiency	0.39	0.019	21

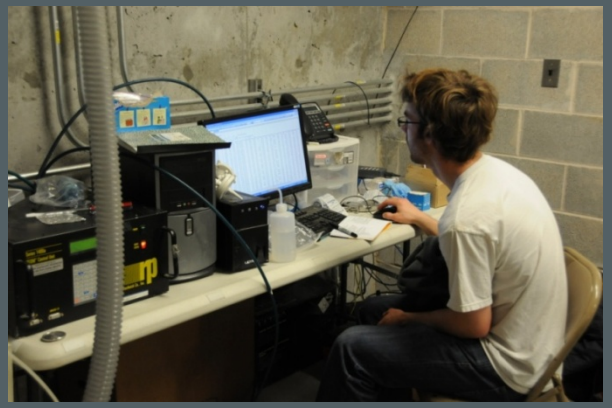
Conventional wood-chip technology

Conventional wood-chip technology

Stack testing of green wood chip-fired stoker boiler

First Made-in-NY high-efficiency wood pellet-fired boiler

Performance evaluation



THE WILD CENTER

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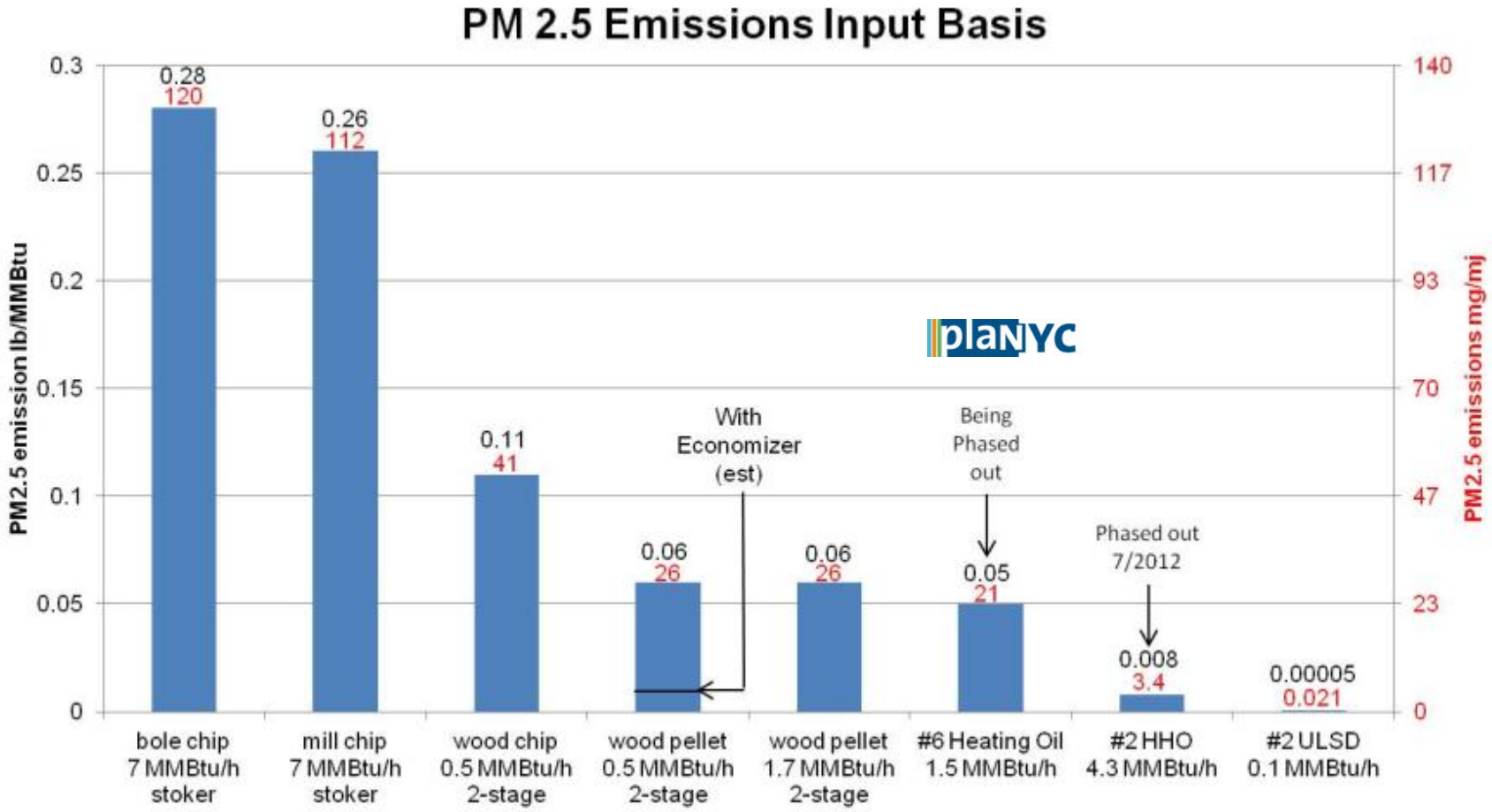
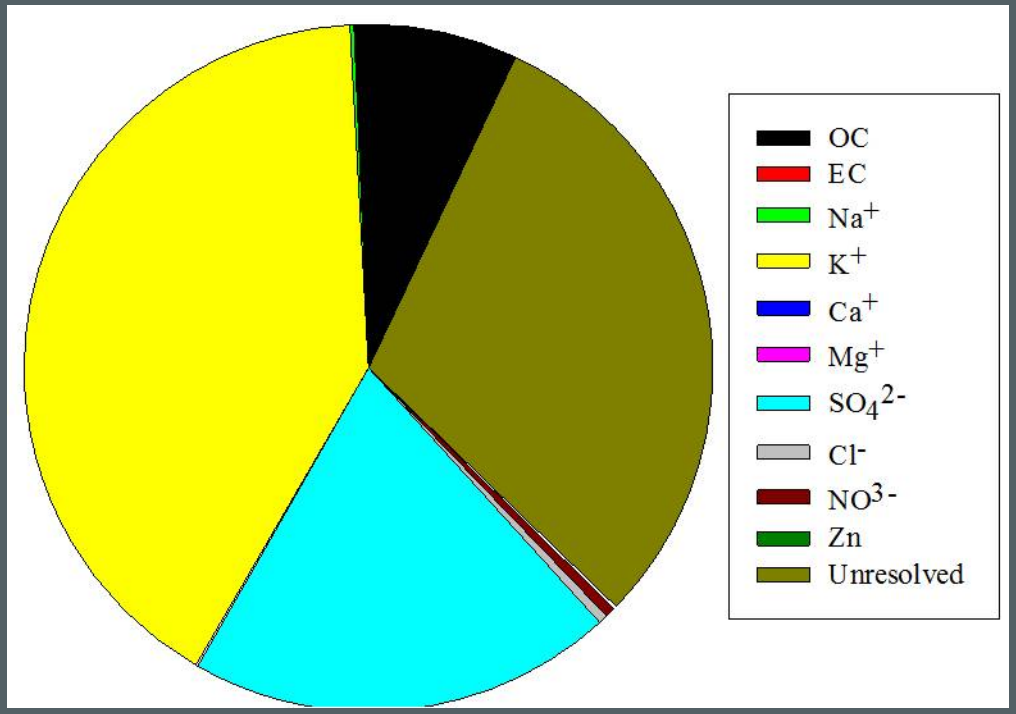
PM 2.5 emissions on energy input basis



Rector, L. (2010), Chandrasekaran, S. et al. (2011), McDonald (2009)

PM composition depends on combustion design



Fine PM composition from stack emission of ACT boiler (0.5 MMBtu/h) when burning wood pellets (Chandrasekaran, S.R. et al., 2011)

Particle size distribution

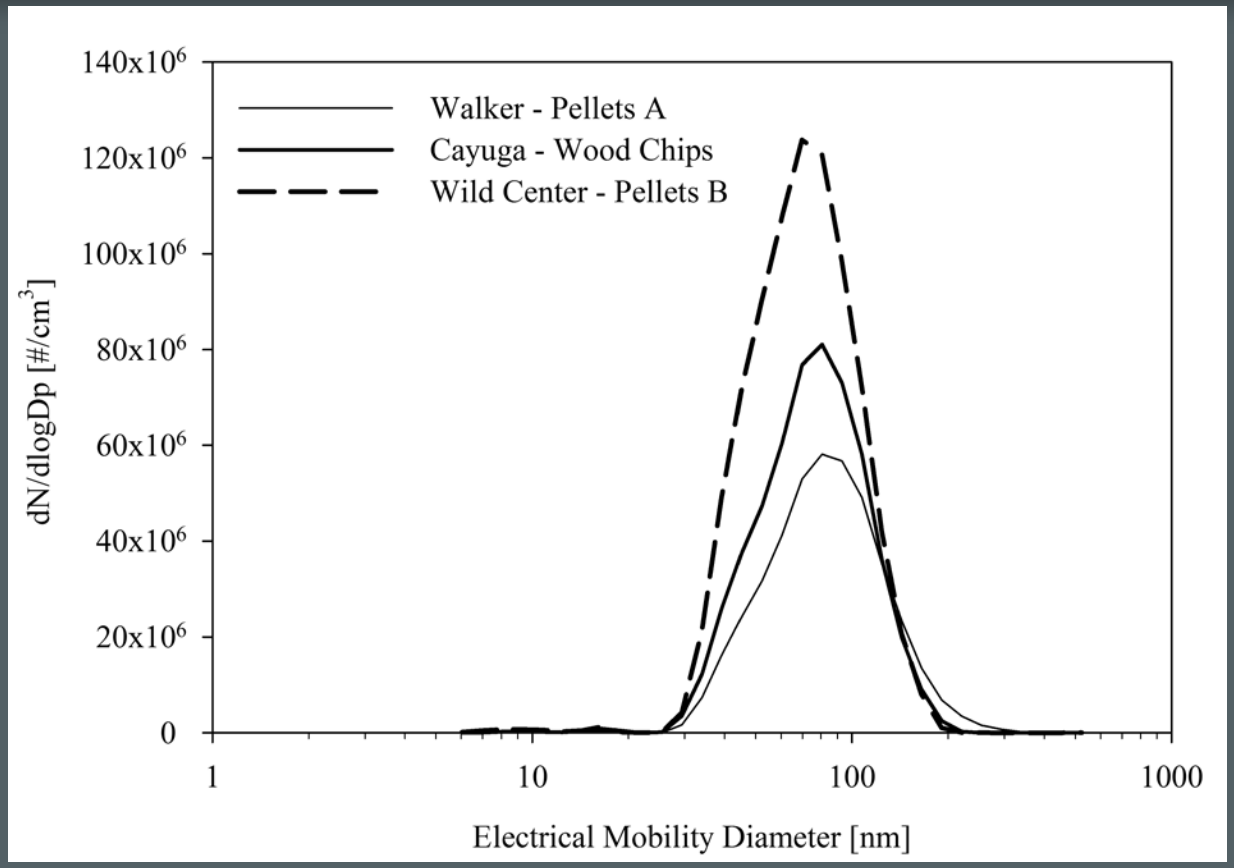


Figure 2. Steady-state ultra-fine particle number size distributions for emissions from 0.5 MMBtu pellet boiler, 0.5 MMBtu chip boiler, and 1.7 MMBtu pellet boiler (Chandrasekaran, et al., 2011).

University of Massachusetts Lowell
Center for Sustainable Production

Symposium held in November 2011

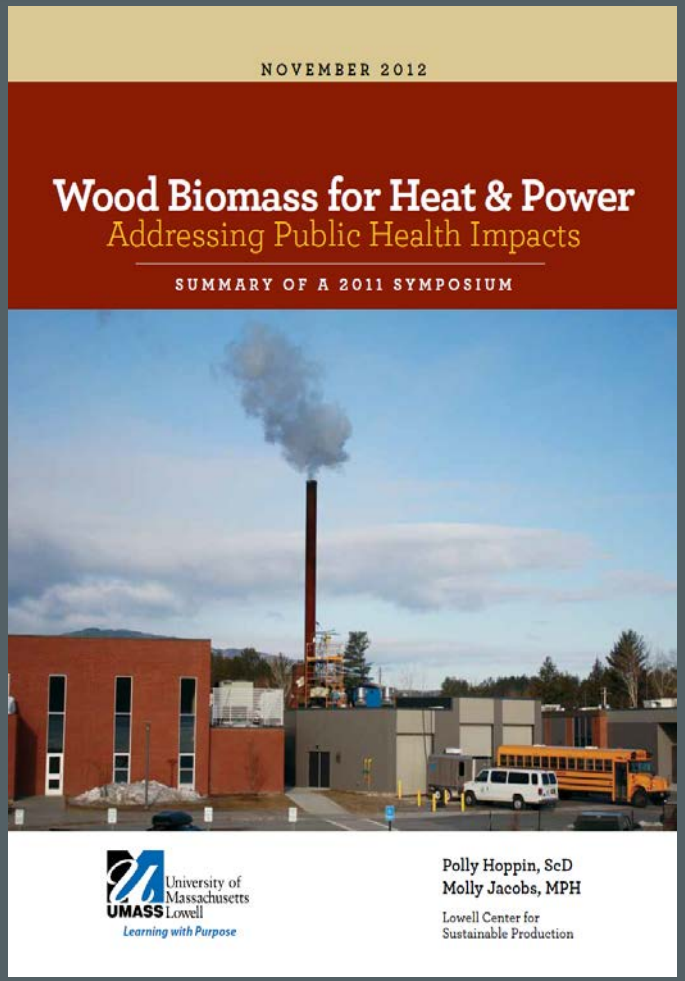
Focus on industrial, commercial, and institutional applications (non-residential)

Broad stakeholder participation from 9 states:

- academia;
- state energy, environment, health, education, and forestry agencies;
- health advocacy; and
- biomass industry participants

State of the Science on Biomass Emissions and Health Effects

Recommendations and Priority Action Steps



http://www.sustainableproduction.org/WoodBiomass.php

Thank you!

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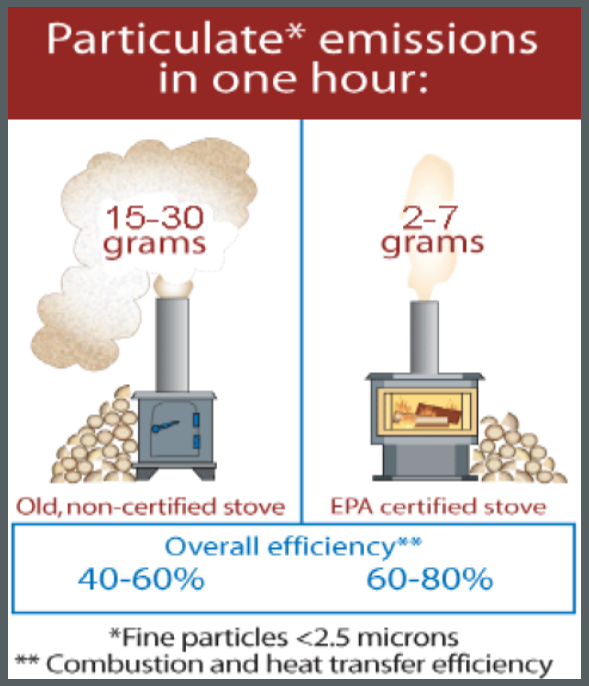
EPA's Residential Wood Smoke Reduction Initiative

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, NC

www.epa.gov/woodstoves



U.S EPA
Setting New Source Performance Standards for wood heaters

DEPARTMENT OF ECOLOGY State of Washington

GLOBAL ALLIANCE FOR CLEAN COOKSTOVES

HPBA Hearth, Patio & Barbecue Association

nyserda Energy. Innovation. Solutions.

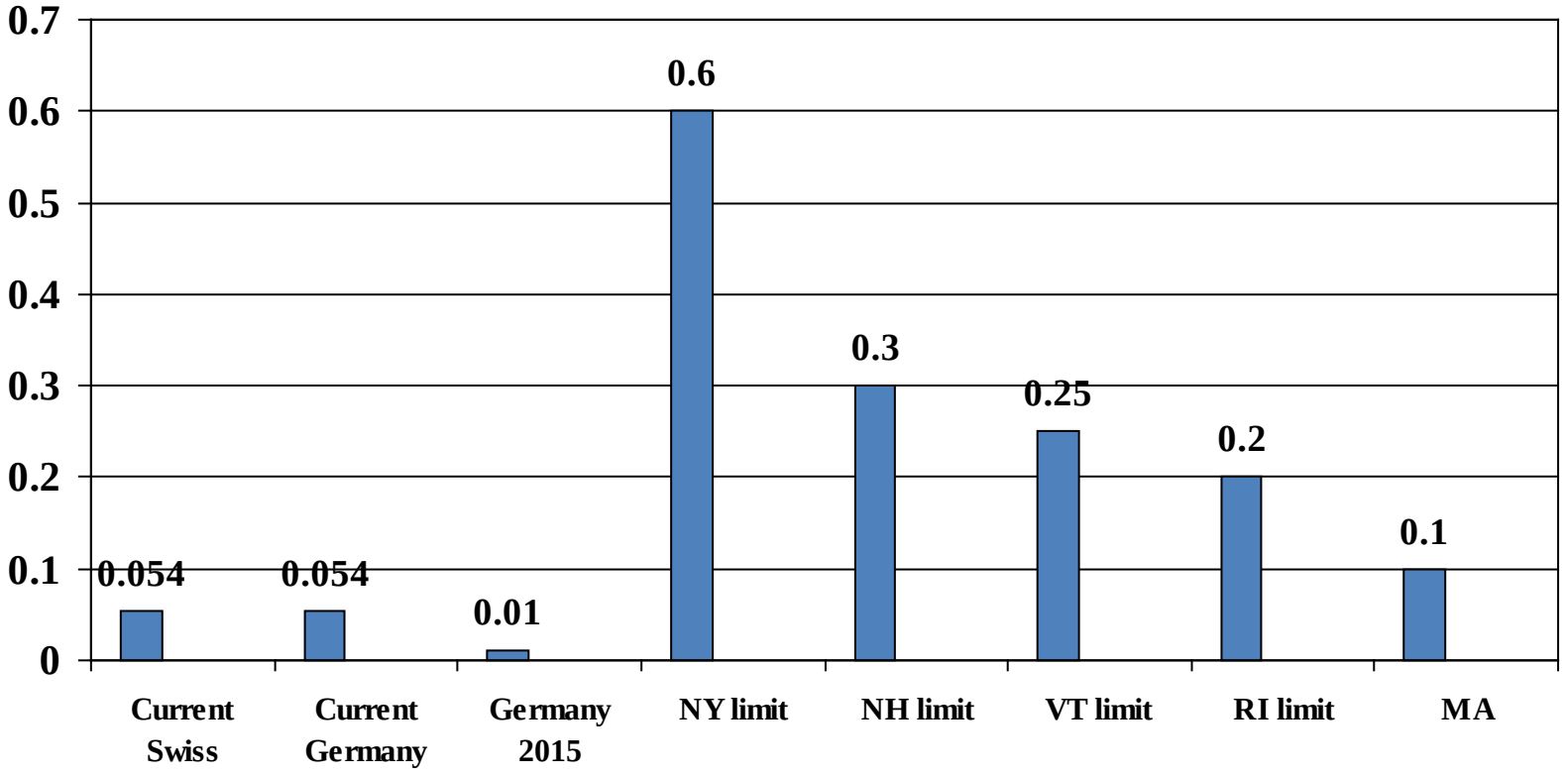
BTEC Biomass Thermal Energy Council

OSPREY FOUNDATION

SUNSTEIN

the arbolito foundation

Comparison of Emission Standards Small Commercial/Institutional Boilers (lb/mmBtu heat input)



No. 2 oil = 0.005