



**EXPANDED USE OF MODERN WOOD HEATING AND IMPROVING AIR QUALITY**

*An Exploration of Strategies to Reduce Particulate Emissions by Integrating Thermal Fuel Switching Programs with Residential Woodstove Change-out Programs*

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Modern wood heating is a vital strategy for measurably reducing the use of fossil fuels for heating while simultaneously helping stimulate local economies and creating essential markets for low-grade wood periodically thinned from local forests. Yet, burning solid wood fuels like pellets, chips, and firewood tends to emit slightly higher levels of particulates than burning liquid or gaseous heating fuels like oil, propane, and natural gas. Particulate matter (PM), small-diameter particles ranging in size from visible to invisible, is an air pollutant that is emitted from a wide variety of sources. Historically, PM emissions from wood heating were dramatically higher than levels typically emitted from fossil fuel heating systems. However, over the past decade modern wood heating combustion technology has improved dramatically – increasing efficiency and significantly lowering emissions. Nonetheless, even today’s “best in class” wood heating technology emits slightly higher levels of PM than similarly sized gas and oil systems. On the other hand, woodstove change-out programs that help homeowners upgrade their woodstoves from old, dirty, and inefficient woodstoves to new, high-efficiency EPA certified stoves offer tremendous opportunity to measurably reduce emissions and improve ambient air quality.

It is essential that efforts to expand the use of modern wood heating do not adversely impact regional air quality. The purpose of this document is to explore how modern wood heating programs that reduce the use of fossil heating fuels can be deployed in ways that improve air quality.

**PM EMISSION RATES FOR HOME HEATING SYSTEMS**

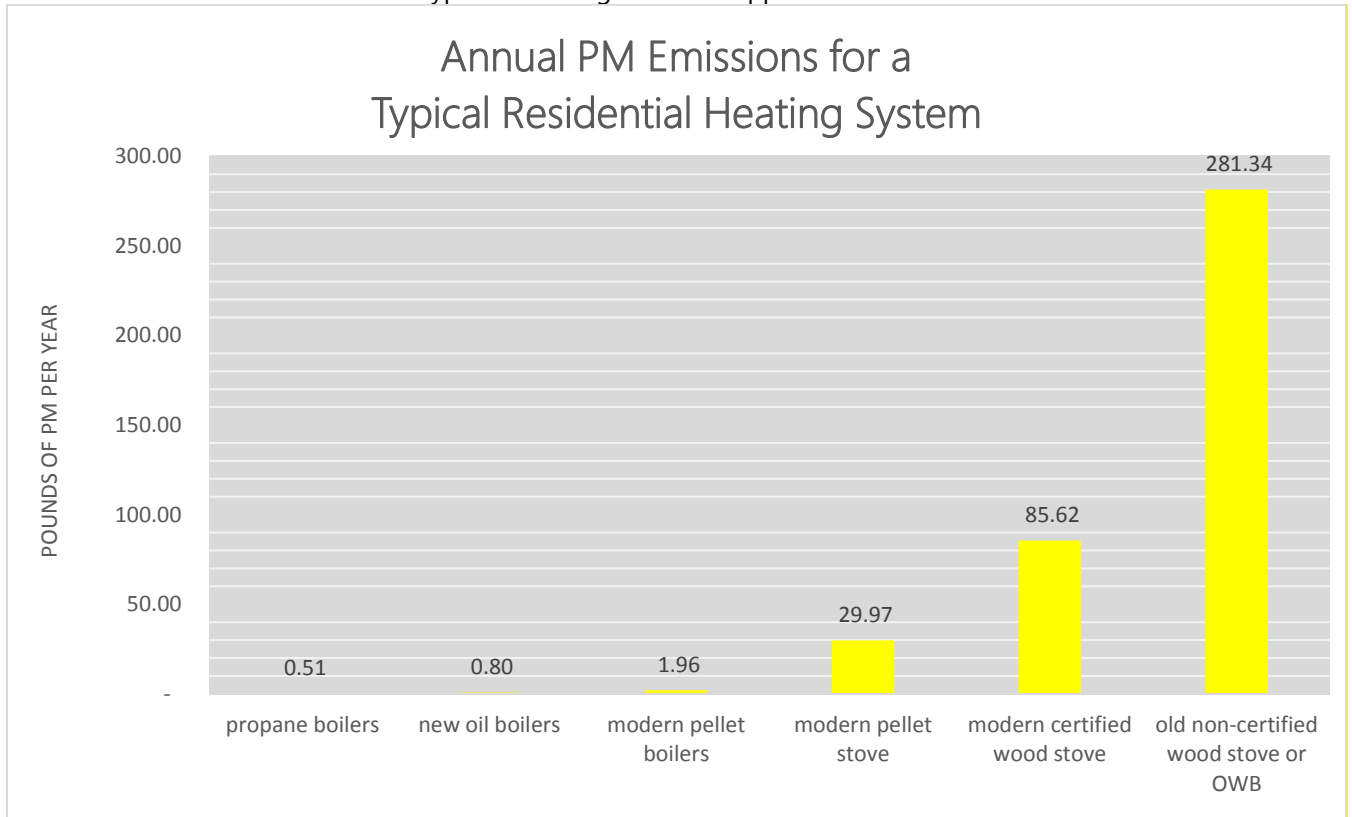
Large-scale wood heating systems at facilities like schools, colleges, and hospitals, are commonly equipped with expensive air emission control equipment (like electrostatic precipitators) that can reduce PM emissions to levels below oil and equal to gas. While these devices are cost-effective for large-scale facilities, they are not a viable option for residential systems. State air quality regulators estimate that over half of woodstoves in use in the Northeast are old, uncertified units predating 1990. Moreover, the US EPA estimates that over half of the PM emissions in the Northeastern US are from residential wood heating.<sup>1</sup>

*Table 1 – Typical particulate patter emission rates and annual emissions for different fuels and appliances*

Residential Heating Appliance	PM Emission Rate Pounds/ Million Btu	Annual PM Emissions Pounds
New propane/natural gas boiler	0.0083	0.51
New heating oil boiler	0.013	0.80
Modern pellet boiler	0.032	1.96
Modern pellet stove	0.49	29.97
Modern EPA certified woodstove	1.4	85.62
Old non-certified woodstove	4.6	281.34

<sup>1</sup> Source: US EPA 2011 National Emissions Inventory (NEI)

Table 1 provides the comparative PM emission rates and the graph below illustrates the major differences in annual emissions between these types of heating fuels and appliances.



As seen on the right side of the graph above, old non-certified wood stoves emit over three times more than a new EPA certified wood stove. While the difference between a 5-10 year old oil boiler and a new pellet boiler is rather small.

### PM EMISSION IMPACTS OF CHANGING FUELS AND APPLIANCES

This difference in PM emissions presents an interesting opportunity to dramatically decrease the use of fossil heating fuels by increasing the use of modern wood heating. However, in order to counter-balance the small incremental increases in PM emissions from each time someone switches from oil or propane to a pellet boiler, a single stove change out could go a long way. Table 2 below illustrates the annual change in PM emissions from switching to pellets from oil and propane boilers and the annual change in PM emissions from switching from an old non-certified stove to a new EPA certified wood stove.

*Table 2 – Change in annual PM emissions for various activities switching fuels and appliances*

Switch from	Switch to	Δ Annual PM Emissions Pounds
New propane/natural gas boiler	Modern pellet boiler	1.45
New heating oil boiler	Modern pellet boiler	1.16
Old non-certified woodstove	Modern EPA certified woodstove	-195.71



A single woodstove change out produces a considerable reduction (nearly 200 pounds) in the amount of PM emissions annually, while the switch to pellets has a small increase 1-1.5 pounds annually. Essentially, for every 216 homes that switched from oil to a pellet boiler or for every 173 homes that switched from propane to a pellet boiler, a single woodstove change out would completely off-set the increased PM emissions.

### IMPROVING AIR QUALITY WHILE EXPANDING THE USE OF MODERN WOOD HEATING

If a single woodstove change-out were performed for every 173-216 homes that switch to a pellet boiler, there would be no net increase in annual PM emissions. Of course, there would be no net decrease either.

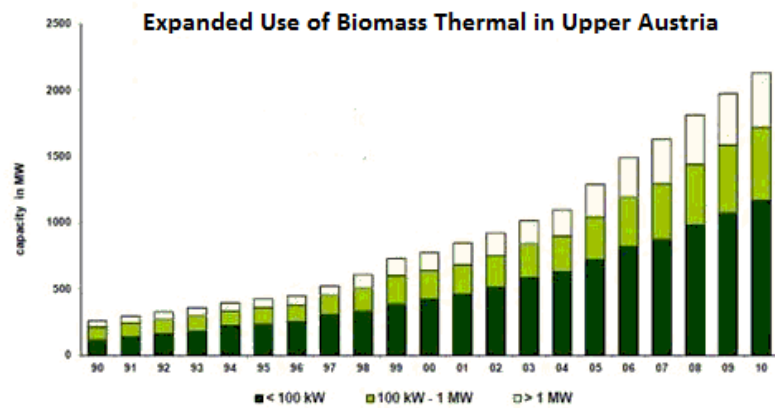
If the goal is to dramatically reduce the amount fossil fuels used for home heating, expanded use of modern wood heating can be used as effective strategy while improving ambient air quality. This can be achieved by simply ensuring that for every 108 homes that switch from oil to pellet boilers and for every 86 homes that switch from propane to pellet boilers at least one old woodstove is replaced with a new EPA certified woodstove. If one wood stove is replaced for every 100 pellet boilers installed, there would be a 50% net reduction of annual PM emissions! The graph below illustrates the impacts of one woodstove change-out, 68 installed pellet boilers replacing propane, and the combined net reduction of annual PM emissions.



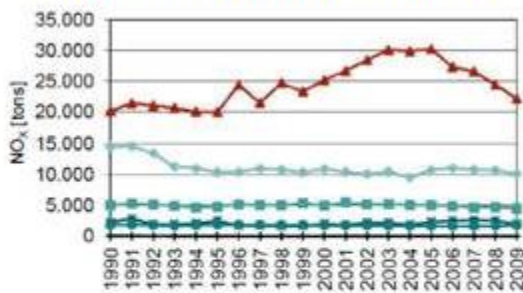
**EXAMPLE FROM EUROPE**

Perhaps the most tangible evidence of improved air quality with rapid market adoption of modern wood heating comes from Europe. The small state of Upper Austria is located in north central Austria and has a population of 1.4 million people. Upper Austria is internationally recognized as a leader in energy efficiency and renewable energy. Over the past decade, Upper Austria has dramatically increased their use of modern wood heating to meet their thermal energy requirements – today over 40% of all thermal energy is met with wood fuels including chips, pellets and cordwood. The graph below illustrates the rapid rate of increased wood heating in Upper Austria from 1996 until 2010 across the residential, commercial, and large-scale district heating sectors.

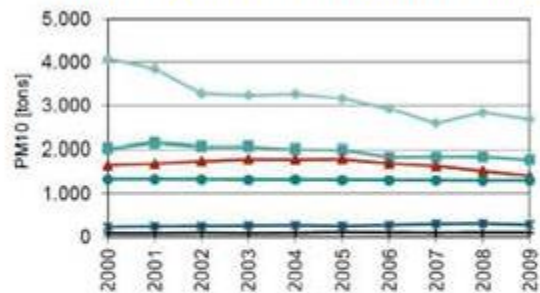
In the period of time between 1996 and 2010, Upper Austria experienced a 900% increase in the use of wood heating and a large portion of the market growth was the residential sector (as illustrated in the dark green). Despite this rapid market growth, Upper Austria has continually experienced improvements in ambient air quality. The two graphs below depict the relatively flat and slightly declining levels of NOx and PM emissions during roughly the same period of the rapid increase in wood heating adoption.



**NOx Emissions from Different Sources**



**PM10 Emissions from Different Sources**



The southern half of the state of Upper Austria is very mountainous and there are hundreds of small communities that heat predominantly with wood nestled in tight mountain valleys and their economies are extremely dependent on tourism. Clean air and a healthy environment are essential for Upper Austria’s economy. One of the specific strategies the Upper Austrian Energy Agency has used, which is a contributing factor to the improvements in air quality, is changing out old wood heating equipment and providing



education and outreach in rural regions to encourage “best practices” for cordwood heating (i.e. proper drying and storing firewood, stove operation and maintenance, and getting fires started).

## **SUMMARY**

Numerous US states (especially in the Northeast) have programs administered by the energy offices or divisions of forestry that promote, support, and incentivize building owners to make the switch from oil and gas heating to modern wood pellet heating systems.<sup>2,3,4,5,6,7</sup> Many states also have small woodstove change out programs or are planning to launch programs pending sufficient funding.

As modern wood heating programs expand as an effective strategy for making clear and measurable progress toward sustaining working forests, reducing dependence on imported fossil fuels, reducing carbon emissions, and stimulating local economies, it is essential that wood heating be expanded in a thoughtful way that delivers maximum benefits including cleaner air quality. Integrating fuel switching programs with woodstove change out programs and regulating the ratio of boiler fuel switches to woodstove change outs can yield net air quality benefits over time – an essential element to securing long-term public and political support.

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<sup>2</sup> Efficiency Vermont - <https://www.encyvermont.com/rebates/list/central-wood-pellet-furnaces-boilers-business>

<sup>3</sup> Clean Energy Development Fund - <http://www.rerc-vt.org/incentives-program/eligibility>

<sup>4</sup> Efficiency Maine - <http://www.encymaine.com/renewable-energy/wood-and-pellet-heating/>

<sup>5</sup> New Hampshire PUC - <https://www.puc.nh.gov/Sustainable%20Energy/RenewableEnergyRebates-WP.html>

<sup>6</sup> Mass CEC - <http://www.masscec.com/technology-programs/biomass-boilers>

<sup>7</sup> NYSERDA - <http://www.nyserda.ny.gov/All-Programs/Programs/Renewable-Heat-NY>