Cleaner, Greener Communities Program:

Residential Biomass Heating System Program Requirements

Cleaner, Greener Communities (CGC) Program is administered by The New York State Energy Research and Development Authority. CGC Progam was announced by Governor Andrew M. Cuomo in his 2011 State of the State address as a competitive grant program to encourage communities to develop and implement regional sustainable growth strategies. Regional Sustainability Planning was the first phase of the CGC Program and as a result, each New York State region developed a comprehensive sustainability plan in coordination with the Regional Economic Development Councils (REDCs). The awarding of Implementation Grants is the second phase, and began in June 2013. Funding will be provided on a competitive basis for implementation of specific projects that provide the greatest opportunities for achieving carbon reductions, energy efficiency savings and renewable energy deployment consistent with a region's sustainability and REDC strategic plans.

This document provides greater detail regarding the eligibility requirements for residential biomass heating system projects through Phase II of NYSERDA's Cleaner, Greener Communities Program.

Outside residential bulk pellet storage bin. This 4.5-ton unit has a ventilated soffit and two ports for pellet delivery. (Courtesy of Vincent's Heating and Fuel Service, LLC)

Eligibility Requirements for Residential Biomass Heating Systems

Residential biomass heating systems in NYSERDA's Cleaner, Greener Communities Program are limited to fully automatic high-efficiency and low-emissions wood pellet boiler heating systems that are rated less than or equal to 340,000 Btu/h (≤ 100 kW) with thermal storage, bulk pellet storage outside of the home and use a premium wood pellet fuel. The heating system operation must be optimized to provide maximum efficiency on a seasonal and diurnal basis and minimize boiler cycling. No systems using wood-chips, cord-wood, non-woody biomass, or systems larger than 340,000Btu/h (100 kW) being installed in commercial buildings will be considered eligible residential technologies (for boilers being installed in commercial buildings, see guidelines for commercial boilers) for this program.

1) Home Energy Audit: All residential projects must have an energy audit to identify energy efficiency measures and to determine the heat load of the home. See NYSERDA's Home Performance with ENERGY STAR® Program for details, funding assistance that may be available, and participating BPI accredited auditors. (http://www.nyserda.ny.gov/Features/Make-Your-Home-More-Comfortable-with-Home-Performance-with-ENERGY-STAR.aspx)

2) Fuel Type: The eligible fuel type is a premium wood pellet (Figure 1). The premium wood pellets must be 100% wood composition with no construction or demolition debris such as pressure treated or painted wood (which may contain heavy metals such as copper, chromium, arsenic, lead and cadmium) or plastic binders or fillers. Pellets must have a calorific value of no less than 8000 Btu/lb, low ash content (<1%), low moisture content (<8%), chlorides less than 300 ppm and no other additives (0%). Other commercially available fuel types in NYS (for example green wood chips and grass pellets) cannot facilitate high-efficiency and low emissions performance even in advanced technology boilers at this time. Awardees must agree to use only the eligible fuel type in the wood pellet boiler for a minimum of the length of pay-back time on the system from fuel-cost savings. Applicants should identify and obtain a bulk fuel price quote from two pellet suppliers where possible.

Figure 1. Premium wood pellets. (Courtesy of Curran Renewable Energy)

3) High Efficiency and Low Emissions Pellet Boiler Performance: Boilers must be fully automatic, low mass (low volume) and have sensors and controls to optimize combustion performance (Figure 2). This is most easily achieved using a staged combustion design with lambda control. The wood pellet boiler must have a minimum thermal efficiency of 85% at rated output using the higher heating value (HHV) of the pellet fuel if tested using an input/output method.

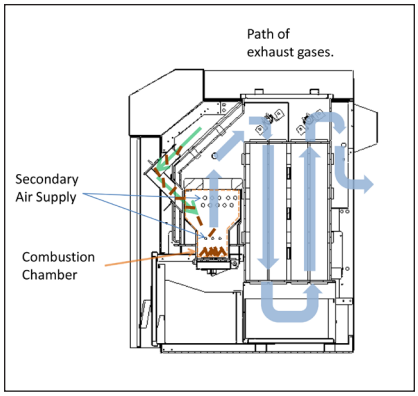

Figure 2. Schematic of a high-efficiency pellet boiler with pellet introduction and exhaust flow path through the heat exchanger. (Courtesy of EVOWORLD)

High Efficiency and Low Emissions Pellet Boiler Performance	
Thermal Efficiency (HHV)	85%
Particulate Emissions	< 0.080 lb/mmBtu
Carbon monoxide (CO) Emissions	< 270 ppm at 7% O_2

Prior to contracting, successful applicants will be required to submit emissions performance verification results of the same boiler model and pellet fuel combination to NYSERDA for review and approval. Performance testing for thermal efficiency, particulate matter, and CO must have been performed by an independent third-party using the U.S. Environmental Protection Agency (EPA) Conditional Test Method 39, EPA Federally Referenced Methods 5 and 202, EPA Other Test Method 15, EPA Method 28 WHH, or a modification of the Brookhaven National Laboratory test method for boilers with partial thermal storage. Alternatively, European Norm 303-5 test results may also be considered, but must include dust and organic gases. In some cases the pellet boiler manufacturer may have already submitted this documentation to NYSERDA for review and approval and have a copy of the approval letter. All projects must also conform with all applicable NYS residential codes (http://publicecodes.cyberregs.com/st/ny/st/b400v10/index.htm)

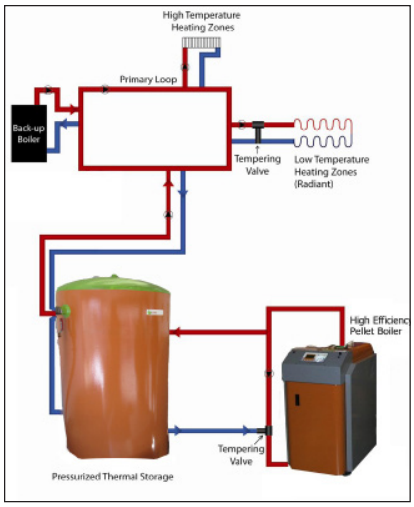

Figure 3. High-efficiency wood pellet heating system with thermal storage. (NYSERDA diagram)

4) Proper Boiler Sizing: The high-efficiency wood pellet boiler must be properly sized for the application with particular attention to avoid oversizing the boiler. Boilers must be sized and systems planned to optimize performance throughout the heating season using thermal storage. A well-designed residential system must be sized based on the heat load of the building where the heat load is determined using a well defined protocol such as Manual J of the Air Conditioning Contractors of America (ACCA) or an equivalent energy simulation program. (Figure 3)

5) Stack Height: The design of the exhaust stack and location should be done carefully to prevent exposure to building occupants and visitors or to people in frequently occupied outdoor areas and meet NYS code requirements. (http://publicecodes.cyberregs.com/st/ny/st/b400v10/st_ny_st_b400v10_10_par038.htm).

6) Thermal Storage: Pellet heating systems must include thermal storage (Figure 4) to minimize boiler cycling and to assist in energy management strategies. The minimum size thermal storage for pellet boilers ≤25kW (85,000 Btu/h) is 119 gallons. For boilers >25kW, thermal storage should not be less than 20 gallons per 10,000 Btu/h.

Figure 4. Pellet boiler with thermal storage tank. (NYSERDA photo)

7) Outside Pellet Storage: Pellets can produce high levels of dust and off-gas CO in storage presenting health and safety concerns. Carbon monoxide is a colorless, odorless gas that has health effects below the levels at which common CO detector alarms are triggered. There have been cases of fatalities aboard ships carrying pellets and in commercial bulk storage facilities in Europe. Research is underway in Europe, Canada and NYS to better understand the chemical reaction that produces the CO. According to the US EPA:

> *CO can cause harmful health effects by reducing oxygen delivery to the body's organs, such as the heart and brain, and tissues. At extremely high levels, CO can cause death. Exposure to CO can reduce the oxygen-carrying capacity of the blood. People with several types of heart disease already have a reduced capacity for pumping oxygenated blood to the heart, which can cause them to experience myocardial ischemia (reduced oxygen to the heart), often accompanied by chest pain (angina), when exercising or under increased stress. For these people, short-term CO exposure further affects their body's already compromised ability to respond to the increased oxygen demands of exercise or exertion.*

Figure 5. Outside residential bulk pellet storage bin. This 4.5-ton unit has a ventilated soffit and two ports for pellet delivery. (Courtesy of Vincent's Heating and Fuel Service LLC.)

Due to concerns regarding CO exposure and the absence of a documented effective ventilation strategy for pellet storage, all bulk pellet storage must be outside of the home (Figure 5).

Applicants may request funds for outdoor bulk pellet storage containers and pellet conveyance systems, but large capital construction costs for residential bunkers or modification of coal bins will not be considered. A sign communicating potential CO hazards associated with bulk pellet storage must also be posted.

8) Programmable Thermostat: Applicants should use a programmable thermostat to conserve energy.

9) Cost-effectiveness: High-efficiency and low-emissions commercial and residential wood pellet heating systems are estimated to have a simple payback period (i.e. without public incentives or tax credits) of about 12 years.

10) Heating system performance monitoring: For residential systems, installers must follow the RHNY Project Design Requirements in PON 3010 Attachment G of the RHNY Program Manual, Section 3.1. (http://www.nyserda.ny.gov/-/media/Files/FO/Current%20Funding%20Opportunities/PON%203010/3010attg.pdf). A piping schematic and electrical controls and wiring diagram for each installation must be submitted for review. Systems must be tested to ensure proper operation of each component of the heating system and establishment of a thermocline in the thermal storage tank. The number of on/off cycles, hours of run time, and wood pellet fuel use (tons) shall be reported by June 1 for each of the first three years of operation.

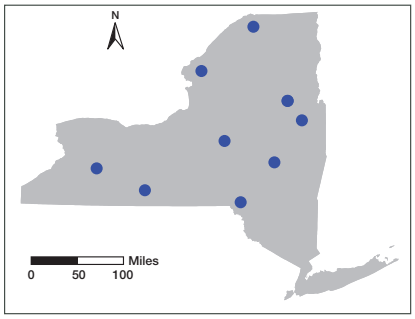

Figure 6. Wood pellet production in NYS.

Pellet Production in New York State

There are nine pellet mills in NYS with an annual capacity of 500,000 tons per year (Figure 6). Several manufacturers produce premium wood pellets that are low in ash and moisture content, and contain no construction debris or non-wood additives. Some mills have pellets that also meet criteria for sustainability by the Forest Stewardship Council or Sustainable Forestry Initiative certification.

High-Efficiency Pellet Boiler Demonstrations

NYSERDA works with manufacturers across NYS to develop advanced, high-efficiency and low emissions heating technologies, regardless of fuel type. As interest in biomass heating has increased, NYSERDA has undertaken efforts to support a clean biomass industry in NYS, including funding demonstrations to measure and verify system performance. Research to date has shown that wood pellets combusted in an advanced boiler yields the highest and most consistent performance among the biomass fuels.

Figure 7. First Made-in-NY commercial high-efficiency wood pellet boiler by Advanced Climate Technologies. (NYSERDA photo)

Advanced Climate Technologies Bioenergy LLC, of Schenectady, NY, produced the first Made-in-NY commercial high-efficiency pellet boiler (Figure 7). High performance is achieved via staged combustion that includes a flue gas oxygen (lambda) sensor to promote optimum combustion conditions. A 1.7 million Btu per hour boiler was demonstrated at the W!ld Center Museum in Tupper Lake, New York. The performance of the boiler was measured by Clarkson University's Center for Air Resources Engineering and Science, and was able to achieve high-efficiency (>85%) at full load, similar to the efficiency level of an oil-fired heating system. A solid fuel system's performance decreases more rapidly under a reduced load than propane-, natural gas-, or oil-fired heating systems. Thermal storage can help mitigate these losses. The W!ld Center did not have thermal storage, and annual efficiency was measured to be about 65%. Despite this, the cost difference between wood pellets and propane yielded an annual fuel savings of $31,000 or about 45%. Clarkson University has recommended adding a thermal storage tank with an anticipated additional annual savings of $5,000. A second manufacturer, EvoWorld of Troy, NY, is manufacturing high-efficiency wood pellet boilers for both commercial and residential applications. The first Made-in-NY residential high-efficiency pellet boiler is shown in Figure 8. Residential pellet boiler demontrations are currently underway by Clarkson University and SUNY Canton.

Figure 8. First Made-in-NY residential wood pellet boiler by EvoWorld. (Courtesy of EvoWorld)

Fine Particulate Matter (PM2.5) Emissions Performance

US EPA and other agencies are concerned about fine particle pollution because as stated on EPA's website:

> *Health studies have shown a significant association between exposure to fine particles and premature mortality. Other important effects include aggravation of respiratory and cardiovascular disease, decreased lung function, asthma attacks, heart attacks, and cardiac arrhythmia. Individuals particularly sensitive to fine particle exposure include older adults, people with heart and lung disease, and children.*

According to the 2009 NYS Asthma Surveillance Report, 11% of children (ages 0–17) have asthma, which exposure to fine particulate matter (PM2.5) is known to exacerbate.

PM2.5 is a pollutant of concern from all combustion systems. A comparison of emissions is made for several residential fuel and heating technology combinations (Figure 9). The highest emissions are from a conventional outdoor wood boiler (OWB), next is a Phase II OWB, a two-stage downdraft boiler with simple controls using a thermal storage tank, a more sophisticated "smart" two-stage downdraft boiler, a pellet boiler, an oil-fired boiler using high sulfur home heating oil, and an oil-fired boiler using ultra-low sulfur home heating oil. As of July 2012, all No. 2 home heating oil in NYS is ultra-low sulfur fuel.

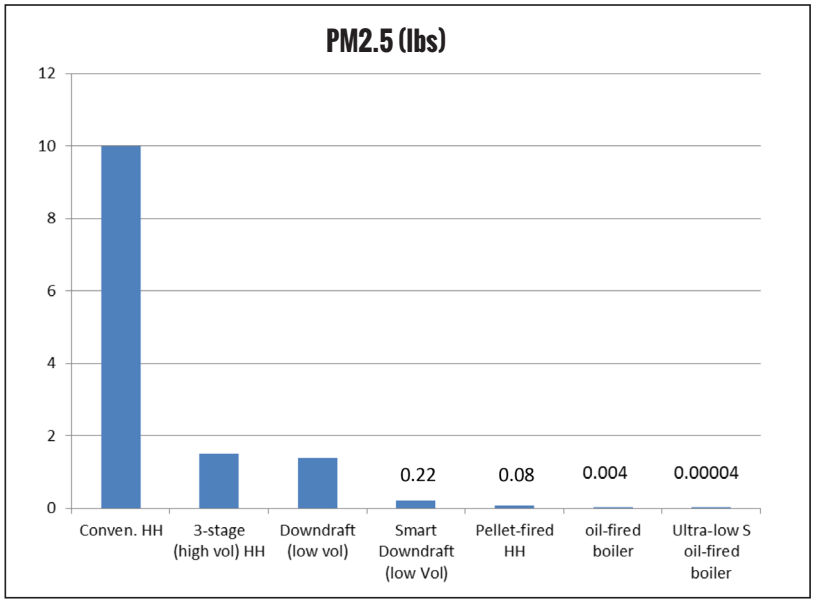

Figure 9. Comparative fine particulate matter (PM2.5) emissions from several fuel-heating technology combinations for an average home in Central NY on a January day. NYSERDA report 12-15, 2012; Butcher, 2013; McDonald, 2009

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More information may be found at:

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