Complementary renewable heating technologies installed at Hidley Farm

Case Study

Customer Name:
Hidley Farm

Location:
North Greenbush
(Rensselaer County)

Equipment:
Econoburn Boiler

Type of Fuel:
Wood

Installation Date:
2008

Background

Hidley Farm is situated on 130 partially wooded acres in North Greenbush, a town in Upstate New York's Capital Region. The original farmhouse was built circa 1790. After additions and renovations, the house is now about 4,000 square feet. During the renovation process, the homeowners implemented many energy-saving strategies such as airsealing, extensively insulating the attic and exterior of the house, replacing all 50 windows with low-e glass, and replacing all doors.

In 2008, a high-efficiency, 200,000 Btu/hr Econoburn cordwood, two-stage wood gasification boiler was installed in an outbuilding with wood storage. In 2009, a solar thermal, hot-water system was installed. Four 4-foot-by-8-foot flat plate collector panels provide additional energy to meet space heating and domestic hot-water loads. An antifreeze solution is circulated from the heating systems through insulated, underground pipes to the home's heating network, which includes a 1,250-gallon thermal storage tank in the basement (see diagram on back). The water within this thermal storage tank is heated by passing the antifreeze solution through three copper-coil heat exchangers. The tank has a nominal operating temperature range of 120-170°F, which provides approximately 500,000 Btu of dynamic thermal storage. The heating system also utilizes the old oil boiler as backup and includes an electric water heater to supplement domestic hot-water production. The heating and hot-water loads are primarily met by the solar thermal system and cordwood boiler.

Challenge

Historically, a major challenge has been the availability of cordwood heating appliances that burn wood efficiently and cleanly. Cordwood boilers also require the owner to load the wood and start the fire. Although some people may find this process undesirable, others take satisfaction in cutting, splitting, and handling the fuel for their home heating system.

The homeowners wanted to use wood harvested from forest stand improvement activities, eliminate boiler operation from spring through fall, and minimize combustion generated air emissions. Integrating the Econoburn cordwood, two-stage gasification boiler with thermal storage and a solar-thermal system maximized efficiency and reduced emissions.

Solution

Staged combustion cordwood boilers are a common design in Europe and are now emerging in the United States. These cordwood boilers are able to achieve 70% thermal efficiency on an annual basis, which is far greater than their single-chamber counterparts. In the first stage, firewood is combusted at relatively low temperatures under oxygen-starved conditions in order to off-gas volatile compounds. These gases are injected into a refractory-lined secondary chamber under oxygen-rich conditions where high temperatures, adequate residence time, and turbulent mixing promote complete combustion. Integrating an advanced cordwood boiler with thermal storage is essential and maximizes performance. This combination optimizes the performance of the cordwood boiler due to the nearly steady-state operation and drastic reduction in cycling, allowing it to achieve performance levels comparable to oil. Installing thermal storage with a cordwood boiler facilitates the addition of a solar thermal heating system. Both the cordwood boiler and the solar thermal heating system can share the thermal storage tank.

For this location, to prevent freezing pipes and other damage when homeowners leave for an extended period, the oil boiler kicks on when the thermal storage drops below 100°F. The electric water heater serves a backup role and is used primarily for summer operation when the solar output is too low (such as during an extended cloudy period) or when hot water demand is high (such as hosting many grandkids).

Results

In the first year of operation, all heat demands including domestic hot water were met by combusting about seven full cords of wood that was split and properly dried (<20% moisture content). Proper seasoning of the wood improves efficiency. Wood should be cut, split, stacked, and stored under cover for about two years to be properly seasoned. Without the insulation and other energy saving improvements, the boilers would have operated more often.

The homeowners can leave for up to three days during the winter, and rely entirely on energy drawn from the thermal-storage tank to keep the home heated. The homeowners did not have to fire either the cordwood or oil boilers from April until late September of 2010 due to the addition of the solar thermal system. The thermal storage temperature was in the range of 110-130°F from the solar panels alone throughout the spring and summer of 2010.

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