On-Farm Energy Case Study:
Hard Coal for Greenhouse Heat
Sam Mazza Farmstand, Bakery and Greenhouses - Colchester, VT

Sam Mazza and his family run one of the largest vegetable, berry, and ornamental farms and retail markets in Vermont. Over 300 acres of land and two dozen greenhouses produce crops that are sold in their market, and three generations of Mazza family members work in the business. Among them is Gary Bombard, Sam's son-in-law, who manages the greenhouse operations.

"We have 31 oil-fired hot-air furnaces, some of them 20 years old" said Gary, "so it was a good time to be looking at our heating options, given the high cost of heating oil and the need to replace these furnaces in the not-too-distant future. We looked at a lot of options. A centralized wood boiler would be nice, but our greenhouses are not clustered in one area. With all the underground insulated piping that would be required, that would have cost a million dollars. We considered corn furnaces but the price of corn seems too volatile. Eventually we decided to try a coal hot air furnace that could be used in individual greenhouses, and so far we're very pleased."

Gary put the first coal-burning furnace in the one greenhouse that is operated year-round. It's a 350,000 Btu warm air furnace, model A300 made by Keystoker Manufacturing Company in Schuylkill Haven, PA (www.keystoker.com). He purchased it for $5,600 from Black Rock Coal, Inc., in East Montpelier VT (www.blackrockcoal.com). This unit was set up as a dual fuel unit, also able to burn oil with a Beckett oil burner. Gary did that because he was not sure how reliable the furnace would be.

It performed well, so he installed 5 more Keystoker furnaces: two 350,000 Btu units were placed in each of two greenhouses used to grow pointsettias, and a 250,000 Btu unit was installed in a smaller greenhouse. His strategy is to replace the oil furnaces with coal furnaces with the same heating capacity. They are starting with greenhouses that use the most fuel because they go into production early; the savings in houses started later in the heating season will not be as great.

The furnaces need to be lit manually. First, Gary by balls up some paper in the firebox and throws a handful of hardwood chips on top, and lights this. Once it's going he adds about a cup of coal which ignites pretty easily.

After that, the furnace feeds coal from the hopper automatically using a very slow metal conveyor like a live-bottom trailer. It doesn't take much longer than with the oil furnaces to get the greenhouses up to temperature from a cold start.

Inside the firebox, you can see three rows of coal on the angled 'broiler.' The new coal is feeding in on the right, the coal that is burning hot is in the middle, and the spent coal is being pushed off to the left, into the ash pan down below.

Currently, Gary is buying coal for $255/ton delivered, in 22 ton loads. He buys it through Black Rock Coal and it comes out of Pennsylvania. Gary figures a ton of coal at this price equals fuel oil at about $1.45 per gallon; the Penn State energy calculator confirms this, see: http://energy.cas.psu.edu/EnergySelector.html.

"I don't think we'll see that price for oil any time soon" says Sam, "and the price of coal has been pretty stable over the past ten years. Plus I like the fact that we have a lot of it right here in the U.S."

The coal being used is hard coal, or anthracite. It has a carbon content of 92% to 98%, higher than bituminous coal or other coals of lower 'rank'. It burns slowly with a short smokeless flame; it makes a good heating fuel for homes. According to the American Coal Foundation, the U.S. has 7.3 billion tons of anthracite, mostly in Pennsylvania. Coal sizes have names like chestnut, pea, buckwheat and rice. Gary's furnaces burn buckwheat, which ranges from 3/8 to 9/16 of an inch, and rice, which is 3/16 to 3/8 of an inch in size.

Rice on the left, buckwheat on right

To store the coal, Gary built a large fabric-covered quonset-shed capable of holding several hundred tons of coal. "It's kind of oversized now, but we planned ahead for converting other greenhouses to coal. Before we do that, we need to figure out how to automate the delivery process so we can fill large outdoor bins next to the greenhouses that allow the coal to flow right into the hoppers on the furnaces." Since the coal furnaces were only recently installed, the hoppers are still being loaded manually using 5-gallon pails of coal.

Maintenance includes emptying the ash pan daily and occasionally opening cleanouts to vacuum coal dust from the heat exchanger and the stack. “I was concerned about high temperature of the exhaust because coal burns so hot. It’s easy to melt greenhouse plastic or burn the wooden end walls, so I used metalbestos pipe inside and outside, with 18 inch clearance. It stays so cool you can put your hand on it when the furnaces are running. The coal seems to burn very clean. There is no visible exhaust from the stacks when the furnace is running.”

Above: Gary Bombard demonstrates the simple adjustment to alter the rate that coal flows into the firebox. The door for the ash pan is just below the combustion blower.

-Vern Grubinger 10-31-08