VERMONT STATE CONSERVATION INNOVATION GRANTS

Quarterly Progress Report

Project Title: Fuel from the Field to the Flue: Grass pellet heating equipment combustion optimization project.
Grantee Name: Meach Cove Real Estate Trust
Project Director: Christopher W. Davis
Progress report author (if different than Director):
Period Covered by this Report: 4/1/2012 to 9/30/2012
Project End Date: 1/1/2013

A) Work performed during this period:

The following is a summary of the research into boilers less than 400,000 BTU's output capacity that have been identified through other studies and testing to be able to handle the unique combustion challenges of burning 1/8" – 1/4" diameter grass pellets made from a variety of species of grass. Where current cost information is available it has been provided.

The following production boiler models under 400,000 BTU's output that are able to handle grass pellets with only combustion adjustments and proper maintenance as reported by others conducting the testing are in alphabetical order:

Foling P-4, 20 kW (Austria)
Harman P-105 (USA)
LEI BioBurner model 200 (USA)
Skanden (Reka) Multi-Fuel 30 kW mini (Denmark)
WoodMaster AFS 900 and AFS 1100 models (USA)
Woodpecker 15 kW and 25 kW models (UK)

Summary:

1. **Froling P-4 (20 kW), Austria.** One of these wood pellet boilers was studied at SUNY, Canton, N.Y. within the past 3 years. Michael Newton at SUNY explained that they were able to adjust this boiler so that it satisfactorily burned EnviroEnergy grass pellets without any major issues and very clean particulate emissions. They have not yet published their study on the boilers they worked with. Mr. Newton said they liked working with this boiler and believe it would be an excellent candidate for longer term combustion with grass pellet fuel due to

the robust design and automatic ash removal system and the ability to easily program the boiler to adjust the combustion parameters to optimize grass fuel combustion. The 20 kW P-4 boiler retails for $12,000 for the boiler delivered in Vermont.

Vermont Technical College in Randolph, VT has installed a larger Froling pellet boiler in one of the buildings on their campus (Red School House) and they are in the process of installing emission monitoring equipment on the flue to be able to accurately monitor the boiler operation when burning different species of grass and other biomass.

2. **Harman P-105 Pellet boiler, USA.** Michael Newton at SUNY in Canton, N.Y. reported that the also tested the Harmon boiler with EnviroEnergy Grass pellets made in Wells Bridge, NY and they were able to adjust the Harmon so that it would burn this fuel without major complications. The biggest concern with the Harmon P-105 is that the fuel moves across a flat surface before dropping onto a manually activated grate. Special attention must be given to the combustion temperatures to prevent large clinker formation or ash fusion from occurring on the flat combustion surface. Because this boiler has no automatic cleaning feature so the operator must be diligent in agitating the grate and removing any ash or clinkers that form in the boiler. These boilers retail for less than $8,000 delivered.

3. **L.E.I. Products BioBurner 100, 200 boilers, Madisonville, KY.** The L.E.I. team has been developing and testing their BioBurner boilers for at least three years and they have shown some success in being able to adjust the boilers to handle grass pellet fuels. This boiler uses a cyclone to trap particulates which allows them to meet the EPA emission standards for particulate emissions even with some grass fuels. LEI had not developed an automatic ash removal system but provided a hand crank for the lower ash tray and a cordless drill was used to rotate screws installed in the vertical flue tubes to clear any accumulated fly ash. L.E.I. was offering to provide early production models of their Bio Burner boilers in the 100,000 BTU and 200,000 BTU size range for $25,000 and $35,000 respectively. As far as I know there has been no long term testing with grass fuel in these boilers but Jerry Cherney at Cornell University in Ithaca, NY has a BioBurner 100 model and they have run grass fuel in that unit in short term tests.

4. **Skanden (Reka) Multi-Fuel 30 kW mini (Denmark).** These boilers are supposed to be popular in Denmark and Northern Europe and are being imported into the US by Skanden Energy. Jerry Cherney at Cornell University in Ithaca, NY has installed a Skanden 30 kW boiler and he has been trying to work through some control issues to get it to operate properly on grass pellet fuel. To date the unit has not operated long enough to get any solid grass combustion performance data but they are still working with it. Because of the freight charges from Denmark these units are almost $30,000 delivered for the boiler with an automatic sash auger and larger ash box.

5. **WoodMaster, Northwest Manufacturing, Inc., Red Lake Falls, MN, models AFS-900 and AFS-1100:** These two outdoor rated boilers were tested with grass pellets from EnviroEnergy by a Cornell University Extension Service program in conjunction with Delaware Valley Watershed that was overseen by Jerry Reustow between 2007-11.

   This testing found that the AFS-900 model was able to handle the grass pellets even though it had only a single agitating auger in the burn area. This model had an automatic ignition but no automatic ash removal. Please see meachcovefarms.org for the detailed analysis of the EnviroEnergy grass pellets.

   The WoodMaster model AFS-1100 was designed to burn shell corn, grains, crop hulls and other solid biomass so that it has dual agitation augers in the burn area and an automatic ash removal auger. There was no automatic ignition provided on this model.

   According to Gerry Reustow and the published information, both of these boilers were able to burn the mulch hay pellets supplied by EnviroEnergy over two heating seasons with only a few mechanical or control issues. The particulate emissions with these types of boilers would be an issue it they were used in longer term applications.

   Other WoodMaster boilers examined:

   I had numerous conversations with the WoodMaster marketing director, Todd Strem, between October 2011 and February 2012 regarding the combustion of the grasses in the two previously mentioned outdoor boilers and other WoodMaster boilers and furnaces that might be suited to grass pellet combustion. WoodMaster agreed to test quantities of various grass species in their **Flex Fuel Boiler** and the **Force** hot air pellet furnace. Because neither of these units have moving ash grates Mr. Strem reported to me that the grass pellets formed a liquid mass prior to cooling into large clinker forms. These boilers were not able to agitate or clear this clinker formation and the air supply to the coal bed would be compromised to the point that the units would not stay running. For these reasons Mr. Strem informed me that WoodMaster would not do any further testing on these units at this time. They had hoped that these two units would be able to handle the grass pellets based on their design features. Todd Strem explained that WoodMaster believed that the new EPA emission standards under review to be be adopted by late 2012 or 2013 would force the company to no longer offer the AFS-900 or AFS 1100 models for sale in the US. Because of the emission performance of the outdoor boiler models I do not recommend further testing of these units with grass pellets. Because of the design of the Flex Fuel boiler it may be difficult to modify this boiler to handle grass fuel and because there is no automatic ash removal this would require frequent manual cleaning with grass fuel.

6. **Woodpecker 15 kW pellet boiler, Woodpecker Energy, UK:** The Woodpecker boilers have been installed throughout Britain and Ireland for almost 10 years and they are being imported into the US by Webiomass based in Rutland, VT. Jerry Cherney at Cornell University in Ithaca, NY had tested grass pellets in a Woodpecker but had issues with the grass ash blocking the sensors in the boiler leading to shutdowns. Michael Newton at SUNY in Canton, NY had also worked with a Woodpecker boiler and they were able to make adjustments to the boiler so that it would run on grass pellet fuel. Overall the burn chamber of this boiler is not as well suited to burn grass fuel as some of the other models but I have left it on the list because of the success that the SUNY program had with the boiler. These boilers retail for less than $12,000 delivered in Vermont.

I have communicated with several other companies and individuals who claim to have boilers that can handle grass pellets. A summary of this information is as follows:

a.) **Pro-Fab Industries**, Arborg, MB Canada, Pelco 1020 boiler: This boiler is able to combust agricultural waste and they claim will handle grass pellets. The price for this unit would be $28,200 before delivery in Vermont. I have spoken with several people familiar with the Pelco boiler firebox design and they feel that it is not very efficient in combusting the grass and the units that they were familiar with had high ash particulate stack emissions with wood pellets. This boiler is an option for the CIG project as it is a production boiler but I would want to test grass pellets in a unit prior to purchasing one. If no other more efficient and proven boiler is identified then I would propose to ship the remaining pellets from WoodMaster in northern Minnesota to a farm facility in southern Minnesota that has several Pelco boilers provided they were willing to run a test burn with the grass pellets.

b.) **Brandelle Biomass Systems**, **Milton, ON**: This company claims to have developed a biomass pellet capable boiler (BX-200). I was able to speak with an engineer at their facility and at first they seemed interested in working with our project. In January they would not return my calls or e-mails. I learned from another Ontario based biomass equipment processing dealer that Brandelle has developed several prototypes of these biomass boilers and done their own limited burn testing with grass pellets but that they are not interested at this time of moving to actual production of these biomass boilers. Jerry Cherney reported that this was his experience when he contacted them several years ago. They have an impressive website with detailed drawings, a photograph of the unit and specifications but that is as far as they are willing to go at this time. They appear to have incorporated all the features that would allow the units to handle grass pellets but they are not thinking about testing or production at the present time.

c.) **Heatilator Corporation**, Mt. Pleasant, IA: The Heatilator Corporation has developed a prototype grass pellet hot air furnace (Bio-500F) that they expect will produce up to 500,000 Btu's and can handle grass pellet combustion issues. The unit appears to be well designed (cast iron moving grate, high ash handling components, simple and practical design features from the drawings provided) but when contacted they said they were in the prototype phase right now and have no units ready for outside testing. They may be interested in working with the project but the prototype status of their unit may not meet the CIG qualifications.

d.) **Biomass Energy Works**, Ashburnham, MA, Mark Carlisle: Mark Carlisle has been working on a design for a 200-350K BTU boiler that is specifically designed to burn grass pellets. His third generation design is burning Enviro Energy grass pellets with success in his shop. He claims that he has developed a unique burner and water filter to make his flue emissions clean and particulate free. He is interested in collaborating on testing his design but since his design is still in development I do not believe it would meet the CIG qualifications.

e.) **Pellergy**, Barre, VT, Andy Boutin, Pellergy has developed a Vermont assembled wood pellet boiler and hot air furnace. They have experimented with grass pellets in their "gun" style burner. They continue to have trouble with clinker formation in the barrel of the combustion chamber which blocks the airflow. They are using an air compressor on a times blow cycle to clear ash and unburned pellets from this chamber. Unfortunately the grass clinkers do not clear from the chamber as easily as the wood pellet ash. They are willing to work with this CIG project but it is clear that modifications to their combustion barrel would have to be made to continuously and effectively burn grass pellets. An automatic ash removal auger would also have to be fitted to their boiler and furnace due to the volume of ash produced with grass pellet combustion. This work would be possible but may be beyond the scope allowed under the CIG program.

October 2, 2012