NY farm viability INSTITUTE

Final Report

Hudson Valley Grass Energy - Mobile Pelletizing Service Company

NRG 08 007 **Duration:** May 1, 2009 - January 31, 2012

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Change to Baseline Farm Data

Overall, baseline data for the farms participating in the project did not change in a significant way in terms of economic, staffing or related changes. This is primarily because of the delayed development of a strong market for grass/hay pellets. The primary emphasis of this project was the development and refinement of a mobile ag biomass pelleting system. This objective was successfully met – although production rate-increasing modifications continue, we reached our minimum production rate goal of one ton/hour. Ag biomass pellets were successfully produced at all eight cooperating producers' farms. Many of the producers would be prepared to hire HVGE to produce pellets if markets existed. Unfortunately, despite the advanced state of grass combustion for heating in Europe, American markets have been slow to develop largely due to the 'chicken/egg' conundrum – US manufacturers have been slow to endorse the burning of grass pellets and make necessary modifications in their appliances since there is limited production, and impetus for increased production has been slow due to the lack of 'endorsed' heating appliances.

Despite this challenge in developing grass pellet markets, some changes and expense savings have occurred on cooperating producer farms. Most notably, on the Weist farm where a good deal of project equipment testing and modification was done, Mr. Weist indicates he has displaced the use of 1485 gallons of #2 heating oil by burning over 6 tons annually of ag biomass pellets produced with HVGE's mobile pelleting system (along with a much smaller quantity of wood pellets). At current oil prices, this results in a savings to the farm of over $5,000 in fuel costs. Based on these experiences, Mr. Weist plans to buy a second US Stove-brand multi-fuel pellet heating appliance for the 2012-2013 heating season which will enable him to heat his entire house and totally wean himself from purchasing heating oil.

Several other producers are poised to convert to biomass heating once a suitable and affordable unit is presented to them. Mr. O'Dell is preparing to build a new home and plans to install a multi-fuel pellet stove. Mr. Sanford is shopping for a multi-fuel boiler that can be installed outside and plumbed into his existing home central heating distribution system. The Sanfords are also interested in selling grass pellets, and are in a good position to become a supplier to the Town of Warwick who has committed to installing a biomass heating appliance in a Dial-A-Bus garage slated for construction in summer of 2012 and to fuel the appliance with biomass from Town of Warwick producers.

Mr. DeBuck, who operates a Harmon corn stove in his home, cooperated with the project to produce several tons of soybean stubble pellets in 2010. Although these pellets did not perform well in standard wood pellet appliances (as was expected), we are confident that larger, more robust commercial pellet heaters will be able to handle pellets from low-value biomass such as soybean stubble. The soybean

stubble pellets burned acceptably in residential multi-fuel stoves operated by HVGE team members. Mr. DeBuck is interested in becoming a pellet supplier for large municipal users such as highway garages. The Tantillo farm saw some income from the sale of rye straw pellets made at their farm with HVGE's pelleter. The pellets were mixed with corn and burned at a nearby Ulster County greenhouse operation who found the grass mixed with corn to improve the performance of their burner. Although this was a one-time sale limited to several tons of pellets, it demonstrates the potential that exists once early innovator experiences are shared and producer-user connections are made.

Profitability, Competitiveness, Sustainability Improvements

See the 'Change to Baseline Farm Data', which also helps to address this area. Contact information for the relevant farms is as follows:
James Weist, (845) 778-7000 ironhorses44@earthlink.net
John Sanford (845) 986-2211 johns@warwickresource.com
Ron O'Dell (845) 355-7916 blodell@optonline.net
Leonard DeBuck (845)258-4131 lmdebuck@warwick.net
As a result of our successes with the project, Mr. Weist has purchased the seed and related materials to bring into production an additional 15 acres of land. These fields were idle because their soil quality was marginal for the production of forage hay, but Mr. Weist will seed a Reedcanarygrass/Orchardgrass mix that could be used for forage hay when harvest conditions permit, but will have an alternate use as biofuel.

This type of expansion of agricultural land use, especially here in the Hudson Valley where farmland loss is a serious concern, is an example of the kind of sustainability/profitability improvements that we feel this project can encourage.

Similarly, Mr. Sanford has recognized the potential value that biofuel production as an alternate use presents to his farm operation which includes significant marginal land and periodic harvest of hay material that is poorly suited for forage. Round bales left to rot along the edges of hayfields, a not-uncommon sight, represent a potential profitability booster for such farmers.

The Tantillo example described earlier in this final report demonstrates a near-ideal arrangement whereby one farm provides ag biomass to another nearby operation. The rye straw pellets were made from old, poor-quality straw that had little value to the farm, and were provided to the Davenport greenhouse operation in large bulk bags – reducing handling expenses for both producer and user. Biomass heating of greenhouse operations represents a potentially large opportunity. The floriculture industry is hugely valuable in the Hudson Valley, and heating is clearly one of their major production expenses. One Orange County orchid producer reports oil usage of 200 to 300 gallons per week! Some innovative greenhouse operators have already installed wood chip boilers – perhaps the most economical heating option currently

available. But the convenience and efficiency of modern multi-fuel pellet boilers and furnaces promises to be a viable option for some of these producers.

The economics of biomass pellet production for NY farmers are expected to be tied closely to two major factors – the price of heating oil and the hay market. A third factor, more difficult to define but discussed repeatedly throughout this project, is the quantity of poor quality hay on the farm in any given year. This could be hay unexpectedly rained on, or marginal-quality fields to which the farmer has access but does not consistently harvest. The price of fuel oil is not expected to go down significantly, in fact is expected to continue to trend up. Using a current average price of $3.50/gallon, a useful evaluation of the potential profitability of biomass pellet production on NY farms can be made. Using data from our HVGE business plan, we currently predict that a pelleting fee of $75/ton would cover all operating expenses for a 'not-for-profit' pelleting service company (a significant increase in diesel fuel price would increase production expenses, but would concurrently be expected to increase the value of pellets). Therefore, a farmer can add the value of his hay to this figure to determine an approximate cost of production to compare to the current value of biomass pellets. Using extensive published data on the BTU value of biomass (which tends to be fairly uniform regardless of type), one ton of biomass pellets can be equated to 100 gallons of #2 heating oil. Therefore, the potential value in terms of BTU's for biomass pellets is $350. Given such adjustments as increased handling expenses and high ash content, the true value of biomass pellets would be somewhat less, but still leaves a considerable margin for profit to the farmer, depending on the value of his hay. As we have noted repeatedly in this project, where a strong market exists for forage hay or even mulch hay, there is little economic sense for a farmer to invest further production expense in converting hay to pellets. But it is a practical reality that many farms end up with unsaleable or very low-value hay many years. An additional consideration is the opportunity presented by ag biomass products with little value to the farm such as soybean stubble. A reasonable retail value for a ton of ag biomass pellets could be considered $225, slightly less than premium wood pellets. At a $75 pelleting fee, anything less than $150/ton raw hay/biomass value yields a potential profit back to the farmer. Based on interviews with many Hudson Valley farmers, their investment in low-quality hay is anywhere from $50 to $100 per ton – which would result in a potential profit of $50 to $100/ton. Using the higher end of this range, a farmer might add $10,000 to his annual net income by pelleting and selling 100 tons of biomass pellets. This quantity could comfortably be harvested from 40 acres of marginal land(assuming a conservative per/acre yield of 2.5 tons) – a reasonable amount of additional hay harvest for most of our commercial livestock, hay and truck crop operations. Although $10,000 is not alone an overly impressive figure, our project concept was always for biomass production to be a supplement to help diversify and provide options for farms in combination with other innovative business practices, and we believe this goal can be achieved. Beyond economic considerations, the development of a regional, sustainable energy network is a goal that must be afforded importance, and ag biomass holds the potential to contribute greatly to such an effort.

As noted in the first report section, identification and development of a reliable market for ag biomass pellets is the key to realization of true economic improvements and improved sustainability on these demonstration farms and in order to expand this opportunity to other NY farms.

Knowledge Gain

One of the key knowledge gains as a result of the project was the contrast in recommended management of hay intended for biofuel usage as opposed to forage usage. While it was generally understood that hay destined for pellets did not need to be 'forage quality', the involved farmers gained a thorough appreciation for the desirable qualities of pelleting raw material. Ash content is a key concern with hay pellets, and the coarser, more stemmy and less leafy the ag biomass material, the lower the ash content. For example, anecdotal information from an ag biomass pellet producer in Dutchess County indicates that properly managed and harvested ag biomass dominated by Goldenrod produced pellets with ash content in the 1% range. Reportedly, the Goldenrod was overmature and most of the leaves shattered so were not picked up by the harvester. In addition, this producer has a regiment of 'retting' (field weathering) thought to contribute to improved pellet quality. Less intuitive is the understanding that nutrients often associated with high-yielding, high (forage) quality hay can contribute not only to higher ash but also to 'clinkers' – solid non-combustible masses that can confound the operation of some heating appliances, and may elevate stove integrity and air quality concerns. 'Leaching' hay in the field as noted above has been discussed in biomass heating literature/research, and is thought to provide a means to reduce nutrient levels. Our limited testing data on 'leached' vs. 'non-leached' hay/pellets did not show a dramatic difference in ash content or nutrients. However, we did gain an understanding that hay for biomass required an entirely different management approach than 'conventional' forage hay management. Despite best management efforts, though, an over-arching emerging need for a successful ag biomass initiative seems to be robust heating appliances that can handle – and be adjusted for – biomass materials of widely varying characteristics. As important of a goal that uniformity of raw material is, real-world factors on the farm will limit this goal.

An additional knowledge gain could be described as opportunity recognition. We understood from the beginning of the project that pelleting of hay would be an income-boosting *option* for farmers – not a replacement for forage hay sales. This concept was refined as – during the course of the project – cooperating farmers encountered such circumstances as failed seedings and idle fields being brought back into production. Often, such fields were harvested simply to remove undesirable biomass before establishment of other crops. Pelleting of such materials then becomes a means to turn a 'no-value' material into a potential income-producing material. Hay intended for forage, but rained on unexpectedly, becomes another biomass 'opportunity'. Already discussed was the use of low value ag biomass materials such as grain crop stubble for biomass material. Our experimentation with such materials as soybean stubble, corn stover, winter-harvested hay and straw, and hay mixes characterized by species not normally considered to be of agricultural value (for example, Goldenrod, Multiflora Rose and other common miscellaneous herbaceous species) helped to solidify the paradigm of ag biomass pellets as a potential profitability booster that might be used as an opportunity to 'turn lemons into lemonade'. In any given year, a farmer might have a great deal, or very little, biomass material suitable for pelleting. The

key point is that having this *option* provides a certain level of resiliency to the farm operation.
Storage/handling options for pelleting raw materials was an another area in which knowledge was gained. It was understood that indoor-stored hay would provide for more uniform moisture content, and generally speaking uniformity is a highly desirable characteristic for pelleting raw materials. In the course of the project, we gained a much better understanding of the ideal moisture content to strive for in terms of efficient and effective pellet production, and found in fact that indoor-stored material can in some cases be too dry. While 12-15% could be considered an ideal moisture range for our pelleting system, indoor-stored hay was commonly encountered in the 6 to 8% range. Steam can expand the acceptability range, so in general too dry is preferable to too wet.
Outdoor storage is an important issue since roof space on farms is normally at a premium. If hay destined for pellets could be stored outside, it would open more possibilities for farmers considering this option. At the Sanford farm, we did make pellets from outside-stored large round bales, however, wet spots in the bales caused some hiccups for our equipment line – particularly for the hammer mill power feed at the front end of the pelleter trailer. Recent upgrades to the power feed are expected to reduce clogging issues associated with wet material, but certain parameters will still be necessary to be met in order to avoid operational issues. We and other pellet producers have experimented with bringing outside-stored bales under cover, ideally in combination with raising them off the ground. Often, removal of the outside or at least the bottom of these bales is necessary in order to allow for processing them into pellets. These procedures obviously add handling costs to a process that does not leave a great deal of room to play with in terms of profitability. However, the stream of materials available for ag biomass pelleting would increase dramatically if an economical way of handling outside-stored bales can be refined. This area needs more focused attention.
Through our extensive experimentation with different pre-processing approaches, we solidified our early prediction and understanding that baling was in theory an un-necessary and cost-*increasing* step in the pelleting process since more energy must be expended in breaking bales apart before further size reduction can be accomplished. Equipment that can handle large round and square bales – the most economical form of bale handling – is large and expensive. In our work at several of the cooperating farms, including Weist, Brown and Ford, we were able to experiment with feeding the pelleter with field-chopped, bulk- stored ag biomass materials. This by far seems to be the most efficient method of making pellets. However, the logistical challenges associated with this approach are considerable. This approach can work if the farmer has time to field chop material and deliver self-unloading wagons to the pelleter where they can be unloaded directly to the hammer mill power feed. But this can happen only in limited time windows – when weather conditions permit harvesting at the same time the mobile mill is at any given farm. In order to allow for operations in varying weather conditions and at various times of the year, and allowing for getting the mobile rig to many different farms, storing and handling of hay as bales almost becomes a necessity unless the farm has facilities for storing and handling large quantities of low-density chopped materials. As alluded to above, such storage space on a farm is often allocated to higher-value materials. So, having the capability of ‘pre-processing’ large baled hay is considered to be a requirement for our business model. A tub grinder with a conveyor outlet that can feed directly into our

hammer mill power feed has just been purchased and is expected to be the optimal way to handle baled hay. Initially we will operate the tub grinder off of a tractor PTO, but ultimately we expect that running the tub grinder with an electric motor powered by our gen set will be the more optimal arrangement. Whether feeding from a self-unloading wagon or a tub grinder, our goal is to power the pre-processor with our gen set and to allow for the pellet mill operator to control the feed rate from the pre-processor (for example, with a hand-held remote control) while monitoring and adjusting the controls on the pelleting trailer. Such efficiencies of operational expenses will be essential to maintain a reasonable level of profitability.

Knowledge gain will undoubtedly go on continuously with field experience, but the above provides an overview of key knowledge gains to date.

Outreach

Our project outreach efforts were undertaken seriously and continuously, but with an underlying restraint. We observed some outreach efforts by another northeast US mobile pelleter project early in the history of our project where the proto-type pelleter was brought to a biomass field day event, but the operators could not produce pellets. Our team always felt that, while there would never be a 'no-risk' public relations opportunity, premature roll-out could do more harm than good in terms of generating interest and support. Similarly, a start-up company in Pennsylvania was advertising a mobile pelleting system via a website and other media several years ago before they had proven the concept. Ultimately, that pelleting system was abandoned and the company turned to a briquetting approach.

Given these and other examples of the challenges of developing a viable mobile pelleting system, HVGE was careful to avoid a similar premature roll out of our equipment line. Nevertheless, outreach was emphasized in other means early on in the project. Our early relationship with SUNY Cobleskill afforded considerable outreach/publicity for the project amongst staff, students and visitors to the college, as the pelleting equipment line began to take shape on the Cobleskill shop floor. Professor Robert Rynk, our primary faculty partner, participated in an alternative energy workshop at SUNY Ulster in Stone Ridge early on in the project where he and other HVGE team members highlighted the goals and accomplishments of the project.

Once the HVGE mobile pelleter was moved from Cobleskill to the Hudson Valley and project staff was hired, our Project Manager, Libby Murphy, made outreach a focus of her duties. She was a regular contributor to the Grass Energy Blog, sponsored by the NY Biomass Energy Alliance. An HVGE informational piece was featured in the Agfocus newsletter, a publication of Orange/Ulster Cooperative Extensions. Ms. Murphy developed a Wordpress-based website where up-to-date project reports and related materials were posted on a regular basis (the webpage is now hosted by Orange County Soil and Water Conservation District (ocsoilny.org). Shortly before her departure from the project to return to graduate school, Ms. Murphy oversaw the completion of a video that showed the HVGE mobile pelleter in operation and interviewed key project staff and cooperating farmers. At this writing, the video had received 2400 views on youtube.

Outreach efforts were made to many heating appliance manufacturers, with several successful partnership activities resulting. These included: 1) Greenheat, a distributer in Ulster County, burned HVGE pellets in

their show room, and participated in a biomass stove demonstration field day organized by HVGE in March, 2011. 2) LEI Enterprises, manufacturer of the Bioburner multi-fuel heating appliance, conducted a trial burn of HVGE biomass pellets in their Bioburner unit and participated in the same stove demo field day. 3) Several other stove distributors were provided with HVGE biomass pellets for trial burns. 4) Harmon company was contacted by one of HVGE's team members, Kevin Sumner, via a local distributor to obtain their concurrence that grass pellets could be burned in their multi-fuel stoves without performance issues or voiding of warrantee. Ultimately, Mr. Sumner purchased an Enviro M-55 multi-fuel stove which was clearly endorsed by the manufacturer for use with grass pellets.

The stove demo day mentioned above included three multi-fuel heating appliance distributors, Ernst Biomass (a switchgrass pelleting initiative associated with Ernst Seeds of Pennsylvania), and the HVGE mobile pelleting system as exhibitors, with approximately 50 attendees. Shortly after this event, a biomass heating field day took place at the Town of Warwick (Orange County) Town Hall. The Town has committed to the concept of installing biomass heating systems in Town facilities and purchasing biomass from farmers within the Town, largely as a result of outreach efforts by HVGE.

Other formal outreach events in which HVGE participated included: 1) Biofuels Panel at SUNY Orange 10/14/2009 (Ms. Murphy and John Brown presented), estimated 50 attendees; 2)Orange-Sullivan Dairy Trade Show, March, 2010, Ms. Murphy and Mr. Sumner presented on the HVGE project, estimated 150 attendees; 3) Heat Northeast Conference, New Hampshire,April, 2011, Ms. Murphy presented on HVGE project; 4) Heat Northeast Conference, Saratoga, NY, March, 2012. Mr. Sumner and Mr. Brown presented on HVGE project, estimated 100 attendees.

HVGE also began to develop a working relationship with RECAP of Middletown, NY (Regional Economic Community Action Program), an authorized home/business energy audit provider, in 2010/2011 to promote the installation of multi-fuel heating appliances in conjunction with energy audits and upgrades undertaken by RECAP. This relationship holds good potential once a better list of residential scale central biomass heating appliances is available.

HVGE has yet to undertake a formal 'roll-out' of its pelleting system at a large public venue, but hopes to do so in late summer or fall of 2012.

Other project deliverables that could be considered outreach include the preparation of a detailed operator's manual, and a 'design concept paper'. The OM, although prepared specifically for operation of our custom pelleting system, is expected to be of significant value for others considering similar biomass pelleting initiatives as it includes such sections as site evaluations, start-up procedures and safety considerations that will be relevant to most similar projects. The design paper presents a comprehensive discussion of our team's thought processes and problem solving approach from the original concept discussion and 'envelope sketch' to our current state of operations. Both of these documents are included as appendices to this final report.

Industry Changes

Changes at the farm level and lessons learned by farmers as a result of this project and of outreach efforts have been discussed in previous final report sections. Changes at the Weist farm are probably the most significant, where experiences gained have compelled the farm owner to convert his home heating entirely to biomass from oil. In addition, he has begun to identify fields that will be targeted for biofuels production (though, as noted previously, even these fields will planted and managed in fashion that allows

for their use for forage hay if conditions dictate). Much of our experimentation with direct feeding of field-chopped hay took place at the Weist farm, and the success of these experiments caused Mr. Weist to secure an additional self-unloading wagon to facilitate uninterrupted pellet production as wagons are filled in the field and brought to the mobile pelleter. Mr. Weist fully expects that he will be able to produce ag biomass pellets in excess of his personal needs and is anxious to develop a list of customers. Several 'neighbors' have expressed interest, and one scenario that may demonstrate a highly efficient delivery method is for relatively near-by customers to bring a bulk storage device – such as a gravity wagon – right to the farm where it would be loaded directly from the mobile pelleter. One neighbor currently feeds corn to a biomass heater in his garage/shop with a gravity wagon and is interested in purchasing grass pellets.

Other participating farms, including O'Dell and Ford, have grain bins on the farm are contemplating using them to store store ag biomass pellets – primarily for on-farm use, but also potentially for sale. Mr. Ford hopes to heat water in his milking center with his own biomass pellets. Mr. Ford has purchased a press, and has been producing soybean oil. He envisions his dairy operation moving more and more towards self-sufficiency with biomass pellets as part of the diversified approach. After a several year hiatus, the O'Dell farm just began milking cows again in May 2012, so will also have potential uses for heating pellets beyond their residential heating needs.

Farm Success Stories

The farm success stories that have resulted from this project have been discussed at some length in previous final report sections. We feel the most successful story is the changes at the Weist farm. We also found the activities at the Tantillo farm to provide great encouragement for future expansion of the project. As noted previously, the potential market for biomass pellets at Hudson Valley greenhouse operations is tremendous. The sale of several tons of rye straw pellets from Tantillo's to a nearby greenhouse operation, and their success in co-firing these pellets with corn to heat their greenhouses, helps to demonstrate that this potential can be realized. Tantillos is a diversified operation that includes a substantial orchard. They own a large grinder that serves to process the large quantity of orchard prunings they generate each year. An experiment was conducted while the mobile pelleter was at this farm to utilize some of the orchard prunings for pellet production. This experiment was not successful due to the high moisture content of the prunings. But this example helps to demonstrate the many different potential ways in which Hudson Valley and NY farms might take advantage of biomass heating opportunities – in some cases using materials with little alternate value to the farm. Creative thinking will be required, for example, a subsequent experiment involving the orchard prunings is to field dry the branches before processing to see it enough moisture can be removed using free solar power. Other potential ag biomass materials that were discussed, in this case at our stove demo day at the Tantillo farm, include a tomato farmer who contemplates using tomato vines. No experimentation was done with this material, but it further demonstrates the long list of possible ag biomass materials.

Photos, Presentations, Charts, Publications

Design Concepts (Design_Concepts_Mobile_Grass_Pelleter.pdf)

5/1/11 This document describes the thought processes and problem solving for the HVGE mobile pelleter

project from initial concept to current status.

operator manual (HVGE Pellet ALL.pdf)

5/1/11 This document is a detailed manual of operation for the HVGE mobile pelleting system. Included as an appendix is a HAZOP evaluation.

Grass Heating Appliances (grass_heating_appliances.pdf)

5/1/11 This document provides a current list of heating appliances, including residential stoves and small commercial furnaces and boilers, that are fully approved or show good promise for grass/ag biomass pellet combustion.

Design Concepts (Design_Concepts_Mobile_Grass_Pelleter.pdf)

5/1/11 This paper describes the thought processes and problem solving that occurred throughout the project from original concept discussions to the present configuration of the mobile pelleting system.

Final Report Summary Statement

The potential for renewable, clean-burning biomass heating to displace fossil fuel usage in the northeast US and support the struggling farming industry is huge. Progress in Europe in Canada demonstrates that the potential can be realized, but several major issues need to be solved. One of these is the issue of transportation of low-density, low value biomass to processing facilities. The Hudson Valley Grass Energy project addresses this issue by demonstrating that factory-scale equipment can be assembled on a mobile platform that can be BROUGHT TO THE FARM to economically produce heating pellets. HVGE's one-of-a-kind machine made pellets from various ag materials at eight Hudson Valley farms from 2009 to 2012 proving the concept of the project. The second major issue is the development of markets for these pellets. Many groups are working on this issue, and once markets open the full potential of the project can be realized.