IPRO 349: Solid Fuel From Biomass For Cogeneration

Final Report

December 8, 2008

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1. Introduction

As the demand for energy increases and our society continues to move toward sustainability, renewable energy sources, especially biomass, continue to increase in popularity. Furthermore, as the U.S. population increases, the demand for energy increases as well; however, the production of energy is not expected to fulfill this demand in the next few decades. As a result, interest in biomass is even furthered. Currently, the technology and infrastructure exist to harness the energy from biomass, but, unfortunately, initial investments in biomass technology tend to be relatively high, and this innately repels investors. Additionally, since a significant portion of the biomass that is being used today can be used for food, social issues can hinder the development of biomass technology by attaching a negative image to its use.

IPRO 349 addresses these issues directly, and aims to develop a practical, efficient, and inexpensive system to harness the energy from biomass via cogeneration of heat and power, without utilizing food sources. Thus, for our project, corn stover, the waste that is left on a cornfield after a farmer harvests the corn, was perfectly fitting. Using corn stover as a source of energy offers many benefits: economically and socially. Among other positive benefits, it helps to reduce dependence on foreign oil; it helps to reduce carbon dioxide emissions, and it helps to reduce the need to use food for fuel. Also, it adds value to what was once considered waste.

Equally imperative to our goal was the use of cogeneration of heat and power (CHP). CHP is much more efficient than conventional heating and electrical systems. In a CHP process, the heat that is released from the generation of electricity is used to heat an area, instead of going to waste. Since CHP technology already exists and has undergone many improvements, we could use it to develop a practical, efficient, and relatively inexpensive system.

2. Background

IPRO 349 of the 2008 Fall Semester is comprised of a diverse group of IIT students hoping to solve one of today's most pressing global issues. The worldwide energy shortage is a major problem for our generation and will only continue to escalate in scope and consequence in upcoming years. IPRO 349 has taken a great leap forward in proposing and analyzing a possible solution to this problem. Our solution is specifically made so that farmers will be able to implement the process quickly and without much new equipment. Our proposed solution would be environmentally friendly, sustainable, and would not compete with the global food market, nor require vast amounts of energy for pre-processing.

Renewable energy is one of the most important and widely researched topics today. It is classically defined as any form of energy that comes from replenish-able sources and, for all practical purposes, cannot be depleted. This may include solar, wind, or geothermal power, as well as biomass or biofuels. When considering biomass, or any living or recently dead biological material, the chemical energy of the molecules is generally collected through the process of combustion.

The area of liquid fuels from biomass has gained much notoriety and support in recent years. This is due to the lower emissions and clean-burning nature of these fuels when compared to more traditional approaches, as well as the obvious renewable nature of the starting material. While vegetable oils or animal fats can be used as a replacement for diesel fuels, corn, switch grass, or other grains are more widely used to produce ethanol for use in common combustion engines. Today's E85 fuel is sold to customers with a chemical makeup of 85% ethanol and 15% gasoline. However, one of the main downfalls of processing ethanol from biomass uses the actual ear of corn, which takes away from a very large source of food worldwide.

The use of solid biomass in forms such as briquettes or charcoal as a direct supplier of energy, however, is an area still left relatively unexplored in this growing field. In theory, and as preliminary research suggests, harvesting energy directly from solid biomass may be considerably more efficient than gathering it from its processed liquid counterpart. In fact, some studies suggest that the energy acquired from burning ethanol is up to 67% lower than is contained in the plant cellulose from which it is derived. *(http://www.ethanol-gec.org/information/briefing/20a.pdf)*

There are, however, several other factors besides energy projections to consider when looking at the economic viability and marketability of such an approach. One of the main advantages of liquid over solid fuels, for example, is the ease of transportation and storage at a much lower cost. Additionally, the feasibility of developing a whole new process of biomass collection and processing must be balanced with economic and logistical constraints. This includes not only careful analysis of energy and cost balances, but also in-depth examination of all equipment, manpower and environmental limitations. For the purposes of this project, cogeneration, or the simultaneous generation of both electricity and useful heat, will be examined with a focus on a smaller scale, which may be a few farms, houses, or businesses, so that large-scale projections may be made for the future.

3. Purpose

Currently, social, economic, and political forces are pushing the U.S. toward sustainability. IPRO 349 was established to propose an alternative solution to the current energy crisis. Specifically, we will consider the viability of sold fuel from biomass. Corn stover was chosen because it is the natural waste product of our current corn industry, and has been shown to have a large yet untapped energy content. With our approach, it may be possible to utilize what would otherwise be considered "waste" to produce useable, renewable energy. Also, cogeneration, or the simultaneous generation of both electricity and useful heat was examined for its high efficiency. The ultimate goal was to develop a practical, efficient, and inexpensive system for the cogeneration of heat and power using corn stover that could be proposed to an investor.

4. Research Methods

At the beginning of the semester, our team divided into two sub-teams: an administration team and a research team. One to three individuals were assigned the task of researching a specific step in the overall process. Many resources were utilized in conducting our vast and diverse research; we contacted companies, performed Internet research, read relevant articles, invited visitors, attended a presentation on the future of energy, and visited a 5,000-acre farm.

To determine what equipment we would use (i.e. grinders, pelletizers, silos, and boilers and turbines for CHP), we used the Internet to peruse a range of products sold by different companies. Afterward, we contacted certain companies in an effort to collect specific information on each item. From the information we obtained, we chose the optimal products for our scale and purposes. We also used the Internet to obtain facts and conversions so that our calculations could be as accurate as possible. For example, the website of the U.S. Department of Energy provided information on the prices of energy, gasoline, diesel, and coal, which we used to calculate energy and monetary expenditures on harvesting, collecting, transportation, pelletizing, and cogeneration. Additionally, we used this and other information to revise and update calculations from the previous IPRO such as the pure potential energy of corn stover in the Midwest.

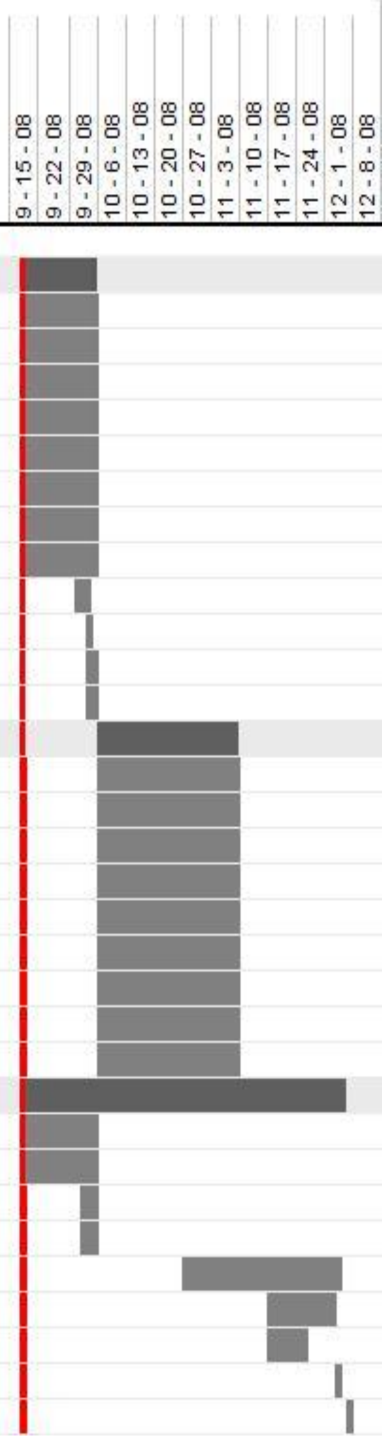
Among our most significant sources of information were the numerous research articles we read. From these articles, we were able to derive invaluable practical information. A particularly helpful article was the *Mechanical Properties of Corn Stover Grind* because it provided accurate data on the mathematical modeling of densification processes and densification equipment. Also, the article, *Costs of Harvesting, Storing in a Large Pile, and Transporting Corn Stover in a Wet Form*, offered needed information; the authors estimated the costs of harvesting corn stover in a single pass with corn grain, delivering chopped biomass to a storage pile, and storing stover in a wet form.

Our IPRO guests also made great contributions. We invited representatives from Red Arrow Products, Packer Engineering, and Viskase Companies Inc. They shared their very practical knowledge and discussed some of their experiences in industry. Their advice and suggestions assisted us in putting our project into perspective. The ADM presentation we attended at Northwestern University entitled, *Agriculture's Role in the Future of Energy* was also helpful in helping us to understand the importance of our project.

Finally, we visited the Pratt's corn farm in Dixon, IL. The farmers answered crucial questions, which helped us to come up with a test model. After visiting the Pratt's farm of 5,000 acres, we determined that the most appropriate farm size for our test model would be between 300 and 600 acres. We assumed a farm size of 400 acres for our test model.

Gantt Chart

WBS	Tasks	Name	Start	End	Duration (Days)
1	Research/Re-evaluation		9-17-08	10-03-08	16
1.1	Collection	Sung	9-17-08	10-03-08	16
1.2	Bunching	MinSoo	9-17-08	10-03-08	16
1.3	Transportation	Funso/Ken	9-17-08	10-03-08	16
1.4	Storage	Sangkyoung	9-17-08	10-03-08	16
1.5	Processing	Grace	9-17-08	10-03-08	16
1.6	Cogeneration	Tyler/Yeseul/Kelsey	9-17-08	10-03-08	16
1.7	Legality/Emissions	Branden/Sangkyoung	9-17-08	10-03-08	16
1.8	Economics	Ademola - Yeseul	9-17-08	10-03-08	16
1.9	Meet with mini-groups	Team	9-25-08	9-29-08	4
1.10	Mini Presentation	Team	9-29-08	9-29-08	1
1.11	Refine Presentation for Midterm	Team	9-29-08	10-01-08	2
1.12	Discuss Ethics	Sangkyoung/Ken w/team	9-29-08	10-01-08	2
2	Compile Data/Create Model		10-06-08	11-08-08	33
2.1	Collection	Sung	10-06-08	11-08-08	33
2.2	Bunching	MinSoo	10-06-08	11-08-08	33
2.3	Transportation	Funso/Ken	10-06-08	11-08-08	33
2.4	Storage	Sangkyoung	10-06-08	11-08-08	33
2.5	Processing	Grace	10-06-08	11-08-08	33
2.6	Cogeneration	Tyler/Yeseul/Kelsey	10-06-08	11-08-08	33
2.7	Legality/Emissions	Branden/Sangkyoung	10-06-08	11-08-08	33
2.8	Economics	Ademola/Yeseul	10-06-08	11-08-08	33
2.9	Develop Model/Flowsheet	Team	10-06-08	11-08-08	33
3	Administration/Deliverables	Branden	9-17-08	12-05-08	79
3.1	Project Plan	Branden/Kelsey/Ademola	9-17-08	9-19-08	17
3.2	Code of Ethics	Sangkyoung/Ken	9-17-08	10-03-08	17
3.3	Midterm Presentation		10-01-08	10-06-08	5
3.4	Midterm Report		10-01-08	10-06-08	5
3.5	Final Report		10-25-08	12-04-08	40
3.6	Final Presentation		11-17-08	12-03-08	16
3.7	Poster/Brochure		11-17-08	11-26-08	9
3.8	IPRO Deliverables CD		12-03-08	12-04-08	1
3.9	IPRO DAY		12-05-08	12-05-08	1



5. Assignment

<table>
<tr><th colspan="7">Research Teams</th></tr>
<tr><td colspan="7">Collect essential data via the internet, articles, books and direct correspondence with companies to evaluate the feasibility and details of the process of generating energy by using corn stover in Illinois.</td></tr>
<tr><td>Collection and Harvesting</td><td>Transpor-tation</td><td>Storage</td><td>Process</td><td>Cogenera-tion</td><td>Legality and Emissions</td><td>Economics</td></tr>
<tr><th colspan="7">Administration Teams</th></tr>
<tr><td colspan="7">Help produce the standard documents required by the IPRO office and help with other administrative items such as minutes, code of ethics, etc.</td></tr>
<tr><td colspan="2">Minutes</td><td colspan="3">Code of Ethics</td><td colspan="2">iGroup Maintenance</td></tr>
</table>

Name	Major	Year	Research topic
Ademola Adekola	CHEM	4th	Transportation, Economics
Oluwafunso Ajigbo	CHE	4th	Transportation, Minutes, iGroup Maintenance
Kelsey Camp	CHE	4th	Cogeneration
Grace Chee	BME	3rd	Process
MinSoo Kang	EE	4th	Process, Minutes
Sung Kim	MMAE	3rd	Collecting and Harvesting
Sangkyoung Lee	ME	4th	Storage, Legality and Emissions, Code of Ethics
Ken Ogata	CHE	3rd	Code of Ethics
Tyler Rhodes	BioChem	4th	Cogeneration
Branden Schombert	BME	3rd	Legality and Emissions
Yeseul Lee	CHEM	4th	Cogeneration, Economics

6. Obstacles

Our most difficult obstacle was getting accurate and adequate information from companies. The group contacted various companies such as Archer Daniel Midland (ADM), Monsanto and John Deere to get information about various stages of the process. These companies either responded with little information because they are also working on the project or directed us to other avenues to get better information.

Another obstacle encountered was deciding the scope of the project. The group had to choose between designing a large scale or a small-scale process, so we decided to have a team debate to elucidate the pros and cons of both a small and a large-scale operation. As a result, we were able to make a well-informed decision to focus on small-scale conversion of corn stover to useable energy via cogeneration.

As the second half of the semester approached, the team encountered new obstacles. Each team member had researched the energy usage and the operating cost of their respective process, but this information had to be put together in a clear, organized, and consistent manner. Thus, we were faced with a problem of standardization. For our purposes, standardization involved using consistent units and ensuring that the specifics on the equipment were appropriate for our scale. The equipment used in each step of the process had to be carefully selected in order to get the required input and output values for each step of the process. This allowed a smooth flow from one process to another.

In addition, finding equipment for small-scale analysis was rather tedious. Most of the equipment we found was almost exclusively for large-scale production.

The group had to look for proper scaling method to go from large-scale production equipments to smaller scale production equipments.

In conclusion, even though the team faced a considerable number of obstacles, we were able to overcome them and achieve the goal of the project.

7. Results

As our team analyzed the possibilities for a system, the importance of choosing a scale of study became apparent. Different operation sizes require not only different sizes of machines, but sometimes entirely different operations to ensure that the stover moved from one stage to the next. For this reason, our team divided up into teams which would present cases supporting both large scale and small scale operations, the results of which shall be explained.

Large scale operation seems to have many benefits, and from our discussion it was determined that this size of operation would in fact be ideal as it allowed large scale farmers to concentrate on harvesting the corn itself and left all the processing of the stover to a larger company which devotes itself to the stover. Specific benefits of a large scale operation by a large plant-like facility would include the creation of many jobs and the localization of a main facility which would reduce the costs that each farmer would have to invest to purchase all of his own equipment and to process the stover. In the large-scale operation with a company devoted to developing proper techniques to maximize the efficiency of the process, gasification becomes an even more feasible approach. As the gasification equipment itself is very expensive, it is possible that a farmer may not want to invest the money to obtain a more complex, technologically advanced system, even though it would result in higher energy yields at a 9:1 ratio (Schubert, Packer Engineering).

Additional benefits of gasification of corn stover include its ease of transport and storage, as well as an increase of operational efficiency.

Some of the disadvantages of large scale operation include the fact that its logistics are much more complicated. Transporting the stover from surrounding farms becomes an extremely important issue as the costs involved therein become all the more prevalent in the overall financial analysis. Also, the sheer gravity of something as large as a plant requires years of planning and often the combining of many subsystem ideas and plans to form such a large operation. The financial investment required to start a large scale operation can also be a disadvantage as the expenses of multiple large-scale machines, construction costs, and other components necessary to the functionality of a plant easily climbs into the million dollar range. The interconnectedness of such a large system suggests an increase in the complexity of the processes involved as it is necessary to accurately calculate and handle such a large mass flow throughout a plant.

Even though it was agreed upon that a large scale system would be the ideal goal and one that should be worked towards, the small scale system was viewed to be a temporary viable solution and one that should be constructed, analyzed, and proven before progressing to a large scale. The benefits derived from a small scale include its conventionality, the fact that transportation is nearly eliminated, the feasibility of investment for a small-scale farmer, and its potential profitability. The fact that farmers already have the tools to complete some of the critical stages expresses the conventionality of a small-scale operation. For example, some farmers today have the stover balers necessary to harvest and bale the corn from the field, and they would not have to add a stover-baler to their expenses. Bale processors, or grinders, are also a relatively conventional tool that is being used around farms today to distribute feed or break down bales for animal bedding. Silos are certainly an important tool being used by farmers today to store grain and other materials, and their characteristics and functional properties are well known by their respective owners. Transportation is another key issue to the process that could be the major downfall of a larger operation because of the large distance between a plant and its supplying farms. In a small-scale farm, which was assumed to be approximately 400 acres in our study, transportation was negligible as most trips were less than 6 miles. The equipment involved would also be simpler to operate and monitor since it must be done only by a farmer, rather than by multiple sub-teams of employees as in the case of a large scale operation. Most farmers would like to know how to operate the machinery so that in the case of equipment failure, they are able to repair it on their own, and thus, reducing professional repair costs. Pelletizers, though possibly foreign to farmers today, are relatively simple machines whose components can be easily broken down and analyzed to determine their functionality; thus the implementation of a pelletizer would not be all that inconceivable for a small scale farmer. Progressing in complexity, the cogeneration system is the most complex component of our process. Even so, when comparing the relative complexity of the engine used in our designed process to one that would be used in a large scale process, the necessary components to monitor and adjust, though similar in nature, are much more comprehensible than a large scale, multi-input engine that may be seen in larger facilities. The systemic simplicity of a small-scale operation, as described above and later in this report, lends itself to a much more marketable appeal, which would be necessary to persuade farmers to invest in such an opportunity. In addition, the profitability of the system should appeal to farmers. The excess electric energy generated by using a CHP engine that produces more energy than that required by an individual house may be sold back to the electric power companies at a certain price per kilowatt-hour for a profit. As the ratio of energy use to energy produced is quite low for most farms, this seems to be a truly viable option for profitability, especially for large-scale farms.

Some disadvantages that were found for the small-scale operation include the fact that multiple small-scale operations across a state or region would be inefficient when compared to a multi-farm or multi-county operation. Since farmers would all have to individually invest in the purchase of each component of the process, the overall cost per unit of energy gained as a region would be significantly higher than a large centralized plant; however, the benefit is that each farmer would have ownership of every BTU produced and he could sell the electrical energy back to the electrical grid and keep all of the profit. Another disadvantage, as stated previously, would be that some farmers might not wish to invest in the gasification process, regardless of the energy yields. As the energy produced from the direct combustion of stover is sufficient to meet both a farmers needs and their desire to sell back electric energy for a profit, the cost of buying more high-tech machinery and trying to learn how it works so they can repair it if necessary, as well as the comfort level involved with this process, outweigh the benefits of the final energy output ratio.

After compiling these findings, the team made a decision to research on the small scale level and to develop a feasible process pathway in attempt to make a small step toward the ideal large scale system rather than trying to conceive the project on a much larger scale and dealing with all of the inherent complications. Producing a logical and intelligent process was essential to the success of the team, and it required calculations of the input and output ratios of each step to make sure that the output of one process with a specific machine was logically fit with the input of another. The time required by the farmer to complete the process using the given machinery was also taken into account when calculating the output rate of each component. To begin to make these calculations, though, a basis had to be established.

After choosing to focus our research on a small scale system, considerations were made to determine exactly the size of the small scale. A contact with a farmer on a 5,000 acre farm lead the team to decide on using a 400 acre farm as the base for our test model. To begin figuring out how much stover the farm could actually produce, the ratio of every pound of corn harvested there was a pound of stover produced (1:1), was used along with the average bushel size per acre (4.9 tons), which resulted in a total of 1,960 tons of stover produced for the entire farm. However according to the American Agricultural Society, the current methods of harvesting stover only allow for forty percent of all the stover produced to be harvested from the field. So, figuring this in to the calculation, the net result of stover harvested from a 400-acre farm was roughly 784 tons. Using that information, the team was able to begin calculating energy usage throughout the process steps.

In order to calculate actual energy amounts and value of the stover produced, 784 tons were converted to pounds, resulting in 1.568 million pounds per acre. Using the fact that there is about 8000 BTU's per pound of corn stover, the total amount of BTU's gained from stover came to 12.544 billion. Converting BTU's to kWh using the conversion ratio of 1 kWh is equal to 3412.14 BTU's, the resulting kWh came to 3.676 million kWh. The current average energy rate per kWh was determined to be $0.104. This information gave us a grand total of $382,304 in value of stover per harvest.

To begin integrating our calculated figures into the process, the team looked at research by the American Agricultural Society. The first goal was to determine the cost of harvesting the stover from the fields. Stover can currently be harvested using conventional hay harvesting equipment, so the cost calculated for the project was that of the cost of fuel used by the equipment to actually harvest the stover. According to “Engineering Aspects of Collecting Corn Stover for Bioengineering” (Sokhansanj), it costs $24/ton to harvest, bale, and transport large round bales of stover within 5.8 miles which is appropriate for a 400 acre farm. However large square bales were less expensive at a price of $23/ton for harvesting, baling, and transporting. In addition, large square bales were easier to handle and stack than round bales with general volume dimension of 128 cu.ft and a weight of 1200 lbs. allowing for a better ability for the farmer to move and store them. The total cost of energy expenditure in these processes is roughly $18000. These were chosen as the ideal medium in our proposed test model.

After deciding the type of bales produced from the harvesting of the stover, a suitable grinding mechanism was researched in order to produce small enough particles to feed into the pelletizer. Several grinders were researched, however the Shenk Livestock-760 Rotogrind was chosen because it could handle a capacity of 5 to 30 tons per hour and specifically the larger square bales we had already chosen. The Rotogrind also had the advantage of being run directly from a tractor and producing particle sizes of 2 to 3 inches, fitting well within the limits of the necessary particle size for a majority of the commercial pelletizers.

The pelletizer was chosen based on a variety of criteria. The main point of interest was in processing the chopped stover as fast a s possible. This was considered most important because of how valuable time is on a farm in comparison to other tasks which need to be one in order to maintain it. The specific pelletizer considered for this was the La Meccanica – CLM 630N. This pelletizer had an extra large motor that could process up to 12 tons of grinded stover per hour. The larger size had a comparatively larger cost of about $93,500 but this allowed the farmer to finish pelletizing after about 65 hours of operation. The large amount of energy usage would be easily paid back later on as the operation would only be for a short period of time.

Once the pellets were produced, storage was considered as it would be necessary for year round operation of the CHP plant. For our system it was decided that the best material for year round storage would be a glass fused to steel compound which would prevent decomposition and have the structural integrity to hold a capacity of at least 1000 tons of stover. The company that had such materials was Harvestore. A rough of estimate of a 43000-cu.ft silo made of the specified materials was $47,000. In this cost is also included a loader and unloader system which will move the stover in and out of the silo when needed.

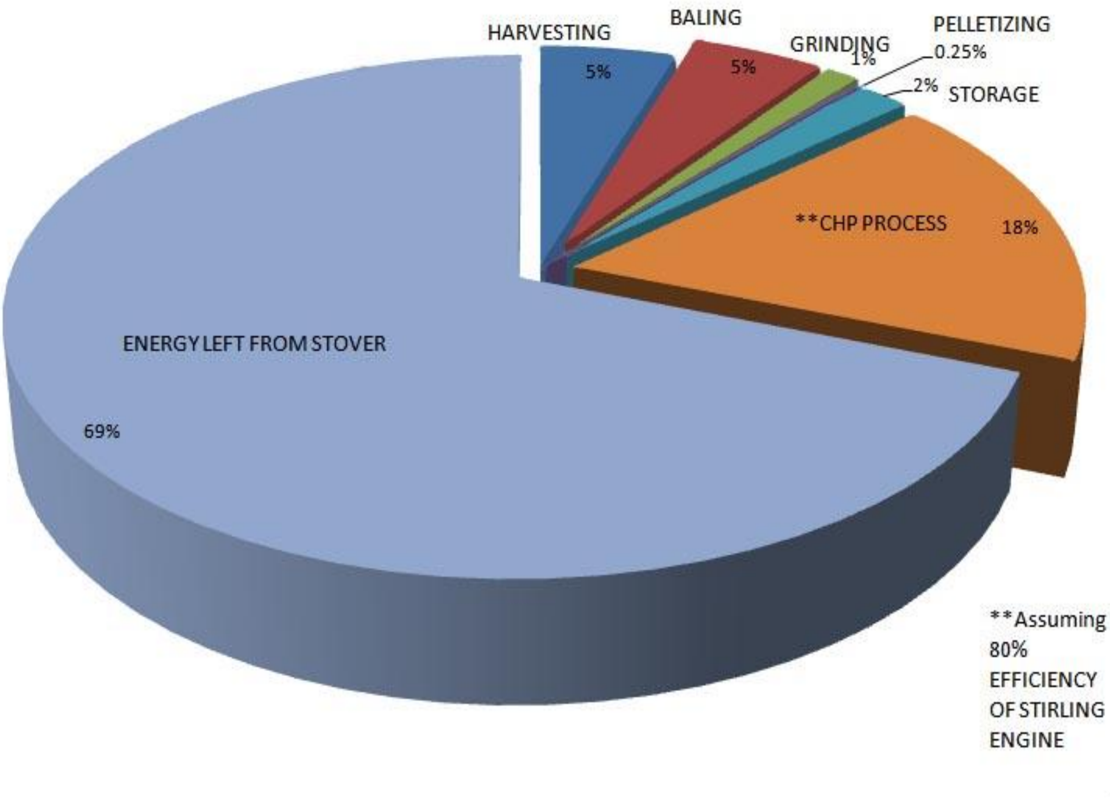
The CHP process was a large part of the project. A simple mechanism was required for the small-scale system. The original idea was to have a boiler and steam turbine mechanism to produce the heat and power. Research was done and the possibility of the gasification of stover was considered in use with a gas turbine and then steam turbine dual process. However, after much consideration, the gasification was left out as the team felt that the process of gasifying and purifying the gas was too complicated for a single farmer in a small-scale setup like this. Much time and effort was put into finding a steam turbine and boiler system that would be suitable for supporting a single house. This was one of the difficulties in developing the CHP process. Much of the equipment commercially available was overpowered and for an industrial use. For a small scale this was not useful. However in considering mechanisms for a large scale, this would work very efficiently (60%). Briefly researching for a larger scale, our team felt the most useful system would consist of a Hurst RG Biomass Fired Boiler. This boiler was setup to process bio based fuels and has a steam output of 3,450 to 60,000 pounds per hour which was more than enough to power a 50kW GE steam turbine, the lowest power turbine the team could find. The total cost of this system was estimated to be around $250,000.

In order to find a smaller system which could sustain a single farm, the team expanded the options to more non-traditional power generation which lead to the institution of the Stirling engine into our model system. The Stirling engine fit really well with our system. The setup we chose was the Stirling Denmark SD5 Stirling Engine. The mechanism to produce the power and heat allowed for a greater efficiency (80%) while reducing the power capacity. In the Stirling engine, the heat is transferred from the combustion of the stover pellets and to the head of the pistons. This allowed for the gas inside the tubes connecting the pistons to expand in series producing torque on a drive shaft. As the piston move down, the gas moved towards a heat exchanger, which was water-cooled. This cooled the gas, pulling the pistons upwards, adding addition torque. The water is then used in heating elements to provide heat to the household, whether it be space or water heating. This process is what greatly improved the efficiency of the system as the transfer of the heat only passed through two mediums, where a similar boiler and steam turbine system, with condenser included, would lose great amounts of heat as it passed through up to four different mediums. Also since the system was smaller than the initial steam turbine/boiler system, the price of the Stirling engine plant came was roughly

$100,000. The total power output of the chosen plant was 10 kWe and 40 kWth. This power level fit our model in two specific ways. The output could sustain the house without overpowering it and lose energy through excess heat. Also the input feed of the stover pellets could be fed at a steady rate of 24 to 32 pounds per hour, which allowed for a continuous supply over the course of the year with the possibility of having excess to sell back to the grid to make a profit.

The total cost for a small-scale system using the equipment selected would require an initial investment of between $260,000 and $300,000. However to the potential money saved through self-power and heat generation in addition to the possibility of selling power back to the grid to make a profit would allow a relatively short payback period.

After choosing all of our equipment, energy calculations were run to find out where energy was lost and how much net energy was produced by the end of all the processes.



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process, fuel was used to complete tasks. The largest amount of energy loss in these steps are in the harvesting and bailing processes, which cost a 630 million BTU's and 610 million BTU's respectively. Grinding cost 160 million BTU's, pelletizing cost the least with 32 million BTU's lost, and storing cost 250 million BTU's which included the use of the loader to move the stover in and out of the silo. The CHP did not cost energy, but since the system in itself is not perfectly efficient only 80% of the possible net energy can be harnessed, thus reducing the net energy by 2.2 billion BTU's. Out of the total 12.5 billion BTU's that are contained in 784 tons of stover, the end net energy product of that is around 69% or 8.6 billion BTU's.

8. Recommendations

While the Fall 2008 IPRO has succeed at developing and analyzing a test model consisting of specific equipment for each process, we have additional recommendations for future IPROs. We have contacted companies and gathered information for equipment specifications, but a future IPRO could look into equipment ordering specifications and conditions for test installation. Similarly, a unit operations safety review will need to be carried out that takes into account OSHA regulations.

For this IPRO, we have drafted an Excel spreadsheet, which gives the user the option to employ different equipment. The calculated data on the spreadsheet change as the user inputs specifics for different pieces of equipment. Another future recommendation is to develop an interactive database and website expanding from our rough spreadsheet. This way, anyone interested in implementing a cogeneration plant using corn stover could find all the necessary equipment and information in one place.

Since the next IPRO may begin looking into a large scale operation, another recommendation is to research the possibility of piping stover slurry. The next team could look into whether the stover should be mixed with water and sent through a pipeline: the possibility of using small enough stover particles to allow fluidized transport or some other option.

Also, one of the biggest expenses of farming is nitrogen for fertilizer. If there is a way to get a nitrogen by-product out of corn stover, farmers might be more easily convinced to start collecting corn stover, instead of leaving it on the field as waste. Also, the production of nitrogen for fertilizers is a very energy intensive process involving natural gas, and there may be a way to use corn stover as the energy source in nitrogen production, which may also be of great benefit to farmers.

Since we focused on small scale and simple processes, gasification was left as a recommendation for future IPROs. The gasification process is slightly more difficult and requires more equipment than direct combustion, but the energy yields have been known to be higher. The gasification of corn stover may be more viable in a large-scale setting as opposed to a single farm. Based on this team's research, gasification is more efficient and is recommended, especially for a large-scale CHP plant.

Lastly, we would recommend that the next IPRO expand on our work and develop a case for using corn stover in a large scale, centralized cogeneration facility. This way, many farms from the area could transport stover, whether by truck, pipeline or some other way, to a large facility. There, it would be processed and used as a solid biomass. This would eliminate the need for farmers to purchase many new pieces of equipment; and then they could just simply collect the stover and sell it. This recommendation is a large extension of the current project and could possibly be made into a separate IPRO.

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LaMeccanica.http://www.lamec-pellets.com/machinery_pelmils_menu.htm

Promill.http://www.promill-stolz.fr/

Small Scale Pellet Mills Manufacturers.http://www.alibaba.com/trade/search?Type=&ssk=y&year=&month=&industry=&location=&keyword=&SearchText=pellet+mill&Country=&srchLocation=&srchYearMonth=&IndexArea=product_en&CatId=0

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Acknowledgements

We would like to thank Professor Donatas Tijunelis for is continued encouragement and expertise throughout the semester.

Additionally, the following people have acted as key consultants for the research that went into IPRO 349:

- Dr. Keith McKee - INTM
- Dr. James Nelson - Director of Research, Illinois Tool Works, Inc.
- Dr. Myron Nicholson - Vice President of Product Development and Technology, Viskase Corp.
- Mark Matlock – Senior Vice President – Research, Archer Daniels Midland
- Peter J. Schubert, Ph.D – Senior Director for Space, Energy & Education Research, Packer Engineering
- John McKinney – Packer Engineering
- Paul DuCharme – Collagen Business Unit Manger, Red Arrow Products
- Mr. and Mrs. Andy Pratt – Dixon Farm Owners
- Jay Van Roekel – Segment Manager, Vermeer
- Dave Shenk – Midwest Representative, Shenk Livestock
- Christopher Scott – Director, Pelheat
- Larry Bubb – Illinois Representative, California Pellet Mills
- Jennifer Keplinger – IPRO Program Coordinator

10. Appendix

CONTACT LIST

Legend:
Company Name (# Replies/Correspondence)
Contact
Contact Info
Emails sent
Emails received

Monsanto (3)
Ranjana Smetacek
Director, International Communications
Office: 1-314-694-2642
Mobile: 1-314-540-5930

"Generic" email sent:

To whom it may concern,

I am part of an interprofessional project research team at the Illinois Institute of Technology looking into using corn stover, or corn waste, to produce solid fuel. We are currently considering pelletizing the corn stover for later processing and have come across your company's products. There are a few specifications we are wondering about in terms of your current pelletizers.
Firstly, we would like to know which of your products would be most ideal for processing and pelletizing the stover in large masses in the order of hundreds of short tons. Specifically, we would like to know what the ideal particle size would be to feed into these pelletizers, and if the pelletizers already include some sort of grinding mechanism. Could you also provide the efficiency of the pelletizer in terms of mass per hour as well as a cost estimate for the machine? We would greatly appreciate information on your products, as they could very well be a good addition to our project.

Respectfully,

Grace Chee
IPRO 349 Business Relations
gchee@iit.edu

I apologize for the delay in responding to you.
I really don't have anything on our stover work other than the press release issued with Deere and ADM.

I'd like to refer you to public sources such as the National Corn to Ethanol Research Center http://www.ethanolresearch.com/ (use the contact NCERC button on right)

This organization has done some good work on power generation and is also an Illinois state research institution.

Darren Wallis

"Generic" email sent.

Sorry for the delay in responding. Thanks for your interest in Monsanto and our research. It appears you have interests in two somewhat different topics: Biomass-based power generation and possibly also biochar (a charcoal-like residue left over from fast pyrolysis (a low budget thermochemical conversion method)).

We've provided a few links to projects and folks working on these technologies in the academic community. Our work is largely proprietary and as such these public repositories might be your best source of information.

Hope this is helpful.

Biochar - Randy Killorn or Rob Anex at ISU might be good contacts

http://www.biochar.org/joomla/
http://www.biochar-international.org/
http://www.biocharfertilization.com/biochar-at-iowa-state-university
http://en.wikipedia.org/wiki/Biochar
Biopower - Larry Johnson is director of ISU's "new century farm" and might be a good general contact
http://www.eia.doe.gov/oiaf/analysispaper/biomass/
http://www.iea.org/Textbase/techno/essentials3.pdf
http://www.nrel.gov/biomass/

Darren,

That's alright; I understand you must be very busy. Yes, it is true that we are looking into two different topics. Thank you for the links. I'm sure we will find them useful as we continue working on our project.

Grace Chee

Connie M. Armentrout
Director, Technology Licensing
Monsanto Company
Mail Code B2NL
800 North Lindbergh Blvd.
St. Louis, MO 63167
(314) 694-5898
Fax (314) 694-4540
Cell (636) 448-2645
connie.m.armentrout@monsanto.com

Mr. Quarles,

I am a student in Biomedical Engineering at Illinois Institute of Technology involved in a continuing Interprofessional Project(IPRO) this semester that deals with finding new ways of gaining energy from solid biomass. In particular, we have been looking into the possibility of using corn stover as a source of solid fuel biomass, including the idea of turning said stover into some sort of charcoal. We heard about your company's collaborative research into the subject from the article "ADM, Deere, Monsanto to Collaborate on Corn Stover Research" that was released just last month.

As an IPRO group, we are very much interested on what sorts of technologies and processes Monsanto is looking into, and if the current research is being done in consideration of a large-scale or small-scale industry. I'm at an understanding that Monsanto is working on the biotechnology regarding the actual plant growth and development. Could you elaborate or send my team in the right direction for more information on the subject?

Also, I was wondering if it would be alright to maintain contact with you or another appropriate Monsanto representative throughout this semester, and possibly further in the future, while we continue our work on this IPRO at Illinois Tech.

Thank you for your consideration,

Grace Chee
gchee@iit.edu
808.224.6046

Thanks for thinking of Monsanto! We appreciate the interest your group has in the stover project. Unfortunately, our work is still in the early stages so we are not in a position to share information with others at this point in time. Please see the references that are listed below. They may be of interest to your group.

The best of luck with your project.

Lee Quarles
lee.quarles@monsanto.com

ADM (2)
Beth Ragan
Corporate Communications

Email sent via Sung.

Thanks for reaching out to ADM. We are quite short-staffed here in communications, and thus are not able to commit the time needed to answer student information requests. Please visit our Web site, www.admworld.com, for general company information. We appreciate your interest and understanding.

Mark Matlock
Senior Vice President - Research
James R. Randall Research Center
1001 N. Brush College Rd.
Decatur, IL 62521

matlock@admworld.com
T: 217.451.2560
F: 217.451.2457
C: 217.412.1086
(Presented at Northwestern University)

Mr. Matlock,

On behalf of our project team here at the Illinois Institute of Technology, I would like to show our appreciation of your recent presentation at Northwestern University on the joint efforts of ADM and other companies into using corn stover for fuel. We would like to thank you for sending our team a copy of your presentation. Our team also feels it would be beneficial for everyone involved to keep in correspondence as more research and development is done in this exciting field.

Thank you again,

Grace Chee
IPRO 349 Business Relations
gchee@iit.edu

Grace,
It was great to meet you last week at the Chicago Council for Science and Technology. Your work using corn stover as a biomass fuel sounded very interesting. ADM is doing some similar work and Glenn Kimball (his email is CCed on this message) is an engineer involved in that project. If you would want to send him some details of your work I'm sure he'd find it interesting.

Best Regards,
Mark

Glenn Kimball
ADM Engineer
G_Kimball@admworld.com

Packer Engineering Inc. (2)
Peter J. Schubert, Ph.D
Senior Director for Space, Energy & Education Research
630.577.1928
pschubert@packereng.com
www.packereng.com
(came in to talk to the team about pelletizers)

Hello Mr. Schubert,

Our team has been working on furthering our process and have been running into some difficulties with getting actual price estimates from companies about their products. We were wondering if you could provide us with a "guesstimate" of approximately how much the pelletizers we are looking into would be.

Here are links to the two we have in mind now:

http://www.pelletmills.com/pelletmills.html

http://www.cpmroskamp.com/pelletmill/products/pelletmills/

We'd greatly appreciate your opinion.

Thank you,

Grace Chee

Hi Grace,

These look nice. I love the animation on the California pellet mill.

My two concerns for you would be: (a) power required, and (b) pressure applied to the pellet (needs about 18 kpsi to hold together, and that is just for large pellets). La Mechanica's power ratings seem a bit steep compared to the output of a farm-scale gasifier. The California concept uses an auger to convey pre-sized material, which introduces 2 additional problems: (1) you need a chopper prior to the pellet mill and a way to feed the auger's hopper, and (2) the lack of a commercial chopper which produces biomass which can be gravity fed.

On this last point, we did a test 2 weeks ago with a borrowed auger and a small 5 HP hammermill on corn stover. The material rat-holed in the auger, even with a 60 degree sidewall to the hopper. We could stack the size-reduced material to have an angle of repose of 90 degrees.

Sorry for the delayed response. Good luck!

Best regards,

Peter

Andritz (0)
andritzsprout.us@andritz.com

Illinois Department of Agriculture (0)
Terry English
Terry.English@Illinois.gov

Mr. English,

I'm a member of the IPRO-349 group and Mr. Tijunelis informed us of your interest in helping with information regarding research into using corn stover for cogeneration. I noticed that the articles posted on the USDA's Economic Research Service website have a lot of information about corn stover, but I have yet to find one that deals with the use of corn stover as a solid biofuel instead of being processed into ethanol. I was wondering if you have any knowledge of others' ongoing research into corn stover as a solid biofuel in Illinois or just in general. Our IPRO team is trying to gather as much information as we can on the subject as we look into further possibilities. Any suggestions would be greatly appreciated.

Thank you,
Grace Chee

Red Arrow Products Company LLC (2)
P.O. Box 1537 (54221-1537)
633 S. 20th St. (54220)
Manitowoc, WI

Paul DuCharme
Collagen Business Unit Manager
Cell: 920-323-0770
Personal cell: 708-724-5631
p.ducharme@redarrowusa.com
www.redarrowusa.com
Fax: 920-769-1281
Direct: 920-769-1108
(Came to speak to team in class)

Hello Mr. Ducharme,

Our team has been working on furthering our process and have been running into some difficulties with getting actual price estimates from companies about their products. We were wondering if you could provide us with a "guesstimate" of approximately how much the pelletizers we are looking into would be.

Here are links to the two we have in mind now:

http://www.pelletmills.com/pelletmills.html

http://www.cpmroskamp.com/pelletmill/products/pelletmills/

We'd greatly appreciate your opinion.

Thank you,

Grace Chee

Ill look at it tonight.

We have some costs on California pellet mills. These are top of the line pellet mills that Red Arrow would seriously consider purchasing for their manufacturing operations. It is possible they are overkill for your requirements and maybe a conclusion is that these pellet mill manufacturers should try to configure a lower cost mill to fit your team's actual needs. But here is the cost information, adjusted for the rise in Stainless Steel prices in the last 1 1/2 years. They include required ancillary equipment.

There are used, refurbished pellet mills on the market @ 50% of list price but not enough to fill all your needs.

Capacity	Mid 2007 Pricing	Est late 2008 Pricing
4.0 ton per hr	$566,000	$700,000
1.0 ton per hr	$298,000	$375,000
0.5 ton per hr	NA	$300,000

Hope this helps

Paul DuCharme

Mr. DuCharme,

Thank you very much for your estimates. This information will be useful in furthering our current cost estimates, and we will definitely look into scaling down these models to suite our particular needs.

Grace Chee

Dixon Farm Owner (4+)
Andy and Katie Pratt
Phone: (815) 739-8473
Email: kdallam@hotmail.com

Dr. Tijunelis -

Thank you for your email.

As Andy said, we are more than happy to host the student group anytime on anyday. Once harvest starts, the work doesn't stop.

The address to our home farm is 1574 Nachusa Rd., Dixon, IL 61021. It may be just as easy to get directions from mapquest, but here is my version:

Exit I-88 at Dixon. Turn right at the end of the ramp onto Rte. 26. At stop light turn, right onto Bloody Gulch Rd. Take Bloody Gulch Rd. to Rte. 52. Turn right onto Rte. 52, and continue to Nachusa Rd. Turn left onto Nachusa Rd. We are the first house on the right side. Large white house with wrap around porch and large grain storage facility (2 grain bins).

Let us know if you have other questions. Email or Andy's cell phone is a good way to communicate, as we are rarely in the house.

Katie

Dear Mr.and Mrs. Pratt,

We have discussed our available times as a team and have determined that about six team members are able to make a visit to your farm in Dixon this coming Saturday, the 11th. We are scheduled to leave the IIT campus at 7:00am so that we may arrive at your farm around 9:30am, and wanted to confirm this visitation with you.

Thank you again for your interest in our project and for allowing us to visit your farm during this busy harvesting season.

Sincerely,

Branden Schombert
IPRO - 349 Team Leader
bschombe@iit.edu

Grace Chee
Communications
gchee@iit.edu

I'll pass the word to Andy. I've had an unexpected family situation arise and may not be able to join you for your visit. If that is the case, I certainly hope you have a good experience on your farm and look forward to helping you and your group out in the future if we can.

See you Saturday (maybe),
Katie

Katie,

We're still eager to visit your farm even though you may still be working with soybeans. We would really like to get to talk to you in person and bounce some ideas that we have come up with off of you for using corn stover.

We are planning to stay at your farm for about two hours, from around
9:30 to 11:30, and then will return to campus.

Grace Chee

Grace -

Saturday is fine with us; however, we will not be combining corn.
We're still in soybeans and probably won't start into the corn until around Oct. 15.

Again, though, you are more than welcome to come out Saturday or any other time for that matter.

How long do you plan on staying that day? We'll want to make sure we can give you the information you need and let you see what you'd like to see in the appropriate time.

Looking forward to your visit,
Katie Pratt

We were happy to have your group. As we said Saturday, if you feel the need to come back out, feel free. Of if you have questions, please do not hesitate to ask.

Thanks,
Katie

Mr. and Mrs. Pratt,

We just wanted to say thank you once more for allowing us to visit your farm this past Saturday. We gained a lot of perspective in regards to what farmers would like to see from our project and future projects. We appreciate your hospitality (the cinnamon rolls and muffins were great!) and are hoping to keep in contact with you regarding any future questions and ideas that we may have.

Thanks again on behalf of our team,

Grace

Illinois Corn Organization (1)
Mr. Rodney M. Weinzierl and Mr. Loos
Executive Director
Email:
www.ilcorn.org
dloos@ilcorn.org
weinzier@ilcorn.org
Phone: 312-567-3940
309-838-5568
309-557-3257
(contacted via Jennifer Keplinger - keplinger@iit.edu)

Dear Mr. Weinzierl and Mr. Loos,

I work with a project-based learning program at the Illinois Institute of Technology. Currently we have a group of students working on a project that is evaluating the use of corn biomass as a solid fuel. For their project, the students are hoping to interview some corn farmers in Northern Illinois. Would you be able to put us in touch with a few? We'd greatly appreciate any guidance you can give us.

A more detailed description of the project is listed below. You can read more about our program, the Interprofessional Projects (IPRO) Program, at http://ipro.iit.edu.

Best regards,
Jennifer

Jennifer,

Here are 2 contacts for corn producers in Northern IL:

Steve Rush
95569 Ashe Road
Sugar Grove, IL 60554
630-461-9879

Paul Taylor
1419 Baseline Road
Esmond, IL 60129
815-751-4014

Let me know if you have more questions.

Rodney

[Bale Grinder]
Vermeer Corporation (2)
1410 Vermeer Road
P.O. Box 368
Pella, Iowa 50219 USA
Phone: (641) 628-3141
Fax: (641) 621-7754

Phil Chrisman
Solutions Specialist
Forage Solutions
Vermeer Corporation
641-621-7782

Grace,

Jay Van Roekel is the proper person to answer this request. He is out of the country this week, so he may not reply to you until next week.

As far as baling corn stover, Vermeer recently launched a 605 Super M "Corn Stalk Special baler". A unique, patented powered windguard allows unmatched baling capacity in corn stover over any competitor.

http://www.vermeerag.com/equip/mbalers/605mbalers/

If you do not hear back from Jay by next Thursday, please let me know.

Thank you for the inquiry,

Phil Chrisman

Jay Van Roekel
Vermeer Segment Manager

Grace
Phil has already mentioned the 605 Super M Corn Stalk baler - in stalks, most farms prefer the biggest bale available because they use them on their own farm. This means the bales are 72" diameter and 61" wide. when transporting in rural areas, the 5' width is acceptable. A full sized 605 bale in normal corn stalks will average around 1250 lbs. If trucking is needed on highways, 4' width maybe desired. The 605 Corn Stalk baler has a list price of $53,655 and would require 120 HP tractor to operate at peak performance level.

Processors - BP8000. this unit is designed to take a round bale and rip it apart, knocking some dust/mold out and then delivering the crop in a windrow for cattle to feed on or spread out for bedding. historically a standard BP8000 will not size the material consistently, perhaps a range of 4" to 20" and will complete a bale in less then 2 minutes. We have just released the Final cut attachment which will improve size reduction . the new Final Cut will deliver material down to 1/4" but will range up to 6" - better then the standard machine but will not be as consistent as a tub grinder but is much less expensive at around $30,000 list price and would require 100 HP tractor . Again the processing time is under 2 minutes per 6x5 bale.

http://www.vermeerag.com/equip/balepro/bp8000fc/

I am sorry we do not have specific efficiency numbers, there are so many variables on the farm; tractor size, operator ability, type of crop, crop moisture, crop maturity but will give you some general comments
Baling
1) Most users will gather 20' to 25' of material together into a windrow
2) Baling speed will be relevant to field crop condition - range will be from 3mph to 14mph. Our 605 Corn Stalk baler will stay on the higher side due to the new powered windgaurd
3) Most will make a bale in less then one minute. Most will use 3 to 4 wraps of net wrap to hold bale together and improve tying time compared to twine by 66% or more.
4) In our test, average conditions will produce a 1200 lbs to 1300 lbs corn stalk bale which is just over 9 lbs/cu. ft density

Processing
1) Will shred a bale in one to two minutes
2) Most of the twine and net wrap is captured on the flail drum - some will pass through
3) Is only for variable chamber round bales
4) Does not have screens to control particle size

Hope this helps,
Jay Van Roekel

Jay,

Thank you for your detailed reply. Our team is currently working on some calculations using the specifications you have supplied us with, and I think they will be very useful. Thank you for your help thus far and would appreciate it if we could continue to contact you if and when any further questions arise.

Thank you again,
Grace Chee

Shenk Livestock (5)
Homedale, ID.
Phone: 208-337-3895, 208-249-1718
Fax: 208-337-3895
shenklivestock@frontiernet.net

Dave Shenk
208-249-1718
(Also had contact over the phone. Sometimes prefers phone correspondence to email)

“Generic” email sent via their website.

Subject: Model 760 Roto-Grind tub grinder (grinding crop residue such as corn stalks)
Thanks for the inquiry into this grinder. These grinders are very affordable, user friendly as well as being versatile. I have sold units to dairymen who use them to grind crop residue for either rations or bedding.
I would be happy to discuss with you your desired uses, and that would help me to know how the unit would need to be equipped. At that time I would be able to give you a price quote. I am very new to the computer age and would be better able to help you over the phone. I can be reached at 208-249-1718. Grace, if you don't reach me leave a detailed message giving your phone number and time to return your call. I'm confident that the unit will be capable of handling the desired use. I look forward to hearing from you soon. Dave Shenk

P.S We have a 760 here at the feedlot and use it weekly. I owned one of their units before I became a dealer for Roto-Grind.

Thank you for your speedy reply. It would be great to speak with you over the phone to go over some specifications and further questions. My personal cell is 808-224-6046 and a couple good times to contact me is 11:30-1:00 on Monday or from 1:00-2:30 on Tuesday.

Grace Chee

Hello Dave,

We have been reviewing some of the specifications that you provided as well as those for the other components in our proposed process as of now. We believe that we will have a tractor that is over 150hp, which would work with the 760 unit. I believe you said this would allow the grinder to work at an average of 80hp. Is this correct?

Is it possible to get a cost estimate for the unit without the flare kit? You gave me an estimate of $19,800 over the phone at factory price with the flare kit. Another question we have is if the different hammers change the cost greatly or if that is included in the cost estimate you provided already.

Also, my team has been working on a presentation that we will be showing to the Interprofessional Project Office and were wondering if it would be possible to use your demonstration video from the Shenk website as a part of the presentation. It would be a great opportunity to show others why we think your tub grinder is one of our top choices in our process. Is it possible to somehow get a copy of the video from you?

Thank you,

Grace Chee

Hello Grace,

I'm getting better at this modern way of communicating, so here goes.....

The 80 HP is a minimum requirement to operate the unit. The actual horse power use will depend on the on the capacity desired, 150 HP will be very adequate and unit should perform very well(it should grind 60-70 1200# dry alfalfa bales per hour with this much HP).

The price w/o the flair is $19,060.00 F.O.B. , a $740.00 savings. Grace there are benefits having the flair but there are drawbacks as well. The flair allows stacking above the rim of the tub with minimal spillage,offering much more tub capacity. The draw backs of having the tub are, added cost of the purchase price and it makes the unit over-width for shipping, requiring additional cost for permits. The kit can be shipped with unit(obligating the purchaser to be responsible for kit installation) thus avoiding the permit fees for over-width shipping. I have a flair on my 760 and really enjoy the added capacity it provides,having said this we ran ours along time with out it and got along just fine. If you buy the unit w/o the flair and decide later that you want one I will sell it to you at my cost at that time plus shipping. I have done this with my other customers in past and wouldn't mind at all. If you order a grinder from me, we need to discuss the P.T.O spline requiremen
ts.

Choice of hammers will not change the price that I give you. I choose the hammers to order based on the materials you desire to grind. Wet, stringy materials(such as 3rd. or 4th cutting hay) or baled corn stalks need alfalfa hammers (540-1000 P.T.O speeds). Our unit is equipped with alfalfa hammers. Standard hammer configuration works well grinding other materials like grass or oat hay ,fine grinding alfalfa,tree bark at the 1000 P.T.O speed only.

Feel free to use any thing from my web site in your presentation ,including the video. I will try to get you DVD, can you use VHS as a second choice? I could send you a brochure about the unit that would give you their specs. I would need a mailing address.

Hope I've helped you,
Dave Shenk

Dave,

Thanks, this is very helpful information. It would be great if you could
get us a brochure and DVD, or VHS if a DVD is unavailable. You can send
it to my address at:

3241 S. Wabash Ave
Chicago, Il 60616
Box #188

Thanks,

Grace Chee

Hello Grace,

I will be going to visit my sales rep. the 18th. or 19th. and pick up some DVD's and will send one along with the brochure promptly. Grace, it will come to you in a yellow manila envelope with Shenk Livestock address
stamp on it and ATTN. Grace.

Thank you Grace,

Dave

Hello Grace,

I was going to pick up the DVDs from my rep,but he is having some health problems that interfeared with that happening. I called the factory and ordered some and when they arrive I will promptly send you them along with the litature to you. I'm sorry for the delay and will Fed-EX them to you.

Sincerly, Dave Shenk

Hi Grace,

Just thought I'd let you know that the vidio discs came yesterday afternoon and I shipped them via Fed-EX. They will go out today. Please let me know that you have received them when you have a moment.

Thanks, Dave Shenk

[Pelletizer]
Double Elephants (1)
www.ecvv.com
Henan, China

My name is Branden Schombert and I'm the team lead on a study concerning the use of corn stover for cogeneration. Our team was wondering what the cost of the (3)model:9pk--350--II was and what other models of similar power would cost.

Thank you for all your help,
Branden Schombert
and Grace Chee (Communications Department)

Dear Sir/Madam
Congratulations!
You have received an inquiry from ECVV.

Hi, Sir, thanks for your inquiry, Could you tell me your e-mail, I think it is much better we talk on that. My - mail: holyphant06@126.com

Here is the information you want to know:

Model: 9PK-350-II
USD2823/30KW
Spare parts for 350#: 2 pcs rollers: USD164, 1 pc mould *USD133.

Main data:
1) Capacity: 450-550 kg/h
2) Power: 30kW
3) Net weight: 750kg
4) Outside dimensions: 1,150 x 700 x 1,350mm

Any question, you can contact me freely.

Monicca Ren

Promill (0)
promill@promill-stolz.fr

"Generic" email sent.

Kahl Pellet Mills (0)
Mr. Martin Johnson
Amandus Kahl

770-521-1021
johnson@amanduskahlusa.com

“Generic” email sent.

La Meccanica (0)
pelletmills.com
General Enquiries: info@condex.co.uk

“Generic” email sent.
Additional email sent for specifics on the CN630N Model.

Pelheat (1)
Christopher Scott
Director
PelHeat Limited
Email: chris.scott@pelheat.com
Website: www.pelheat.com
Blog: www.pelheatblog.com
Guide: www.biomasspelletmill.com

Ademola,

Thank you for your email

Our product is still in development, however we hope it will be available before the end of this year.

Price: £20-£25 (Estimated)

Output Pellet Sizes: 6mm or 8mm

Energy Use: On average 5 litres an hour, the unit can also run on bio-diesel

Output Productivity: 100-300kg/h for wood pellets and high density materials and between 200-400kg/h for grass/straw pellets and low density materials.

Mobility: The unit will be completely mobile, can be towed by the average hatchbach or saloon and will be complete with a weather proof cover.

The unit will require the raw material to have a moisture content between 10-20%, and raw material input size for the hammer mill should have a diameter no larger than 1 inch.

Biomass Pellet Production Guide : www.biomasspelletmill.com

This guide provides detailed information on pellet production in a simple 10 step process. The guide is not specifically about the PelHeat unit, but pellet production in general, in small and large scale setups.

There are more details on Prototype MK1 on the PelHeat website in the Products section.

There is also lots of information in our blog at: www.pelheatblog.com

I will add you to our mailing list to inform you with more information. If you have any more questions please ask

California Pellet Mill Co. (1)
1114 E. Wabash Avenue
Crawfordsville, IN 47933
Tel (765) 362-2600
(800) 428-0846
sales@cpmroskamp.com

Larry Bubb
P.O.Box 109
Clear Lake, IA 50428
319-230-2075

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Thanks for the inquiry. California Pellet Mill Co. makes a complete line of grinding and pelleting equipment. This equipment comes in various sizes ranging from test lab sized equipment to high capacity production sizes. For example our pellet mills range from 2 - 800 horsepower depending upon your capacity requirements.

Corn stover is pelleted typically thru a 1/4" die. The product is ground in a hammermill thru a 1/4" screen prior to pelleting.

I am the sales representative for CPM in Illinois. Please let me know if I can be of further assistance.

Thanks again.

Larry,

Our team is still interested in using one of your products for our research purposes. We are now looking into more specific aspects of prospective pelletizers. We are currently hoping to find a machine that is capable of processing approximately 15 short tons. Is there a particular model that you think would best suit our needs? Would it be possible to get some specifications for a few pelleting machines in terms of tons per hour and energy usage? Also, we would greatly appreciate a cost estimate on some of these machines.

Grace Chee

[Storage]
Harvestore (0)
Hanson Companies
11587 County Rd. 8 SE
Lake Lillian, MN 56253
hscinfo@hansonsilo.com
http://www.hansonsilo.com

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TO CONTACT

University of British Columbia
Dr. Shahab Sokhansanj
Adjunct Professor of chemical and biological engineering
Phone: (604)827-5668
Email: shahabs@chml.ubc.ca

John Deere and Iowa State University Research Team
(Request detail information about the one-pass harvesting machine that was invented one and half years ago)

Stuart Birrell
Agricultural and Biosystems Engineering
(515) 294-2874, sbirrell@iastate.edu
Mike Krapfl, News Service, (515) 294-4917, mkrapfl@iastate.edu

University of Hawaii
(Request information on their current use of CHP with sugar cane)

4H Club
Bob Becker
Head of 4H extension
Phone: (815)739-8473

Biomass
Jane M F Johnson
(This person is an expert in biomass field, also has been doing lots of research related to biomass)
Research Soil Scientist
Jane.Johnson@ars.usda.gov
Phone: (320) 589-3411 ext. 131
Fax: (320) 589-3787
803 Iowa Ave.
Morris, MN 56267