IPRO 349: Solid Fuel from Biomass for Cogeneration

Project Plan

February 6, 2009

1. Objectives

The following are our objectives for the Spring 2009 semester:

-Survey the potential for CHP application using modified EPA guidelines

-Scale up from single to multiple farm system for corn stover conversion to CHP

-Identify future stover CHP options

-Investigate creation of an online database

2. Background

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 renewable 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, switchgrass, 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 is the use of the actual ear of corn, which prevents the valuable corn kernels from being used in other applications.

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.[1]

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.

IPRO 349 was established to examine these (and many more) considerations in the viability of sold fuel from biomass. Specifically, we have narrowed the scope of our research to biomass derived from corn stover (leaves and stalk left in the ground after harvesting) within the state of Illinois. Illinois was chosen because it is currently the largest producer of corn in the nation.[2] Corn stover has been shown to have an energy content of 5,290 Btu/lb. wet, and 7,560 Btu/lb. dry.[2] With such an approach, it may be possible to utilize what would otherwise be considered "waste" to produce useable, renewable energy, since the stover makes up 50% of the yield of a crop.[3] 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 larger scale, which may include community colleges, businesses, or other sizeable operations.

3. Methodology

Our main focus for this project is to develop specifications for the usage of solid corn stover as fuel for cogeneration of heat and power (CHP) at a larger scale than that of the previous teams. Our first step in the project is becoming familiar with the research, calculations and recommendations of the previous IPRO team in order to ensure we are on the same path as a team. We must initially devote majority of our time to researching because most specifications were chosen as best fitting for the CHP process on a smaller scale, not a large scale. Our team is then divided into three subgroups: survey, supply and conversion. In order to ensure each subgroup is making reasonable progress a leader is also selected amongst the three subgroups. Each subgroup conducts research and collects data in order to determine the equipment, storage, transportation and conversion process best suited for a larger scale system. The members of each team are then assign specific areas to research. The team will meet and discuss findings to their team members and the entire IPRO team during weekly meetings. During these meeting we will also discuss completed task, what we want to accomplish by next the next meeting along with deadlines and making sure we stay on task. We will also utilize the iGroups site to post important information and findings for the team members to review.

The final goal of our project is the development of the most reasonable process including equipment specifications for successfully carrying out the CHP process at a larger scale. We also want to have established one or more candidate(s) interested in the possibility of implementing the cogeneration system at their facility. In order to accomplish these two goals, we will need to determine the most economical way of storing, making the conversion from corn stover to energy and the effectiveness of the cogeneration process on the facility utilizing it. Careful calculation and analysis of the chosen cogeneration system will allow our team to obtain such results.

In order to accomplish our goals, we must spend time outside of scheduled weekly meetings to meet with our subgroups. As we proceed in the research process we will keep in mind alternative/combine processes that can be used and recommended for future teams to investigate. Each team member is assigned specific duties as shown below.

4. Team Organization

Research Team:

Help in collecting important information by using internet, articles, books and contacting the rural community colleges to determine the potential of solid corn stover for the cogeneration of heat and power.

- Team Leader: Tyler Rhodes – The team leader organizes the activities of the research and deliverable teams, conducts some research and makes sure that the team meets the IPRO deadlines.
- Sub-Team Leaders: Richard Bryne, Michael Clark and Elena Dorr – The sub-team leaders make sure that their sub-team members are consistent with their research, apart from researching on their own topics. They also carry out the responsibilities of a team leader if he is unable to make it to a meeting etc.
    - Ross Brazzale – Survey
    - Richard Bryne – Survey
    - James Cheever – Supply and Conversion
    - Michael Clark – Conversion
    - Elena Dorr – Supply
    - Jeremy Gibbs – Supply and Conversion
    - Katherine Lazicki – Supply
    - Abhishek Prabha Kumar – Conversion
    - Bertha Vandegrift – Survey
    - Robert Williams – Survey
    - Terrika Worthon – Supply
    - Xin Yi Yeap – Survey and Supply

Deliverables team:

Assist in getting the standard documents required by the IPRO office in time as well as helping out with other administrative tasks like meeting minutes, code of ethics etc. Everyone on the team is expected to lend a hand with a few final deliverables such as final presentation, poster, final report, etc.

- Team Leader: Tyler Rhodes – The team leader will oversee the activities of both the deliverables and the research teams besides conducting some research, compiling reports and being aware of IPRO office deadlines.
    - Terrika Worthon – minutes
    - Katherine Lazicki – minutes
    - Ross Brazzale – code of ethics
    - Tyler Rhodes – project plan compilation
    - Michael Clark – project plan compilation
    - Richard Byrne – project plan compilation

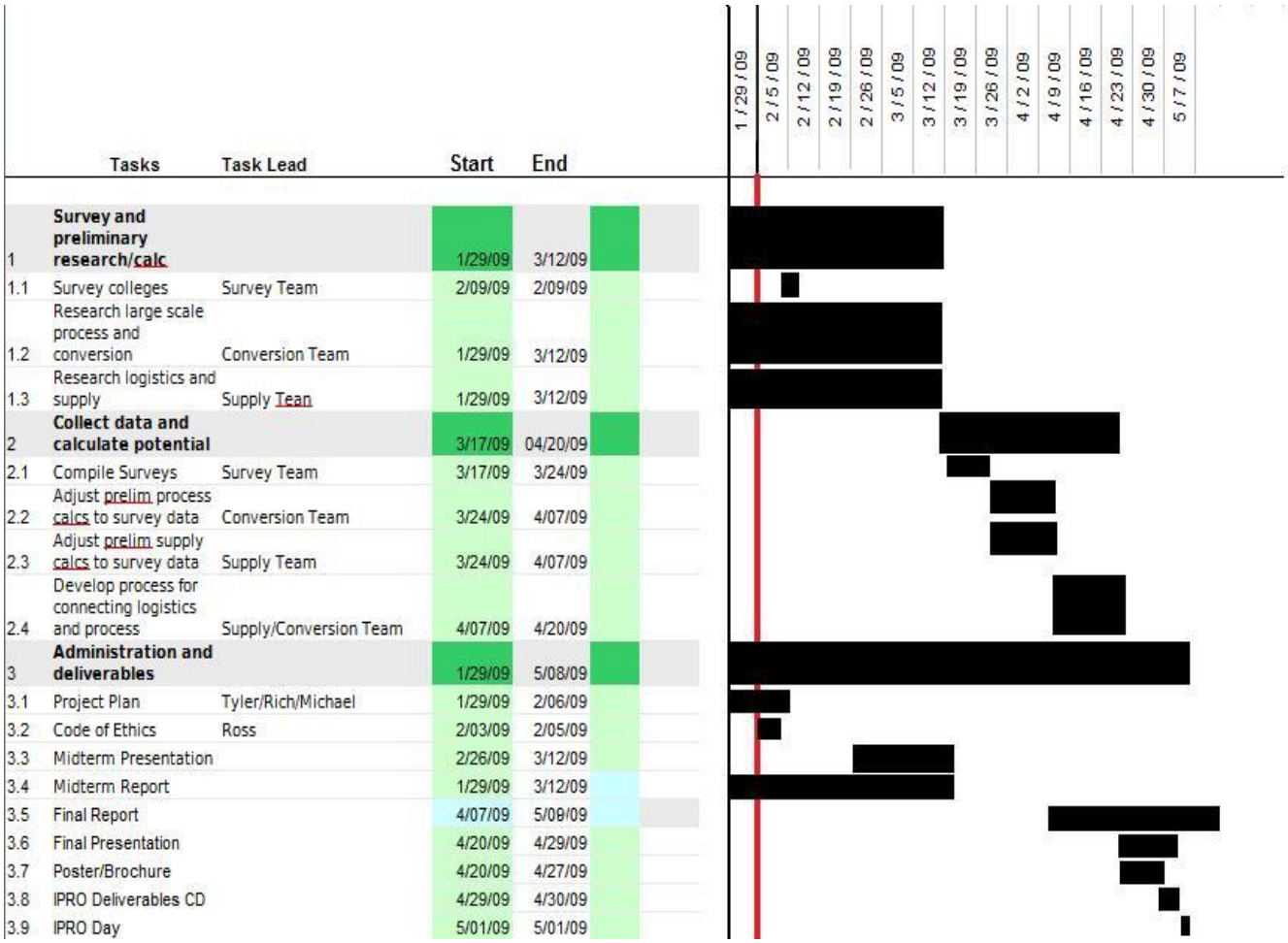
5. Expected Results

- By the end of the semester we plan to achieve the following results:
  - Propose equipment and processes for the conversion of corn stover to energy or electricity for use at a community college in Illinois based on research and investigation.
  - Generate and send a survey to at least 50 community colleges in rural areas based on EPA guidelines to determine feasibility of CHP at their locations. Identify potential candidates based on evaluations of survey responses.
  - Establish correspondence with potential candidates to further determine feasibility of a possible CHP project at their site and gain insight into their interest.
  - Create a supply plan including logistics and cost of corn stover shipment (scale up from previous IPRO).
  - Propose a viable solution for farm collection and storage requirements of corn stover (scale up from previous IPRO).
  - Identify at least five future corn stover CHP applications.
- Challenges, risks and assumptions:
  - Challenges include the number of corn stover applications. It will be important to balance investigating alternative applications/processes with choosing "best" application so that we can meet goals. Other challenges may include lack of interest from community colleges, difficulty in obtaining necessary information in a timely manner from candidates, investigation of supply and production methods stifled by information needed from candidates, and working as a team to coordinate efforts.
  - Assumptions include that the work done by the previous IPRO is accurate and that a community college is realistic application of corn stover CHP.
  - The main risk of our project is the focus of community colleges as there is the possibility they may not be interested or the application may not be practical.

6. Project Plan Budget

Expense	**Description**	**Amount**
IPRO Day Materials	Presentation board and handouts	$50.00
Transportation	Visits to farms and/ or Cogeneration power plants	$150.00
Team Dinner	Informal team-building activity	$120.00
Mailing Material	Envelops, Paper and Stamps	$40.00
	Total:	$360.00

7. Schedule



	Tasks	Task Lead	Start	End
1	**Survey and preliminary research/calc**		1/29/09	3/12/09
1.1	Survey colleges	Survey Team	2/09/09	2/09/09
1.2	Research large scale process and conversion	Conversion Team	1/29/09	3/12/09
1.3	Research logistics and supply	Supply Tean	1/29/09	3/12/09
2	**Collect data and calculate potential**		3/17/09	04/20/09
2.1	Compile Surveys	Survey Team	3/17/09	3/24/09
2.2	Adjust prelim process calcs to survey data	Conversion Team	3/24/09	4/07/09
2.3	Adjust prelim supply calcs to survey data	Supply Team	3/24/09	4/07/09
2.4	Develop process for connecting logistics and process	Supply/Conversion Team	4/07/09	4/20/09
3	**Administration and deliverables**		1/29/09	5/08/09
3.1	Project Plan	Tyler/Rich/Michael	1/29/09	2/06/09
3.2	Code of Ethics	Ross	2/03/09	2/05/09
3.3	Midterm Presentation		2/26/09	3/12/09
3.4	Midterm Report		1/29/09	3/12/09
3.5	Final Report		4/07/09	5/09/09
3.6	Final Presentation		4/20/09	4/29/09
3.7	Poster/Brochure		4/20/09	4/27/09
3.8	IPRO Deliverables CD		4/29/09	4/30/09
3.9	IPRO Day		5/01/09	5/01/09

8. Team Roster

Name	Major/Year	Sub-Team	Skills/Roles
Ross Brazzale	CAE/3rd	Survey	Creating letter, Research
Richard Byrne	ChE/3rd	Survey	Research, Organization, 2nd Vice President
James Cheever	ChE/3rd	Supply, Conversion	Research, Presenting
Michael Clark	ChE/3rd	Conversion	Research, 1st Vice President
Elena Dorr	ChE/3rd	Supply, Conversion	Project Management, Communication
Jeremy Gibbs	ME/3rd	Supply, Conversion	Research, Farming, Experience
Katherine Lazicki	ChE/3rd	Supply, Administration	Research, Minutes
Abhishek Prabha Kumar	ChE/3rd	Conversion	Research, Survey
Tyler Rhodes	BME/4th	Administration	President, Research Critical Thinking
Bertha Vandegrift	MBB/3rd	Survey	Organization, Survey
Robert Williams	EE/3rd	Survey	Research, Programming, Organization
Terrika Worthon	ME/4th	Supply, Administration	Research, Minutes
Xin Yi Yeap	BIOL/4th	Survey, Supply	Research, Survey

Ross Brazzale:
-Strengths: Writing, excel programming, researching.

-To develop: following federal guidelines (EPA), working with a large team on a continuing project.

-Expectations: Receive information from community colleges from which we can tailor and best use our research and analysis of supply, conversion, and usage of currently wasted corn stover for the development of localized CHP generators.

Richard Byrne:
-Strengths: knowledge of residential, industrial and commercial electrical construction

-To develop: understanding for useful application of CHP

-Expectations: gain insight into the functionality of CHP processes

James Cheever:
-Strengths: works well with others, does what needs to be done in order to complete a given task

-To develop: teamwork skills and learn about an interesting area of research

-Expectations: gain knowledge from a field related to my major

Michael Clark:
-Strengths: Time and task management, working in a group and listening to others.

-To develop: Learn more about gasification and cogeneration. Develop better team leader skills.

-Expectations: I think it will be a very interesting project that I will be able to get into.

Elena Dorr:
-Strengths: communication, project management

-To develop: knowledge of corn stover CHP applications and processes, group problem solving.

-Expectations: working together toward common goals and embracing new ideas.

Jeremy Gibbs:
-Strengths: Mechanical engineering knowledge, farming experience, hands-on intuition, organization

-To develop: Chemical issues when converting fuel into usable energy, time management

-Expectations: develop specific information for larger scale operations to use when considering the development of a biomass energy plant, for all team members to contribute equally and enthusiastically.

Katherine Lazicki:
-Strengths: writing, working with others.

-To develop: communication skills, articulation.

-Expectations: for everyone to work towards completing the decided goals.

Abhishek Prabha Kumar:
-Strengths: - Microsoft Excel, Word, PowerPoint, team work, good in math and science, written communication and research.

-To Develop: - verbal communication skills, knowing more about the different CHP options.

-Expectations: - Contributing more to the team personally and active participation from all team members.

Tyler Rhodes:
-Strengths: critical thinking, organization of information, interested in green technology

-To develop: leadership skill, provide team with efficient work atmosphere

-Expectations: learn about useful methods in which the world can become less dependent on fossil fuels

Bertha Vandegrift:

-Strengths: organization, excel

-To develop: communication

-Expectations: An educational experience that puts me out of my comfort zone, and a great opportunity for working with a diverse team.

Robert Williams:
-Strengths: motivated, takes initiative

-To develop: team working skills and appreciation for time management

-Expectations: gain some insight on real world applications of CHP

Terrika Worthon:
-Strengths: communication, non-bias decision making, math

-To develop: research skills, presentation skills

-Expectations: To gain knowledge of the CHP system and its benefits once implemented.

Xin Yi Yeap:
-Strengths: multilingual, organized.

-To develop: open to new ideas.

-Expectations: Good communication with everyone on the team, complete assigned tasks in time or before deadline.

REFERENCES:

[1] http://www.ethanol-gec.org/information/briefing/20a.pdf
[2] http://www.epa.gov/chp/documents/biomass_chp_catalog_part3.pdf
[3] http://www.agr.state.nc.us/drought/documents/1217andNCDACSCornStoverGuidance082707.pdf