IPRO 349: Solid Fuel from Biomass for Cogeneration

Project Plan
February 22, 2008

1. Objectives

Our objectives for the Spring 2008 semester are:

- Examine the logistics for the collection of corn waste stover within the state of Illinois.
- Conceptualize the technology that would be required in the form of a process flow sheet and equipment considerations.
- Deliver a final report that evaluates the overall energy and economic potentials of such an approach.

2. Background

Renewable energy is one of the most important and widely researched topics today. It is classically defined as any form of energy coming from any naturally replenish-able source. This may include everything from solar to wind 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 combustion.

The area of liquid fuels from biomass has especially 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.

The use of *solid* biomass 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 and market viability of such an approach. For example, one of the main advantages of liquid fuels over solid is the ease of transportation and storage. 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. For the purposes of this project, cogeneration, or the simultaneous generation of both electricity and useful heat will be examined.

3. Methodology

Because our project is primarily research based, all members will be expected to gain a background and understanding of the topics at hand. However, a team for administrative purposes has been created to manage all paperwork and deliverables. As many members as possible are asked to attend all IPRO workshops and tutorials regardless of what team they are on. This is to ensure that all members gain as much as possible from the IPRO experience across all discipline, not just the one relating to his/her team.

Research Team	Administrative Team
Team Leader: Jonathan Mikesell **Researchers:** Anna Dlugosz Joseph Heffernan Joshua James Anna Vassi Ying Bing Yap Xin Yi Yeap	**Team Leader:** Serena Chacko **Secretary:** Ryan Ruidera **Webmaster:** Terrance Stanfield

Each team member will be assigned individual tasks by his or her team leader throughout the semester. iGroups has been organized so that each team will upload relevant files to their own folder locations. Classroom hours will be a time for the teams to interact and update one another on progress and goals. Class time will also be spent discussing findings and decisions that may affect the project. For example, though a variety of options or paths may exist for one particular aspect of the process design, the team must collectively decide what will be the best and most efficient path to take in the scheme of the overall project. In general, the team leaders will delegate tasks to the teams, and individual members will conduct research on his/her topics outside of class. This research will then be discussed and analyzed as a group at the next class meeting for decision-making. The ultimate goal will be to research all possible methods of cogeneration from stover, but to then narrow this to the most viable and efficient process. At this point, the proposed process will be analyzed in detail for all logistical and economic considerations.

Currently, the overall research has been subdivided into smaller categories. These categories were decided upon as being the main considerations for cost and logistics for the process. One team member has been assigned to each category and is expected to cover it thoroughly and in-depth. The subcategories include, collection, bunching, storage, transportation, compaction, cogeneration, energy and emissions. Once all

possibilities in each category have been presented, the team will collectively decide which specific option is best in each category. At that point, team members will resume their research, but this time gathering details in their respective subcategory on the specific options decided upon (see Gantt chart in section 6). It is assumed that team members will dedicates as much time to their research as is necessary to retrieve the relevant information. Based on current proceedings, this may range from 5-8 hours a week outside the classroom, depending on the topic and methods of the week.

Additionally, the two main teams will be further divided into sub-teams of 2-3 members as new projects and tasks become apparent. As this IPRO is mainly research based, it is impossible to know exactly what paths and avenues to pursue until more research has been completed. As such, many of the specific tasks and requirements will be better understood as the research information continues to stream in. As new tasks become apparent, new sub-teams will be created based upon the background and interest of the team members. Below is a breakdown of the current team and member roles.

- Administrative Team: Produce the standard documents required by IPRO office while organizing the Research Team's focus toward a final report.
    - Team Leader: Serena Chacko – Directing the team during deliberations to focus the ideas on the deliverables and final report.
        - Terrance Stanfield – Using Microsoft Project to determine critical point in project and estimation of completion of tasks and report writing.
        - Ryan Ruidera – Dictating the minutes of the group meetings and organizing critical information on the iGroups website.
- Research Team: Gather essential data to determine whether corn waste could be processed in the state of Illinois for use as solid fuel.
    - Team Leader: Jonathan Mikesell – Assigning topics for members to research while researching as well.
        - Anna Dlugosz – Research filtering / cleaning during production
        - Anna Vassi - Research on emission laws.
        - Joseph Hefferman – Research on transportation.
        - Joshua James – Research on collection.
        - Ying Bing Yap – Research on turbines.
        - Xin Yi Yeap – Research on charcoal.
- Flow Chart Sub-Team: Make a flow chart for the whole team to understand the process of the life of corn waste during the production process

- Team Leader: Anna Vassi – Organizing the flow chart using Microsoft software for the Business Team's reports/website.
    - All members of IPRO organize the data to create the flow chart.

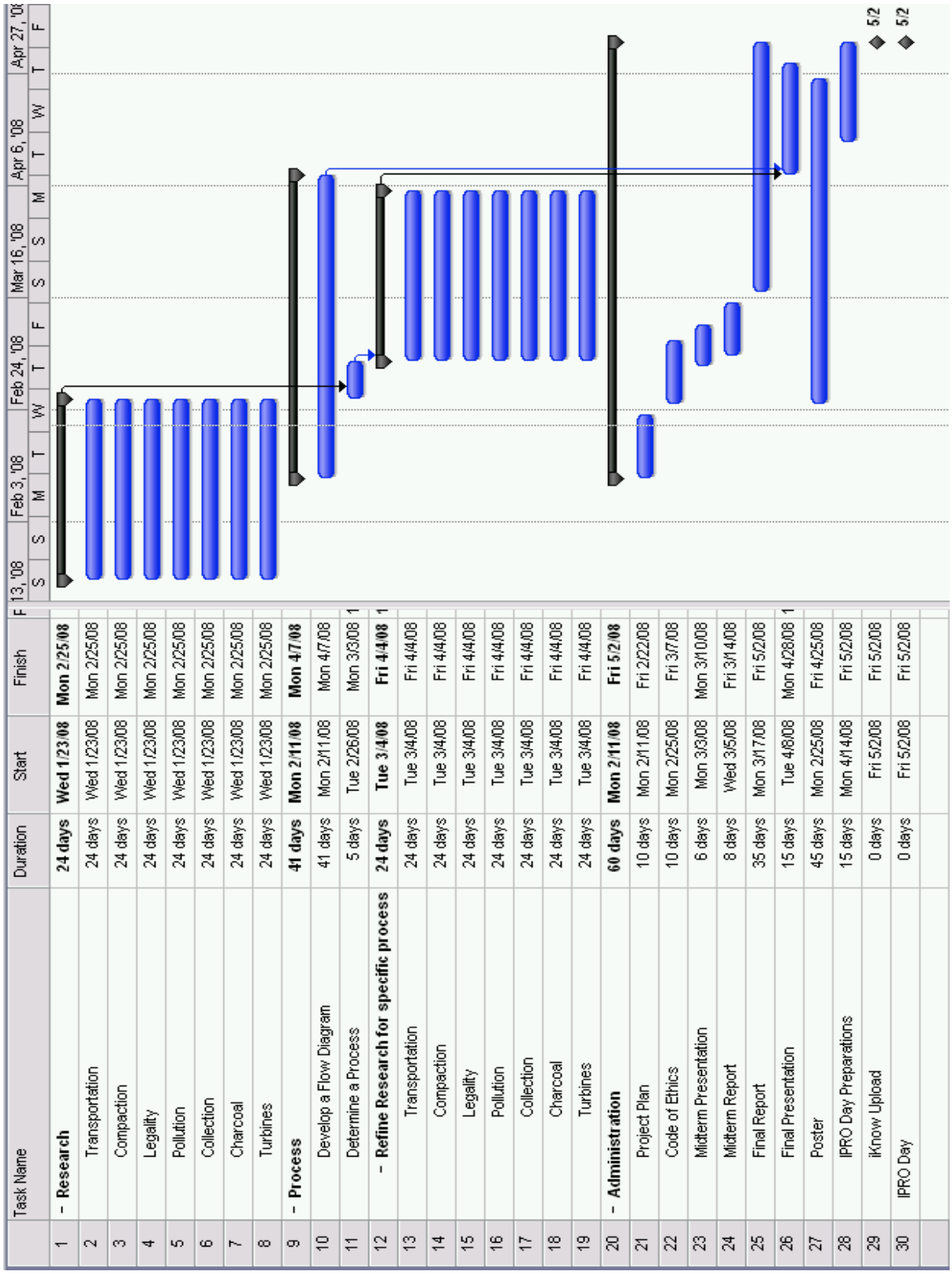
4. Expected Results

By the end of the semester, all team members are expected to have a gained a thorough, working knowledge of how to efficiently harvest energy from corn stover through cogeneration. The team will analyze all relevant data critically and compile a comprehensive report detailing all process and cost consideration. An assessment as to whether corn stover for cogeneration is a viable alternative to current processes within the state of Illinois will be made. This information will be presented on IPRO day with a special emphasis on diagrams and flow charts to conceptualize the process for the viewer.

5. Project Budget

Expense	Description	Amount
2 Appetizers and 2 Large Giordano's Pizzas	The team would like to have an informal team building dinner at a local restaurant. This will allow members to get to know one another and develop more relaxed relationships.	$60.00
Corn Stalks	Prop for final exhibit and presentation	~$20.00
Charcoal (or other example of solid fuel)	Prop for final exhibit and presentation	~ $5.00

6. Schedule of Tasks and Milestone Events



	Task Name	Duration	Start	Finish	F
1	**- Research**	**24 days**	**Wed 1/23/08**	**Mon 2/25/08**	
2	Transportation	24 days	Wed 1/23/08	Mon 2/25/08	
3	Compaction	24 days	Wed 1/23/08	Mon 2/25/08	
4	Legality	24 days	Wed 1/23/08	Mon 2/25/08	
5	Pollution	24 days	Wed 1/23/08	Mon 2/25/08	
6	Collection	24 days	Wed 1/23/08	Mon 2/25/08	
7	Charcoal	24 days	Wed 1/23/08	Mon 2/25/08	
8	Turbines	24 days	Wed 1/23/08	Mon 2/25/08	
9	**- Process**	**41 days**	**Mon 2/11/08**	**Mon 4/7/08**	
10	Develop a Flow Diagram	41 days	Mon 2/11/08	Mon 4/7/08	
11	Determine a Process	5 days	Tue 2/26/08	Mon 3/3/08	1
12	**- Refine Research for specific process**	**24 days**	**Tue 3/4/08**	**Fri 4/4/08**	1
13	Transportation	24 days	Tue 3/4/08	Fri 4/4/08	
14	Compaction	24 days	Tue 3/4/08	Fri 4/4/08	
15	Legality	24 days	Tue 3/4/08	Fri 4/4/08	
16	Pollution	24 days	Tue 3/4/08	Fri 4/4/08	
17	Collection	24 days	Tue 3/4/08	Fri 4/4/08	
18	Charcoal	24 days	Tue 3/4/08	Fri 4/4/08	
19	Turbines	24 days	Tue 3/4/08	Fri 4/4/08	
20	**- Administration**	**60 days**	**Mon 2/11/08**	**Fri 5/2/08**	
21	Project Plan	10 days	Mon 2/11/08	Fri 2/22/08	
22	Code of Ethics	10 days	Mon 2/25/08	Fri 3/7/08	
23	Midterm Presentation	6 days	Mon 3/3/08	Mon 3/10/08	
24	Midterm Report	8 days	Wed 3/5/08	Fri 3/14/08	
25	Final Report	35 days	Mon 3/17/08	Fri 5/2/08	
26	Final Presentation	15 days	Tue 4/8/08	Mon 4/28/08	1
27	Poster	45 days	Mon 2/25/08	Fri 4/25/08	
28	IPRO Day Preparations	15 days	Mon 4/14/08	Fri 5/2/08	
29	iKnow Upload	0 days	Fri 5/2/08	Fri 5/2/08	
30	IPRO Day	0 days	Fri 5/2/08	Fri 5/2/08	

7. Our Team

Name	Major	Team	Skills	Roles
Anna Dlugosz	AE	Research	-Multilingual, woodcraft -Read blueprints	Research on filtering / cleaning bio-fuel production.
Anna Vassi	ChE	Research	-Research -Multilingual	Research on emission.
Jon Mikesell	CPE	Research	-CAD -Typing -Java/C coding -English composition	Assigning topics for members to research while researching as well.
Joseph Heffernan	BME	Research	-Typing -Matlab -Reports	Research on transportation.
Josh James	BME	Research	-Chemistry -Bio-engineering -Thermodynamics -Matlab	Research on collection.
Ryan Ruidera	MMAE	Admin.	-Organizing -Stress analysis -Microsoft Office -Open Office -Matlab	Dictating the minutes of the group meetings and organizing critical information on the iGroups website. Organize flowchart.
Serena Chacko	BME	Admin.	-Administrative duties -Report writing -Thermodynamics - Multilingual	Directing the Research Team during deliberations to focus the ideas on the final report.
Terrance Stanfield	CPE	Admin.	-Typing -Coding -Reports -Research -Problem solving	Using Microsoft Project to determine critical point in project and estimation of completion of tasks.
Xin Yi Yeap	BIO	Research	-Typing -Research work -Multilingual	Research on charcoal.
Ying Bing Yap	EE	Research	-Coding -Writing reports -Conduct lab experiments	Research on turbines.

8. Assigned Roles

Team Leader: Serena Chacko

Sub-Team Leaders: Jonathan Mikesell, Serena Chacko, Anna Vassi

Minute Taker: Ryan Ruidera is in charge of recording decisions made during meetings including action items or changes under consideration.

Agenda Maker: Serena Chacko is responsible for creating an agenda for each team meeting. This provides structure to the meetings and offers a productive environment.

Weekly Timesheet Collector/Summarizer: Terrance Stanfield is responsible for collecting weekly timesheets from each member of the team.

Schedule Maker: Ryan Ruidera is responsible for collecting schedules from all the team members and developing a master schedule, which tells the team when members are available and how to contact them.

iGroups Coordinator: Ryan Ruidera is responsible for the maintenance of iGroups.

9. Sources

[1] http://www.ethanol-gec.org/information/briefing/20a.pdf
[2] http://www.epa.gov/chp/documents/biomass_chp_catalog_part3.pdf