



I PRO 347

Project Plan

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Abstract

The IPRO 347 team intends to seize the opportunity given by Robbins Community Power (RCP) to improve the efficiency of the power plant. RCP plans to convert the facility from its original role as an incinerator into a wood biomass electricity plant. Working with RCP, the team will look at thermodynamic values to determine how to best utilize the excess heat generated from the boiler that currently radiates out the cooling towers. Additionally, the team will research and discuss possible solutions to be implemented on the 22 acre site.

The intricacies that arise from the nontraditional nature of our plan require we split into two groups. One sub-team will look into exactly where the waste heat exists and the values of viable energy available in the form of steam or hot water. This team will seek interdisciplinary advice as part of the energy analysis. The second, but most influential, sub-team will predominantly be researching feasible outlets for the recovered energy. Some solutions they will pursue include supplying nearby greenhouses with CO₂, providing on-site and local heat, and increasing the efficiency of the plant through drying processes.

Team Information

Appendix A contains more specific team member information

Purpose

I PRO 347 brings together students of diverse majors to create a solution derived from principles of various fields of engineering. We will suggest ideas for utilizing the plant's waste heat, increasing the plant's efficiency and exploring possible economic opportunities for the plant and the community.

Team Objectives

- Quantify heat to be captured with counterflow heat exchanger
- Determine the requirements and market for biochar
- Measure the feasibility of using the heat and/or exhaust for greenhouses
- Choose a pellet mill able to increase efficiency of RCP
- Cost-benefit analysis of heat exchanger, pellet mill, and biochar furnace
- Pursue means to secure enough green wood to continuously supply the power plant each year

Background

History

A municipal solid waste power plant was seen as a solution to overflowing landfills in Chicagoland in the late 1980's. Finally constructed in Robbins, Illinois, in the early 1990's, the plant was active from January 1997 until October 2000. However, the operating company, Foster Wheeler, out of New Jersey, closed the plant after \$10 million in funds could not be raised. For two years prior to the closing the company wrestled with Illinois legislators to increase the subsidized price of energy (from 2 cents per kilowatt to 8 cents-- a substantial amount) to no avail. Furthermore, locals' concern over pollution from the waste incinerator added to the company's struggle to gain political approval. The loss of the incinerator's production capacity eliminated 80 full-time jobs and impacted the village itself. At the time of the power plant's initial closing, 17 percent of Robbins' spending money came directly from incinerator dumping fees.

For nearly ten years, the plant has been dormant. But, the ambitious Robbins Community Power LLC (RCP) has big plans for this relatively small plant. RCP is joint-owned by Aspen Pipeline II LP (through the Aspen-Robbins limited liability company) and Sylvan Power Company. Capable of producing 50 MW of energy at full capacity (a typical nuclear power plant and the proposed Lake Erie wind farm produce around 1 giga (10e9) watt) the plant is being retrofitted to burning wood in place of trash. Steam & Control Systems, Inc. from Tennessee will complete the transformation of the fluidized boilers to allow for 3 inch wood chunks and pellets to be burned to create steam. The steam expands in a turbine, originally built by Dresser Rand to receive 480,000 lbs/hr of 900 psi and 830 deg F steam, that will be refurbished by GE Energy. The turbine turns a generator to produce electricity that can then be sold to ComEd through a deregulated market that serves Midatlantic and Midwestern states. Many of the present filtering systems required for trash incineration are not required (or required less often) for wood burning. In addition to remov-

ing these processes, RCP intends to foster new avenues of revenue created by the surplus of wood fuel that will be stored on-site.

Current Interests

The site can hold 25,000 tons of wood, or 20 days worth of feedstock, composed of 70 percent dry wood from construction and demolition and 30 percent from green wood. The local Emerald Ash Borer is predicted to create a windfall of ash tree lumber from local villages in the near future. The wood will be delivered in the form of 3 inch chips--allowing for 10 percent of the delivery to exceed 3 inches in length to prevent further pulverization--that have been determined to be optimal for heat generation within the boilers. Initial investigations into conditions of the exit flue gas in the cooling towers suggests that energy from the heat of the 450 deg F gases can be used to create steam and dry the feedstock to significantly increase the heat released by the wood in the boilers. In addition, the steam could be used to power certain processes or provide heat to a local industrial park in nearby Robbins. RCP intends to pursue any opportunity to improve efficiency not only to augment their revenue, but the revenue of Robbins as well from taxes on businesses deciding to relocate near the wood biomass power plant.

Team Values

Desired Behaviors

- Give 100% effort
- Work as a team to achieve shared goals
- Be on time to all the meetings
- Communicate clearly and effectively
- Respect all team members and their ideas
- Perform assigned tasks
- Ask for help if needed
- Meet deadlines
- Use resources wisely

Addressing Disputes

- The following steps can be taken to resolve issues
 1. Attempt to resolve the problem within the subgroup
 2. When necessary ask other I PRO group members for advice
 3. As a last resort, contact I PRO instructors
- No-shows and incomplete tasks need to be recorded and addressed personally. If not resolved, then issue will be reported to the instructor in order to avoid any delays in the project
- Resolve problems with time conflicts within individual subgroups on personal basis
- Promptly report time conflicts with weekly meeting to the instructor

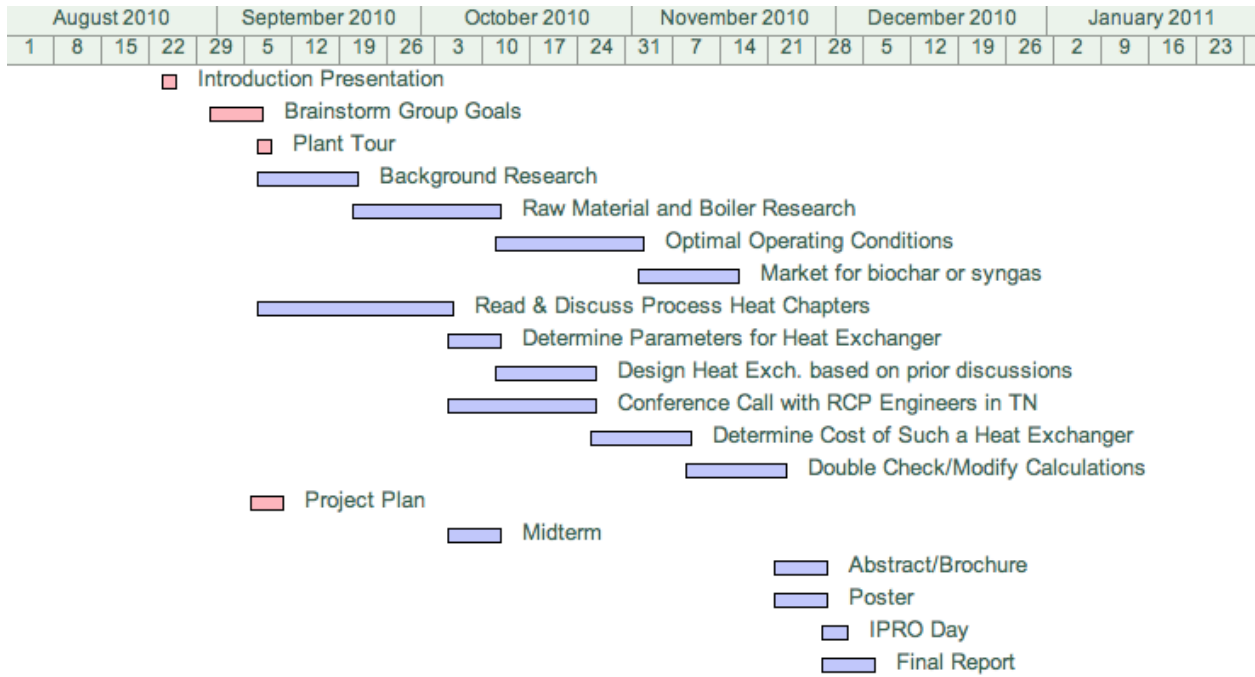
Work Breakdown Structure

To go about solving the above subtasks of the overall problem, our team will be divided into two groups to work on individual tasks. The individual tasks will be categorized, and one category given to each subgroup. The chosen categories are thermodynamics and applications. The thermodynamics subgroup will work with RCP to determine the availability of energy in the residual heat of the wood biomass boiler-turbine system. Using the recommendations of the thermodynamics group, the applications group will discuss the feasibility of outlets for this energy.

Team Structure

- Sub-team leaders: It is the responsibility of the group leaders to steer the subgroups toward the given IPRO objectives and to assure that said goals will be accomplished within the semester timeline.
- Application/Tour leader: Students interested in specific applications for recovered heat are encouraged to lead discussions with research. Also, any tours to facilities involved in handling green wood or proposed retrofitted processes should be scheduled by a self-appointed (or appointed) student.
 - All members share this role as each has at least one particular interest they have shared in discussions or hope to pursue with tours.

Gantt Chart



Expected Results

The overall group goal is to aid RCP in their goal to bring economic viability to Robbins, Illinois. We have arranged our specific goals by subgroups below.

Biochar Group

- Determine the requirements for continuous/batch production of biochar
- Perform a cost/benefit analysis of each option in terms of capital expenditure, operating costs and expected revenue.
- Report our findings to Robbins Community Power.

Greenhouse Group

- Plan for a plant visit are being finalized to learn further details about the plant layout and operating procedure.
- Expected data include final carbon dioxide emissions levels after the proposed solution is instated.
- Potential products resulting from research are to be multiple solution possibilities. These include fresh produce or other plant products.

Wood Supply Group

- Communications and connections with local mulch dealers and city refuse groups
- A proposal for the means to providing the plant with a quarter of its fuel supply as green wood

Heat Exchanger Group

- Suggest reasonable solutions to RCP for utilizing waste heat of the flue gas
- Gain a better understanding of heat exchanger operations
- Transform waste energy into a source of revenue or a cost-reduction method.
- Perform a cost/benefit analysis of an exchanger in terms of capital expenditure, operating costs and expected revenue.

Budget

Activity	Cost	Description
Greenhouse Scale Model	\$70	Model for proposed greenhouse design for presentation purposes
Simple Experiment	\$250	Subject wood to similar conditions experienced within the 450 deg F flue gas
Team Building	\$100	Dinner with RCP manager to discuss findings
Total	\$420	