IPRO 345: Chicago Sister Cities China: Fuel Cell/Geothermal Sustainable Energy USX Site

Midterm Report

Spring 2008

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1.0 Revised Objectives

A. Create a working software tool that assists in the capacity of planning, decision making and accessing the economic feasibility of implementing an integrated fuel cell technology and geothermal energy system.

B. Through a case study approach, research and evaluate the energy needed in residential homes to use as a basis for determining the fuel cell size and heating/cooling capacity of the fuel cell/geothermal hybrid system.

C. Design a suitable heat exchanger/heat pump system to utilize the heat exhaust from the fuel cell and use it for heating and cooling needs.

D. Demonstration of the viability of the integrated fuel cell and geothermal system in a specific location through the prototype testing of the database tool.

~~**E.** Connect an alternative energy source for heating and cooling to the industrial world by providing an efficient way to analyze the design and economic parameters required to implement such an integrated energy system.~~ By providing a tool that analyzes the design and economic parameters required to implement an integrated fuel cell/geothermal energy system, this IPRO hopes to make installing these systems much easier, thereby giving developers an incentive for investigating relatively clean energy sources.

F. Research on all parameters needed for our project's implementation including environmental laws and regulations, permits, funding, weather, population, and energy consumption.

2.0 Results to Date

The design sub-team has researched the implementation of this type of energy system elsewhere. A type of fuel cell which this design tool will eventually be used for was determined to be a Molten Carbonate Fuel Cell because of its high operating temperature. Also, the design team has realized that part of the objectives is actually selecting a proper design of the heat exchanger/heat pump system since none has been investigated in depth by other parties.

The economics sub-team has researched the cost of installation, the cost of fuel, the federal subsidies which would apply to this type of energy source installation, and the social implications like the reduced hospital visit due to decreased pollution.

So far, the environmental/law sub-team has finished the environmental impact research. They have determined that the fuel cell/geothermal system, when properly installed, has little negative affect on the environment, but enormous

benefits, especially in terms of the fossil fuels that it saves. The research on federal law concerning a fuel cell/geothermal system has also been completed. There are few laws concerning this system, since it is a relatively new technology. Laws that do exist are usually energy laws which do not affect the placement of the technology. Some research has been completed on the site conditions such a system requires. There are some soil conditions that regulate whether the geothermal pump component will be cost-effective. There are no site restrictions on a fuel cell system. In Chicago the soil conditions are more suited for a vertical or lake system, since the large quantity of debris in the soil makes digging horizontal trenches more expensive than deep holes.

There has been some progress made with the database component of the project, but it has been limited since the focus has been primarily on research. A database file structure and template has been created, and as the project moves away from the purely research phase and progresses into the database phase it will be quick to format the research into the proper templates. A code of ethics was written up by the ethics sub-team, and the midterm presentation was completed.

3.0 Revised Task/ Event Schedule

Task	***Members Responsible***	***Hours total***	***Dates***
Research Environmental impact/guidelines/regulations of fuel cells	Maruja Yoshimura	17 hours	February 17th-March 11th
Research Environmental impact/guidelines/regulations of geothermal pumps	Abhishek Prabha Kumar	17 hours	February 17th-March 25th
Research codes and laws (federal, state, city) pertaining to fuel cells	Suk Hwan Yun, Maruja Yoshimura	17 hours, 6 hours	February 17th-March 25th
Research codes and laws (federal, state, city) pertaining to geothermal pumps	Nick Leep	17 hours	February 17th-March 25th
Research site conditions necessary for a fuel cell/geothermal system	Daisy Agose	12 hours	February 17th-March 11th
Research environmental conditions in Chicago	Eliza Bober	12 hours	February 17th-March 25th
Plan database format	Eliza Bober	3 hours	March 10th – March 17th
Organize research into	Daisy Agose	36 hours	March 17th - April 11th

Task	*Members Responsible*	*Hours total*	*Dates*
database	Eliza Bober Abhishek Prabha Kumar Nick Leep Maruja Yoshimura		
Research costs (electricity, fuel, machinery, installation)	Jonathan Lockridge, Yoon Sung Chung, Matt Dado, Yun Jin Lee	55 hours	February 10th – March 28th
Research federal, state, and local subsidies	Richard Byrne, Funso Ajigbo, Gregory Enadeghe	55 hours	February 10th – March 28th
Perform calculations on existing sites	Brian Hogan, Won woo Park, Jaehyuk Kim, Min Zheng	40 hours	February 28th – March 28th
Develop database for tool	Brian Hogan, Won woo Park, Alex Horner	15 hours	March 20th – March 27th
Build software tool	Hired CS programmer	100 hours	March 27th – April 8th
Test design tool on project sites	Brian Hogan, Jae hyung Park, Alex Horner, Min Zheng	20 hours	April 8th – April 24th

4.0 Individual Team Member Assignments

Name	*Major*	*Position*	*Skill*
Daisy Agose	Chemical Engineering 4th year	Team Leader Site Requirements Research	MatLab, Hysys, Excel
Eliza Bober	Architecture 4th year	Sub-Team leader Environment Research Sub-team clerical	Presentation Experience, IPRO Experience, Word, Excel, Photoshop, Illustrator and AutoCAD
Abnishek Prabha Kumar	Chemical Engineering 2nd year	Environmental – geothermal research	Teamwork, Excel, Word, Photoshop, AutoCAD, MatLab
Nick Leep	Chemical Engineering	Geothermal codes and	MatLab, Excel, Word,

Name	***Major***	***Position***	***Skill***
	2nd year	laws research	HTML
Maruja Yoshimura	Chemical Engineering 2nd year	Environmental – fuel cell research	Very Organized, Word, Excel
Suk Hwan Yun	Chemical Engineering 2nd year Environmental Engineering (in Korea)	Fuel Cell codes and laws	Looking into Environmental Effects and Alternative Energy Basic Computer Skills
Jonathan Lockridge	Architecture 4th year	Economics Sub-team Leader	Auto CAD, CS3, 3dmax, VIZ, Carpentry
Yoon Sung Chung	Material Science	Economics sub-team	Bilingual
Mathew Dado	Chemical Engineering 2nd year	Economics sub-team	Strong Technical and Analytical skills
Richard Byrne	Chemical Engineering 2nd year	Economics sub-team	Strong technical and analytical skills
Funso Ajigbo	Chemical engineering	Economics sub-team	Bilingual, good organizer, MatLab, Hysys, Excel
Gregory Enadeghe	Chemical engineering	Economics sub-team	Strong Technical and Analytical skills
Yun Jin Lee	Mechanical engineering	Economics sub-team	Bilingual, MatLab, Hysys, Excel
Brian Hogan	Chemical Engineering 4th year	Design sub-team leader	Strong technical and analytical skills
Chris Wolcott	Chemical Engineering 2nd year	Design sub-team	Strong technical and analytical skills
Jennifer Peavler	Chemical Engineering 3rd year	Design sub-team	MatLab, Hysys, Excel
Jaehyuk Kim	Architecture 4th year	Design sub-team	Strong technical and analytical skills
Jae hyung Park	Aerospace Engineering 4th year	Design sub-team	Strong technical and analytical skills
Won woo Park	Architecture 4th year	Design sub-team	Strong technical and analytical skills
Min Zheng	Chemical Engineering 3rd year	Design sub-team	Strong technical and analytical skills
Alex Hornero	Chemical Engineering 4th year	Design sub-team	Bi-lingual, strong technical and analytical skills

Name	*Major*	*Position*	*Skill*
Raisa Pelae	Chemical Engineering 4th	Environment sub-team, minute taker	MatLab, Hysys, Excel
Nyah Zarate	Chemical Engineering 4th year	IPRO deliverables, economics sub-team	MatLab, Hysys, Excel
Christian Arnoux	Chemical Engineering 4th year	Economics sub-team	MatLab, Hysys, Excel
Cheryl Mukai	Chemical Engineering 4th year	Design sub-team	Strong technical and analytical skills

5.0 Barriers and Obstacles

Our first and biggest obstacle was defining the scope of the project, from the locations we would be investigating, to the information that we want to consider in the development of this software. Through many group discussions we decided to focus on Chicago for this semester. At the beginning of the semester, many students in the IPRO were unaware of the computer programming nature of the project. We discovered that there was not one computer engineering on the team.

Another obstacle faced was juggling all of the team roles. This IPRO is comprised of senior-level chemical engineering students (CHE 496), general IPRO students (IPRO 345), and sophomore level chemical engineering students (CHE 296).The latter group only earns one credit hour, and they spent the first quarter learning a simulation software. Because of this structure, it made assigning tasks a bit difficult. The sub-team leaders were careful to assign proper amounts of work to the team members based on individual skills and level of involvement.

Not only did the CHE 296 students' level of involvement affect the sub-team leaders designating roles, it affected, understandably so, their motivation to find time to complete tasks. This team has overcome this by assigning fair roles to the CHE 296 students and making the class time productive *and* fun.

Our biggest future obstacle will be to database all of our research. Although the group has come out with a basic database structure, there are still many details to be worked out, and this is a crucial step in making our software work.