

## Objective

IPRO 347 will ~~be designing~~ a biorefinery that converts ~~a~~ commercially available biomass feedstock into ~~both~~ transportation fuels and energy, ~~which~~ both of which can be sold as commodities on the market. This ~~is the~~ first semester of a hopefully continuing IPRO project will ~~the final~~ result ~~will~~ in a detailed process design and preliminary economic analysis of a biorefinery that uses a thermochemical route to convert 500 tons/day of biomass. ~~be a design which could be marketed to customers.~~ The initial design process for ~~the~~ semester will focus on a variety of areas, including the following:

- Thorough investigation and reporting of background materials
- Selection of biomass feedstock and plant location
- Selection of suitable most appropriate gasification technology
- Specification of target products~~(s)~~ and market~~customer(s)~~
- Development of a detailed process flow ~~-~~diagram
- ~~Means of Exploration of energy balance and means of~~ efficient thermal process integration
- Preliminary economic analysis
- Analysis of safety/environmental impact issues

While the ultimate goals of the project is to develop a complete conceptual design of a ~~possible bio~~-refinery, teamwork and project management fundamentals are also important concepts ~~that which~~ will be emphasized throughout the semester.

## Background

A conventional petroleum refinery is a complex network of separation and chemical conversion processes ~~is~~ used to produce a variety of liquid fuels (~~e.g. gasoline,~~ liquefied petroleum gas, gasoline, diesel, jet fuel) and chemicals used for production of fertilizers, plastics, synthetic fibers, asphalt, etc. Increasing prices and finite supply of fossil fuels, in addition to environmental and geopolitical concerns, are leading to increased interest in renewable energy sources. As the current price of ~~petroleum crude oil~~ continues to rise, renewable energy sources, such as water, wind, solar, geothermal, and biomass, become more ~~and more~~ economically attractive. ~~B~~While renewable sources include

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~~water, wind, solar, geothermal, and biomass, only biomass uniquely offers an abundant, domestic, renewable supply of energy that can be used to produce both transportation fuels and other chemicals such as plastics and electricity.~~ Biomass currently contributes to approximately half of the total renewable energy sources, ~~also biomass~~ is a resource that is geographically flexible, not location dependent and has related process economics that are more favorable than other types of sustainable energy, are more reasonable than the sources previously mentioned. In designing a biorefinery, concepts and process attributes can be leveraged from conventional petroleum refineries, as both systems ~~Therefore, biomass is the design pursued. Further it is easy to understand the similarity between a biomass refinery and the typical petroleum refinery because comparable reactors exist in both processes using both the same chemicals and producing the same products~~ consist of similar unit operations and yield similar products. One advantage of biomass-derived transportation fuels, however, is that they are typically clean-burning.

## Methodology

~~While the final product will be a preliminary design package that could then be be further explored further by either a future IPRO or an engineering firm in order to address, which could design and commercialization issues that are beyond the scope of the current work~~ begin finding further design issues. The basic design concept for the process has been well researched and defined. The key components of this process are given below listed:

- Feedstock: Basic selection of different biomasses, such as wood, animal residue, crops (wheat or corn), and municipal waste
- Pre-treatment: cleaning and drying the stock; basic preparation
- Gasification: This ~~critical is the most important~~ process involves the thermochemical conversion of biomass under conditions of sub-stoichiometric oxygen to form a “synthesis gas” consisting predominantly of hydrogen and carbon oxides, ing a chemical shift from a variety of hydrocarbons to hydrogen and carbon oxides. Despite significant interest in the research community, technological hurdles exist for gasification as related to many types of

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~~biomass. This process has been well researched; however, for biomass the process is not as well defined.~~

- Gas Cleaning and Processing: ~~Removal of still existing impurities (e.g. H<sub>2</sub>S) from the initial "synthesis gas" gasification and conditioning of the cleaned gas for conversion to fuels in a Fischer-Tropsch reactor, preparing the gas for conversion to fuel or to electricity in a gas turbine, etc.~~ This part of the process is also necessary to achieve appropriate compositions, purities, temperature, and pressure for these downstream operations following reactor.
- Fisher-Tropsch: ~~Heterogeneous catalytic reactor that which convert hydrogen gas and carbon monoxide and hydrogen gas and converts them to hydrocarbons, —chained carbon structures— such as paraffins and olefins. Unfortunately a water gas shift reaction can also happen, which would be minimized.~~
- Other Process Components: A general collection of a variety of components which can be used to generate power, make systems more efficient, store the fuels, etc.

Each aspect listed above will be ~~thoroughly researched, very heavily,~~ and the final technology will be developed with design consideration of ~~aided which contributes to the overall good of the process by considering such design parameters as~~ safety, efficiency, reliability, and economics. Further economics and safety will also be considered heavily as chemical plants in the past have often caused many environmental problems, and such an incident would severely hinder the ~~emergence-widespread adoption~~ of biomass as a renewable energy source.

Because this project does not ~~involve laboratory experiments or contain experiments and requires no~~ physical labor, safety risks related to this project are minimal. However, participants will spend significant amounts of time reading and using personal computers. Therefore, general fatigue, posture, and repetitive stress injury precautions will be taken.

~~the safety of this project is thus increased, but because a lot of time will be spent researching and using computers, as well as meetings, ergonomics will be strongly encouraged.~~

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## Expected Results

The final results will ~~include be both~~ a detailed report and a portfolio explaining the entire design process in detail, ~~as well as with cost analysis ing and process~~ safety ~~issues~~parameters. The report will contain ~~relative background~~ research and available experimental data related to topic mentioned above. ~~on all topics mentioned above and will also contain available experimental data.~~ Because this project involves a novel chemical process, As this process has not been constructed before, much research needs to be done to ensure its technical consider the feasibility of such a process. Beyond the value of our conceptual design and preliminary economic evaluation, a more detailed plant design and related pilot plant work would be needed as a future step toward commercialization. ~~While it is proven theoretically, experimental data is necessary to prove such a concept is in fact possible to design.~~

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## Budget

Because this process is almost entirely research and computer-related work, the budget is very limited and should be limited to two hundred dollars for general supplies, ~~or necessary~~ texts, and team-building activities. There may also be small fees related to acquisition of certain technical literature. ~~If certain research papers require fees, that cost could be included.~~ Overall, this project will not require any any significant funding for experimental equipment or computer hardware/software.

## Project Deliverables and Milestones

IPRO Deliverable	Due Date
Project Plan & Budget	February 3
Mid-term Report	March 10
Web Site	April 28

Final Oral Presentation	May 3
Professional Style Exhibit	April 28
Project Abstract	May 1
Final Report	May 5
Comprehensive Deliverables CD	May 5

## Predicted Schedule

Week	Goal
1	<del>Bewilderment</del> , Assessment of <u>team member skills, orientation</u>
2-3	Clarify the problem statement, Choice of feedstock, Select conversion technology, Safety/environmental risks
4	Identification of discrete tasks, resource allocation, accountabilities
5-11	Flowsheet development, Technical Writing, Progress Monitoring, Periodic memos explaining progress
12-13	Economic analysis, Suggestions for improvement, Final Report