# OU Biorefining

# Business Plan

Submitted To
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## 1.0 Non-disclosure Agreement

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Recipients' signature

## 2.0 Executive Summary

OU Biorefining, Inc. will be formed as a chemical processing plant specializing in the production of bio-chemicals (succinic acid, fumaric acid, ethanol, sodium propionate) from renewable resources. The biofinery will be established in Dubuque, Iowa and begin operations as early as the year 2005 and be in operation for the next 20 years. The founders of OU Biorefining are professional engineers, with years of progressive and responsible experience.

The total capital available for the plant is projected at $150M throughout the 20 year lifespan of the project, and the projected net present value for this initial investment is $321M.

The total initial capital available is only $150,000,000, but once revenue is generated, this monetary sum will be used to invest in expansion opportunities for the plant. The total fixed capital requirements for the production of each chemical is given in the figure below, as well as the percent distribution for each process.

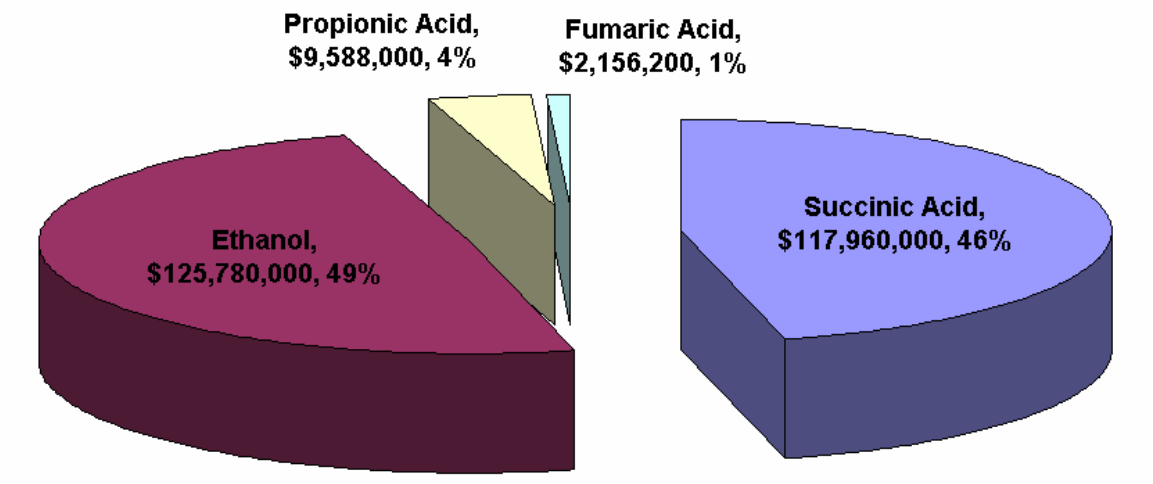


**Figure 1:** Fixed Capital Distribution for Lifespan of Project

Based on the figure above, the majority of product produced from the biorefining plant will be ethanol and succinic acid. They will be produced in the greatest quantity, as well as have the greatest allocation of the fixed capital investment. This is because the market prices for these chemicals are greater than that of fumaric and propionic acid.

The initial annual total capacity for the project will be 180 million pounds, but with expansion opportunities, the final annual total capacity is projected at 550 million pounds.

The plant will specialize in providing an economically profitable alternative in the production of petrochemically derived products by producing similar products using biorefining. These chemicals produced will include succinic acid, sodium propionate, fumaric acid, and ethanol.

## 3.0 The Enterprise

The main objective for OU Biorefining is to provide a viable and economically profitable alternative in the production of petrochemically derived products by producing similar products using biorefining. The market for this is expected to increase due to a large increase in demand of the production of environmentally friendly chemicals. The biorefining process includes using renewable raw materials from agricultural crops and a decrease in waste byproducts formation. In addition to this, the products formed from the biorefining process are biodegradable making it safe for the environment.

This venture will be implemented to compete with the petrochemical products. The construction of plant will consider the optimization of all design parameters to maximize the net present value. A reducible mathematical model will be used to consider the plant location, production flow rates, and expansion opportunities for the lifespan of the project. Based on the input data, the plant was determined to be located in Dubuque, Iowa for the 20 year lifespan of the project.

### *3.1 Objectives*

OUBR aims to become a leader in production of useful goods from renewable sources over the next 20 years. This enterprise will eventually compete with petrochemical based products as soon as the technology catches up.

Corn will be our raw material of choice for all the processes based on price, availability, stability, and consistency. Below is a figure depicting the harvested corn for 2002.

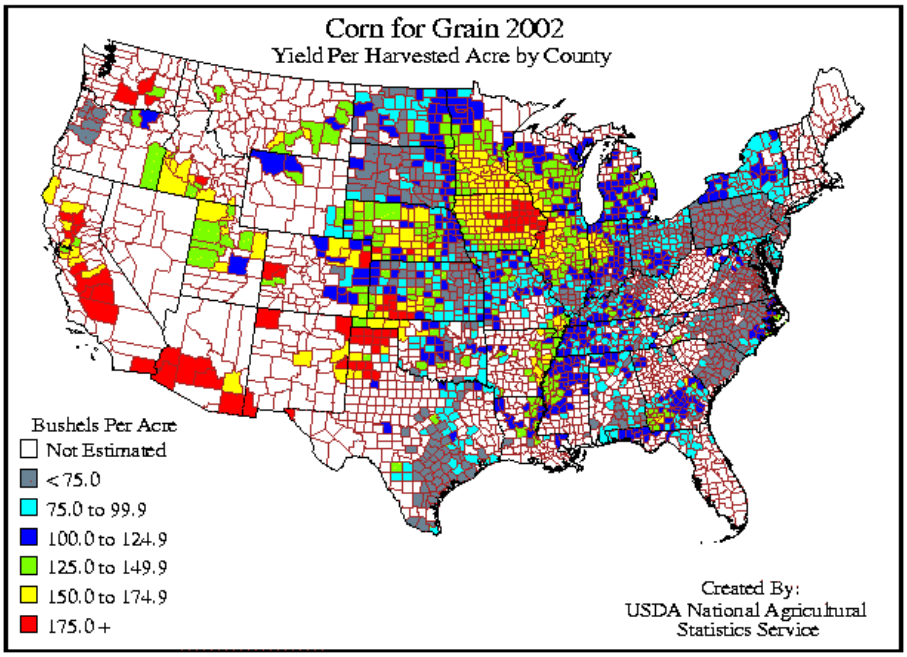

**Figure 2**: Yield of corn by region[1]

To compete with petrochemical based products, OUBR will:

- Constantly upgrade facilities to meet rising demand for 'green' products.
- Maximize our net present value by purchasing raw materials from most feasible markets.
- Achieve an expected NPW of almost 340 million over the 20 year life span of the project.
- Adding new products to existing line as respective market demands increase for the different products. These products can be easily modified to meet the performance needs of different market segments.
    - food / beverage products
    - chemical intermediates
    - fuels
    - biodegradable plastics and fibers
    - solvents

## *3.2 History*

OUBR will be financed privately in addition to government incentives to aid in the initialization of the project. Government incentives will be provided because of improvements to waste reduction and environmental concerns.

The enterprise is projected to be profitable with a plant on ground as early as 2005 with a continued increase of profit over a 20 year period. OUBR will initially be constructed to capture about 1 percent of the total market for the production of each chemical.

The project members are able to run the business and will therefore serve on the board and be fully responsible for all business operations as envisioned by the team.

## *3.3 Organization*

### 3.3.1 Personnel

OU Biorefining will have 7 personnel this year, 60% of whom will be involved in the manufacturing/assembly process. We currently lease our office and manufacturing space which is adequate, but not what we want for the long run. Our lease commitment is through April of this year at which time we expect to acquire a new building offering a nicer, safer and more effective working environment. The organization structure is quite traditional. Because of our slow growth, we have been able to be selective about the

[1] http://www.usda.gov/nass/aggraphs/cropmap.htm

personnel we have hired, thus maintaining a very high quality of expertise. The coming year will be a period of much faster growth, putting more pressure on us to maintain the quality of personnel.

Below shows the task and responsibilities for each member of the upper management team of OUBR.

*President & CEO*

Miguel Bagajewicz is the President of OUBR and is the sole authority with regard to proposing, negotiating and finalizing any and all consultation and clean up contracts with service seeking companies and proprietors. Mr. Bagajewicz will share in managerial duties and decision-making because we are a small and decentralized organization.

*Business & Sales Consultant*

Mr. Bambo I-Obe is the head of business and sales department. He is responsible for the marketing and sales of the products. He is also responsible for preparing all contract proposals based on OUBR capabilities. He will report his findings to Mr. Constantino.

*Production Engineer*

Ms Trenika Iland, and Mr. Tony Tran are production engineers. They are in charge of delegating project responsibilities, managing all managers in the field. They will report their findings to Mr. Constantino.

*Simulation & Optimization Engineer*

Tejas Patel and Jeremy Contantino, simulation and optimization engineer is in charge of running the PRO-II software from the data that are obtained from the production of oil. They will directly report to Mr. Tran for production purposes.

*Chief Financial manager*

John Truong, networking and web design engineer, is responsible for creating and updating the website on which all the findings and net profits will be published. He will report all of his updates to Ms. Iland.

### *3.3.2 Benefits for our Employees*

The majority of our personnel are under 40 years of age, many of whom have young children. We, in concert with another business enterprise, have made an arrangement with a national child care chain to maintain a child care center for our personnel. OU Biorefining, Inc covers 50% of the employee's expense for the child care, as well as guaranteeing the center a minimum amount of business. We provide our employees and their dependents with insurance covering medical and hospitalization. They also get two weeks of vacation and ten holidays each year.

## *3.4 Operations*

OU Biorefining plan to purchase or construct a plant in Dubuque, Iowa. This plant will also serve as corporate headquarters until a need for relocation is observed. The company

will subcontract transportation of finished goods from the plant to the potential markets throughout America.

### *3.5 Future*

The plant will begin operation with an initial capacity of 35 million pounds of final product in the first year and expand to produce 65 million pounds by final year of operation. To achieve this expansion new equipment will be purchased and more capital will be invested to attain our final goal of 280 million dollars NPV by the end of 20 years of operation. The total initial capital investment necessary to achieve this net present value is $150 million.

## 4.0 The Market

The prospect buyers for our biorefinery products are the several manufacturers that incorporate the use of solvents and plastics. Generated from the various fermentation chemicals, the following products and chemicals can be manufactured.

**Table 1:** Chemicals Produced by Fermentation

| Fermentation Chemical | End Uses |
|---|---|
| Succinic Acid | Pharmaceuticals, toiletries, paper,<br><br>Beverages, dyes, manufacture of lacquers |
| Fumaric Acid | dyes, printing ink, cleansing agents, plastic<br><br>Flavoring agent |
| Propionic Acid (Sodioum Propionate) | animal feed/grain preservatives<br>calcium & sodium salts (sodium propionate) as mold inhibitant |
| Ethanol | Plastics, herbicides, fuels, solvents,<br>chemicals, beverages |

### *4.1 Objectives*

There are many prospective buyers of the products and biochemicals produced in our biorefineries. Solvent usage is an essential part of many industries. Solvents are used in adhesives, paints and coatings, pharmaceuticals, inks and printing, semiconductor manufacturing and metal cleaning.

The prospective buyers of bioplastics are market areas that are associated with fibers, packaging and fiber-fill. Fibers are needed for use in carpet tiles, apparel, industrial fiber and non-wovens. Bioplastic packaging is useful for films, coated papers, and rigid

containers. The prospective user can use the fiber-fill bio plastics for comforters, pillows, mattresses toppers, and mattress pads.

The benefits of our biorefinery solvents are that they generate less volatile organic compounds, are biodegradable, and less toxic. Therefore these solvents are safer to handle as well as being more environmentally friendly.

Bioplastics and fibers are beneficial in that they are breathable, resilient, have improved dyeability and are biodegradable. The demands and projected growth outlook of each product we plan to produce are shown in Table 2.

**Table 2:** Market Analysis[2]

| | Demand | Growth Outlook |
|---|---|---|
| **Succinic Acid** | PVP (polyvinly pyrrolidinone) 50M lbs/yr<br>Itaconic acid - 20M lb/yr world-wide | 6-10% /yr Overall |
| **Fumaric Acid** | 4.34M lb/yr | Historical (1994-1999): High $0.65/lb, Low $0.58 /lb<br><br>Currently: $0.65 /lb industrial grade<br><br>$0.85 /lb food grade |
| **Ethanol** | Industrial (synthetic and fermentation)-<br>2001: 269M gal<br>2005: 287M gal projected<br><br>Fuel, Food, Beverages (all fermentation)-<br>2001: 1.7M gal<br>2005: 2.79M gal projected | Historical (1996-2001): 7.8 % /yr<br>10.5% yr through 2005 projected |
| **Propionic Acid (Sodium Propionate)** | 2002: 204M lbs<br><br>2006: 219M lbs projected | Historical (1997-2002): 1.2% /yr<br><br>1.8% /yr through 2006 expected |

[2] http://www.the-innovation-group.com/ChemProfiles/.htm

## *4.2 Size*

The production of four different fermentation processes (fumaric acid, sodium propionate, succinic acid, and ethanol) will be performed in the biorefinery. Each of these acids is generated using a nearly identical process with different bacteria that dictate the end results and produce various end produces.

Propionic acid, used for the conversion to sodium propionate, is used mainly for animal feed preservation, and in human food applications, (mainly baked goods and cheese) to inhibit mold. The microorganism used to ferment sodium propionate is Propionibacterium acidipropionici.[3] The theoretical yield or amount of glucose converted into the respective product for this fermentation processes is 67%.

Using the bacterial microorganism Anaerobiospirillum succiniciproducens which presents a yield of 87%, succinic acid can be converted into chemical feedstocks used to manufacture plastics, inks, fabrics, paints, and food additives.[4]

Ethanol is created through the fermentation of glucose with the Saccharomyces cerevisiae bacteria.[5] According to research on fermentation ethanol use, fuels makes up 92% of usage, followed by industrial solvents and chemicals, and beverages, each of which make up 4%.

Fumaric acid is polymerized to polylactic acid with the help of the Rhizopus bacteria.[6] This bacteria converts 69% of the glucose into respective products such as dyes, cleansing and flavoring agents, and plastics.

The growth outlook for fermentation chemicals is expected to be substantial as the use of fossil fuel derived products are phased out due to increases in federal regulations and initiatives encouraging renewable resource use. Demand in the United States is forecasted to surpass a value of $9 billion in 2007 with a volume expected to exceed 30 billion pounds with the majority of use coming from the areas of solvents, plastics and fibers, and fuels.[7]

The United States, consumption for solvents are in excess of 8.4 billion lb/yr and the market demand for plastics and fibers is about 80 billion lb/yr.[8] It is projected that this market area will see the fastest growth, while that of fuel will remain the largest market

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[3] http://www.ryanherco.com/Industries/Health/Articles/BiotechnologyBook/Health03_Microorganisms.pdf

[4] http://www.ryanherco.com/Industries/Health/Articles/BiotechnologyBook/Health03_Microorganisms.pdf

[5] http://www.ryanherco.com/Industries/Health/Articles/BiotechnologyBook/Health03_Microorganisms.pdf

[6] http://www.ryanherco.com/Industries/Health/Articles/BiotechnologyBook/Health03_Microorganisms.pdf

[7] http://www.mindbranch.com/listing/product/R154-858.html

[8] http://pep.sric.sri.com/Public/Reports/Phase_2003/RP206A/RP206A.html

for fermentation products; however much uncertainty exists in this market, since demand is highly sensitive to politically derived influences. Figures 3 and 4 below show the forecasted market demand as well as the forecasted market prices for biomass production.

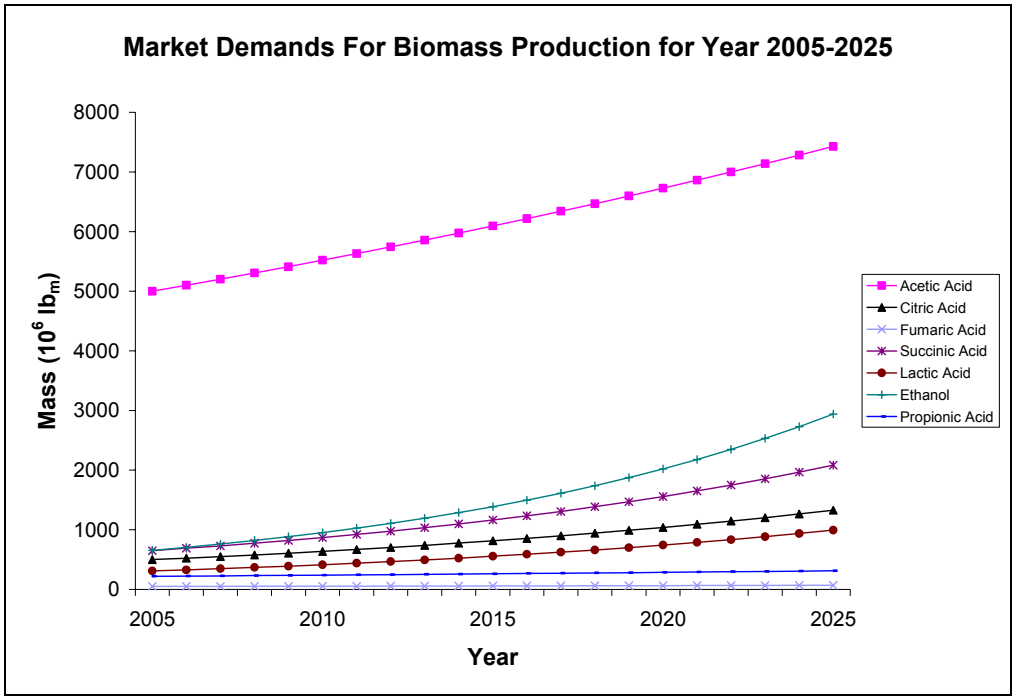


**Figure 3**: Market Prices Projects of Bioderived Chemicals for Next 20 Years[9]

[9] http://www.the-innovation-group.com/ChemProfiles/

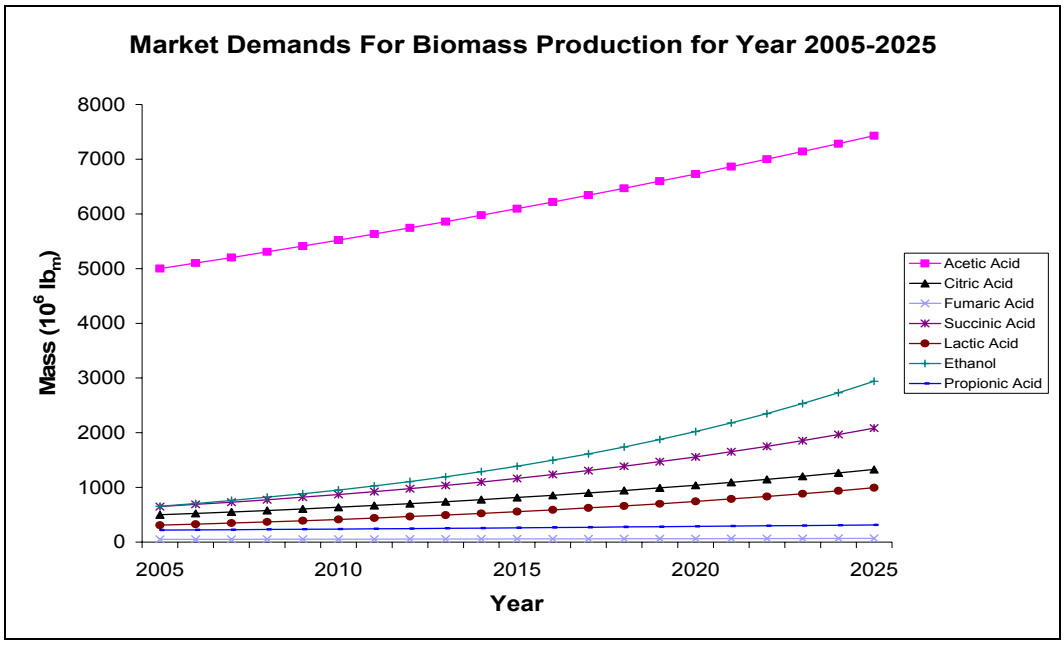


**Figure 4**: Market Demand Projects Bioderived Chemicals for Next 20 Years[9]

It is expected that the demand for fermentation chemicals will steadily grow due its environmental profile. This positive profile will increase consumer interest and industrial applications of fermentation chemicals. As a result, it is assumed that more competition will arise to take advantage of the demand, and this will result in an over capacity of production. Therefore, because price is a combination of supply and demand, it is projected that prices will drop and remain fairly steady over the lifetime of our project**.**

## *4.3 Environment*

There are an increasing number of national and local policies that promote the development of bio based products as shown in Figure 5. As these initiatives continue to be encouraged, the use of nonrenewable fossil fuel derived products continue to be phased out due to strict environmental regulations. There has been a sharp rise in the number of laws and amendments that have been implemented as the awareness of the many benefits of biorefining is gained.

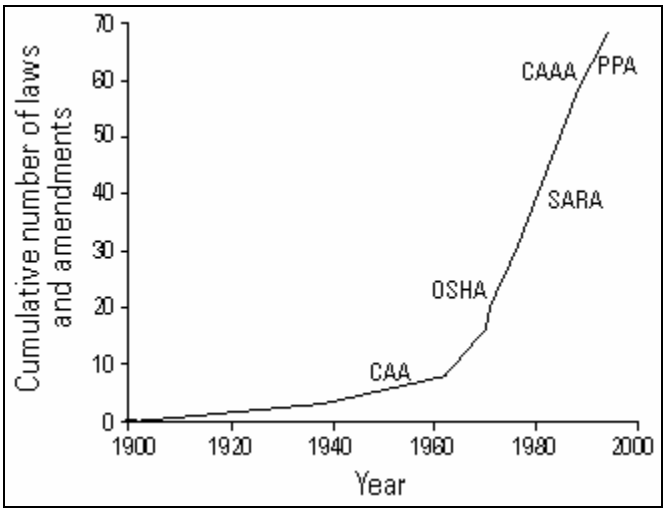


**Figure 5:** Laws and Environmental Regulations. CAA - Clean Air Act, OSHA - Occupational Health and Safety Administration, SARA – Superfund Amendment and Reauthorization Act, CAAA -Clean Air Act Amendment, PPA - Pollution Prevention Act of 1990.[10]

Having an improved, more positive impact on the environment is one of the best qualities of bio based products and chemicals. Both upstream and downstream pollutions are reduced. Less pollution is generated from the overall manufacturing process and there is less amount of energy needed. Furthermore, the chemical products produced at our biorefinery are biodegradable, and can safely be disposed of with fewer toxic waste emissions resulting in less pollution in the downstream process. Overall, the pollution generated in all phases of production, manufacturing, and disposal are eliminated or significantly reduced.

Because of the many positive aspect of these factors, the popularity of bioplastics and biochemicals continue to grow at a rapid rate.

## 5.0 Capital Investment

The total capital investment of the project was a constraint that was selected based on maximizing the net present value. The total capital investment was determined from the equipment cost based on simulations that determined the equipment cost per mass flow rate of the product. These numbers were considered in the reducible mathematical model to determine the optimal design to maximize the net present value.

### *5.1 Total Capital Investment*

The total initial capital available is only $150,000,000, but once revenue is generated, this monetary sum will be used to invest in expansion opportunities for the plant. The total fixed capital requirements for the production of each chemical is given in Figure 6 as well as the percent distribution for each process.

[10] http://ehp.niehs.nih.gov/members/1998/Suppl-1/253-271sherman/full.html

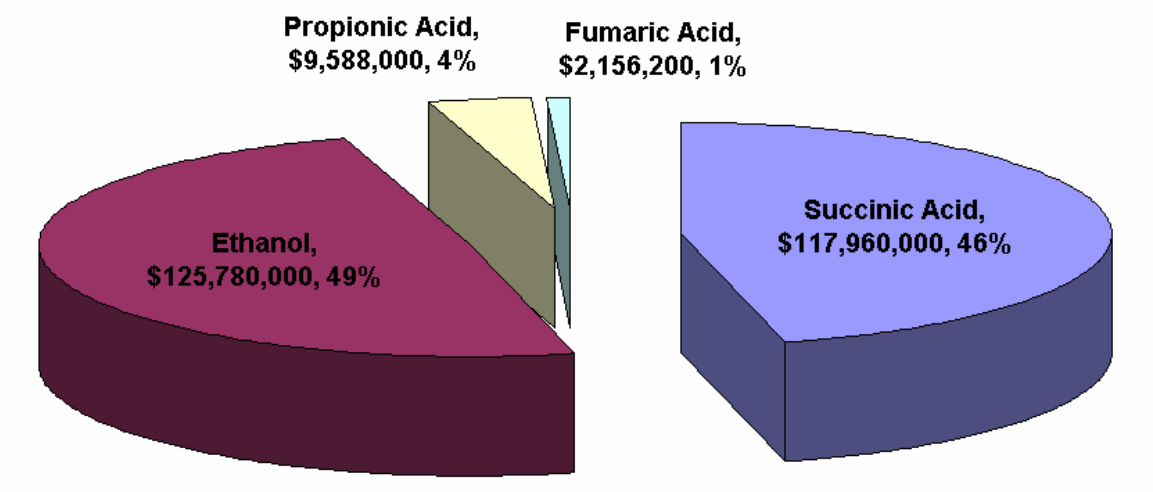


**Figure 6:** Fixed Capital Distribution for Lifespan of Project

Based on Figure 6, the majority of product produced from the biorefining plant will be ethanol and succinic acid. They will be produced in the greatest quantity, as well as have the greatest allocation of the fixed capital investment. This is because the market prices for these chemicals are greater than that of fumaric and propionic acid. Even though the capital investment for fumaric and propionic acid seem relatively insignificant, there was excess capital available to make the investment profitable.

In addition to the consideration of different possible fermentation products, different markets throughout the United States will be considered. These markets are broken down by three regions: West, Central, and East. Because the demand and the market prices for the chemicals produced vary between the regions, each region varies in the amount of the product transported to their region. Figure 7below illustrates the distribution of the amount of the products sold by region.

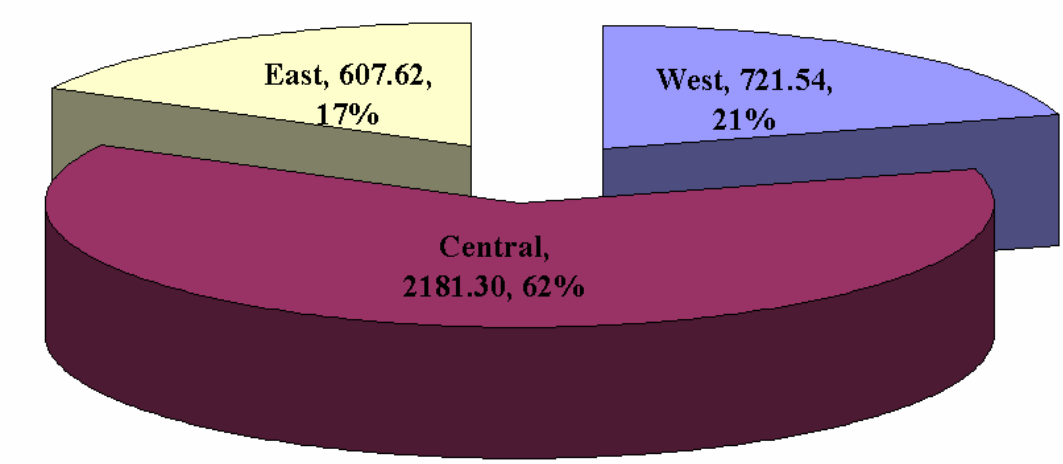


**Figure 7:** Market Region Distribution of Sold Chemicals (MM $lb_m$) for Lifespan of Project

As revenue is being generated, this inflow of cash will be used to invest in expansion opportunities for the biorefining plant. Figure 8 illustrates the increases in production due to these expansion opportunities.

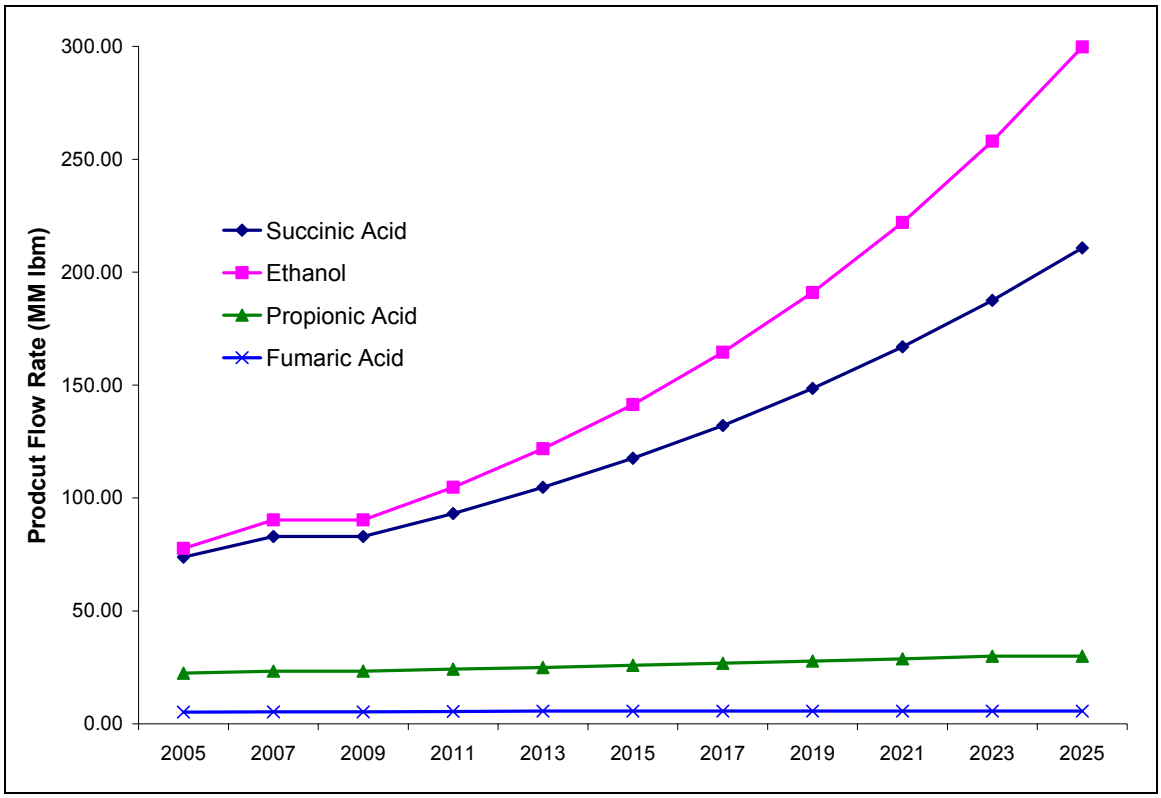


**Figure 8:** Biomass Production Increase for Lifespan of Project

## *5.2 Operating Cost*

The annual operating cost is dominated by the raw material cost. Also contributing greatly to the annual operating cost is the maintenance cost to keep equipment functioning. The figure below shows the breakdown of annual operating cost for a general biorefining plant.

| Table 3: Summary of Operating and FCI | | | |
|---|---|---|---|
| Acids | Capacity ($ MM lb) | FCI ( $ /MM/yr) | Operating cost ($ MM/ yr) |
| Succinic Acid | 34.9 | 71.9 | 20.5 |
| Acetic Acid | 37.9 | 49.8 | 14.4 |
| Propionic Acid | 34.1 | 56.9 | 15.8 |
| Citric Acid | 35 | xxxxxxx | 14.7 |

## 6.0 Conclusion

Based on the net present value from the mathematical model, the proposed project is profitable and therefore recommended to implement. OUBR believes that the total capital investment is $150 million and the net present worth will be $280 million. Therefore it is recommended that biorefining based products be derived to replace petroleum based products.

OU Biorefining Business Plan Time Line