FEASIBILITY STUDY OF A 100-MILLION GALLON ETHANOL PLANT IN DES MOINES, IOWA

by

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ABSTRACT

The cost of energy is a major concern for the United States and its citizens. With domestic demand at all time highs, the need for renewable fuels has become a key in reducing our countries reliance on imported energy. It is important for the U.S. to examine the feasibility of producing its own energy from renewable resources that can be grown domestically. Along with the potential financial gains from renewable fuels, the ability to control the supply of energy for the U.S. is also very important. With the amount of oil imported by the U.S., the ability to produce more of our nations needs and not be forced to rely on other countries could be important for our country moving forward. With the political unrest in many oil producing areas, the security of energy independence is a goal for the U.S.

This study uses United States Department of Agriculture, Pro Exporter, Advance Trading, and other statistical sources to analyze the economic feasibility of an ethanol plant near Des Moines, IA. It looks at the available supply of corn in the area as well as the production of ethanol and distillers grains.

An increase in the price of imported oil does not necessarily results in an economically viable ethanol plant. Many variables go into the economic viability of an ethanol plant and consumers will still buy the low cost good, and that may be imported energy. Some of these variables affecting economic viability include corn price and availability, denaturant price, natural gas price, ethanol demand and distillers grains demand.

With the push for cleaner air and a cleaner environment, ethanol is also used as a gasoline additive to reduce emissions. As more states regulate a higher inclusion rate of ethanol, this will continue to create greater demand.

A 100 million gallon ethanol plant is an economically viable investment in the Des Moines area, but when looking at the sensitivity tests, the better investment option if investors want to enter the ethanol industry, is to buy an existing ethanol plant.

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CHAPTER I: INTRODUCTION

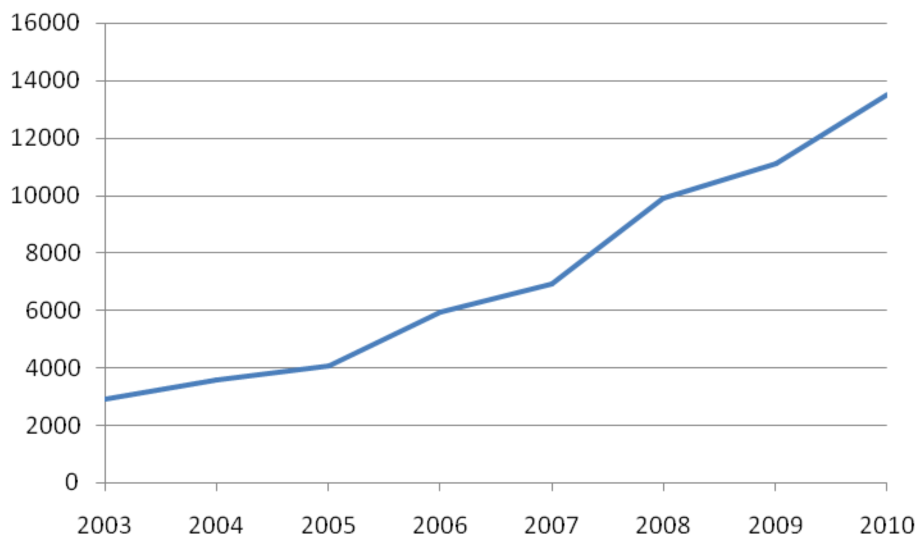
The United States is the world's largest consumer of oil, and yet produces only a small percentage of its oil needs. The U.S. must rely on other countries to produce oil and energy. As the U.S. strives to become more energy independent in a world of economic and political turmoil, renewable energies such as ethanol play a major role in that independence. The world is also facing moral questions such as food versus fuel. For the purpose of this paper, the author will be assuming that no food will be taken away from a nation's people, and the job of the market is to ration corn as necessary for food.

Because of the ever changing political make up of the ethanol industry, all calculations and profitability projections are made without any blenders credits. All calculations are done on the basis that the ethanol plant will rely on its own income and revenue generated from sales. This however will not completely eliminate the government's influence on our study or the ethanol industry. As long as there are ethanol production mandates, the government has a role in the size and profitability of the ethanol industry.

The ethanol industry has seen many changes since its inception in the 1970s. The ethanol industry was a small specialized industry until the mid to late 1990s when more plants began production across the Corn Belt. The expansion in the early to mid 2000s was unprecedented and grew at a rate that many argue was faster than the infrastructure could handle. The industry has seen margins go from four dollars per gallon at its peak in 2006-2007 to the point of break even or a slight loss in 2010. There have been many factors leading to the difficulties today that will be addressed in this thesis.

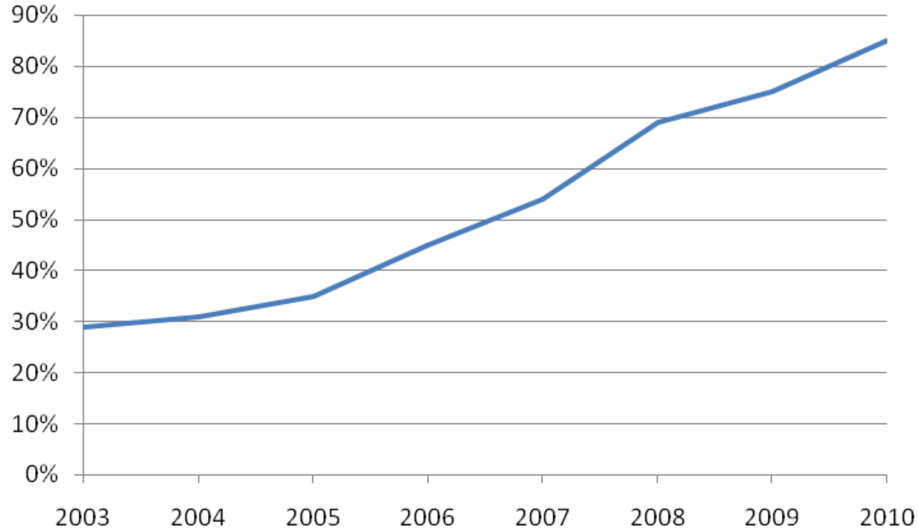
Production and consumption of ethanol continues to grow in the United States (Figure 1.1). The U.S. will produce approximately 12.595 billion gallons of ethanol in 2010. The industry has seen tremendous growth in the last few years and is predicted to reach 15 billion gallons before the year 2012 according to many private analysts and industry leaders. With the added supply, there has been increased demand. Approximately 85% of the gasoline consumed in the U.S. has some ethanol blended with it (Figure 1.2). Depending on the region and state regulations, it may range from a 1% to 2 % mix, an E10 blend, or an E85 blend.

Figure 1.1: U.S. Ethanol Production in Million Gallons



Source: Pro Exporter

Figure 1.2: Weekly Percent of Gasoline Containing Ethanol in the U.S.



Source: Pro Exporter

This thesis explores the economic feasibility of a corn ethanol plant in Des Moines, IA. The domestic demand for renewable energies has increased over the past few years as the price of crude oil has risen from $40 per barrel to over $100 per barrel. The U.S. also saw increased supplies of corn in the market, making corn ethanol a viable replacement for crude oil. But now with higher prices of corn, many are concerned that we are spending more energy and money to make ethanol than can be generated from the refined product.

Chapter 2 provides a conceptual model of the ethanol plant as well as a background on the ethanol process and what is needed to produce a gallon of ethanol. Chapter 3 discusses the capital requirements for construction as well as the initial investments that are needed to start up the plant. The fourth chapter will analyze the production and input costs as chapter five discusses the outputs and incomes. Chapter 6 analyzes net present value and does sensitivity testing. And finally, the conclusion (chapter 7) summarizes the process and answers the question of whether or not an ethanol plant should be built near Des Moines, IA.

CHAPTER II: BACKGROUND

In chapter 2, the conceptual model will be defined, as well as a background on the ethanol process, how ethanol is produced and what is needed to produce a gallon of ethanol.

2.1 Model

The economic model consists of four different variables; the cost of corn (inputs), the cost of natural gas (inputs), the value of ethanol (outputs), and the value of distillers grains (output).

Economic theory suggests that the price of corn and other grains will decrease in years of high production and increase in the years of poor production. Distillers grains closely follows the price of corn as it is a substitute for corn in many feed rations. Therefore, as the price of corn increases, so does the price of distillers grains and vice versa as corn prices fall.

In the same way, the demand for energy, both ethanol and natural gas, can be predicted by not only national but international supply and demand. When the nation or world experiences times of cold weather, natural gas demand increases causing an increase in price.

Conceptual Model:

Ethanol Plant Profit = Ethanol Revenue + Distillers Revenue – Corn input costs – Natural Gas input costs – Fixed costs.

2.2 Net Present Value

When a company or groups of investors are looking at a project, they need to use tools to help them decide whether to make that investment. Net Present Value (NPV) will be used to calculate the economic return on this investment. NPV compares the value of a dollar today to the value of that same dollar in the future, taking inflation, risk, and the preference for consumption into account. If the NPV of a prospective project is positive, it should be accepted. However if the NPV is negative, the project should be rejected.

The key factor to NPV is the discount factor. When looking at any financial decision, the amount of interest paid on money borrowed, or the lost opportunity on money that could have been invested some place else, must be considered and weighed in the equation. NPV also converts future cash value to present value, as one dollar today is worth more than one dollar a year from now. Embodied in NPV is the ability to estimate future cash flow and expected interest rates.

There are a couple of draw backs to NPV. First, NPV assumes that all inputs and outputs are known. Therefore the results are only going to be as good as the data used to determine the NPV. In this study, all of the futures prices and values have been pulled from industry analysis, but like all things in agriculture, prices are subject to change. The second drawback is in assessing risk. If you have two projects you are looking at and one of them is in a very volatile high risk industry such as the ethanol industry and one is a very low risk investment such as government bonds, NPV may come back with results very similar unless the discount rate is properly adjusted. Unless the investment is a pure publicly traded investment, it is difficult to determine the appropriate adjustment for the discount rate. It is then up to the individual investor to decide how to adjust the discount rate.

2.3 Corn Supply

A local supply of the primary feed stock, corn, is essential for locating an ethanol plant. The following are the 7 year historical planted acres (Table 2.1), harvested acres (Table 2.2), the percent of planted acres harvested (Table 2.3), the yield (Table 2.4) and production (Table 2.5) for the nine-county study area. U.S. corn production has ranged from 163 to 202 million bushels over the last seven years. A 100 million gallon ethanol plant will consume approximately 36 million bushels of corn per year.

Table 2.1: Planted Acres of Corn for a Nine County Area in Iowa

County	2003	2004	2005	2006	2007	2008	2009
Boone	144,000	148,500	145,000	150,000	168,000	163,500	166,500
Dallas	129,000	127,000	133,000	128,000	144,000	135,000	140,000
Jasper	162,000	161,000	165,000	161,500	183,500	172,500	185,500
Marshall	140,500	144,000	144,000	142,500	160,000	146,000	155,000
Polk	89,500	94,500	94,000	89,500	99,000	93,500	93,500
Story	161,000	162,500	168,000	159,500	189,000	176,000	173,000
Madison	65,500	66,500	68,000	63,000	74,500	63,500	76,000
Marion	77,000	79,000	78,000	77,500	90,000	84,000	85,000
Warren	67,000	71,000	74,000	68,000	75,000	70,500	69,000

Source: USDA

Table 2.2: Corn Harvested Acres for a Nine County Area in Iowa

County	2003	2004	2005	2006	2007	2008	2009
Boone	142,000	148,000	144,000	149,700	166,000	158,500	166,000
Dallas	126,000	126,000	132,000	127,000	142,500	131,000	139,000
Jasper	159,500	159,500	163,500	160,800	181,500	172,500	185,000
Marshall	137,500	142,500	142,500	141,600	157,700	141,500	154,500
Polk	88,000	94,000	93,000	89,300	98,500	90,000	93,000
Story	159,000	161,000	166,500	158,000	187,500	169,000	172,500
Madison	62,500	64,000	66,000	61,300	72,800	62,000	75,200
Marion	75,500	76,500	75,500	75,900	88,100	81,000	84,000
Warren	64,500	68,000	71,000	67,100	73,000	68,000	67,800

Source: USDA

Table 2.3: Percent of Corn Harvest Acres vs. Planted Acres for a Nine County Area in Iowa

County	2003	2004	2005	2006	2007	2008	2009
Boone	98.60%	99.70%	99.30%	99.80%	99.80%	96.94%	99.69%
Dallas	97.70%	99.20%	99.20%	99.20%	98.96%	97.03%	99.28%
Jasper	98.50%	99.10%	99.10%	99.60%	98.91%	99.99%	99.73%
Marshall	97.90%	99.00%	99.00%	99.40%	98.56%	96.91%	99.67%
Polk	98.30%	99.50%	98.90%	99.80%	99.49%	96.25%	99.46%
Story	98.80%	99.10%	99.10%	99.10%	99.21%	96.02%	99.71%
Madison	95.40%	96.20%	97.10%	97.30%	97.72%	97.63%	98.94%
Marion	98.10%	96.80%	96.80%	97.90%	97.89%	96.42%	98.82%
Warren	96.30%	95.80%	95.90%	98.70%	97.33%	96.45%	98.26%

Source: USDA

Table 2.4: Corn Yield in Bushels per Acre for a Nine County Area in Iowa

County	2003	2004	2005	2006	2006	2008	2009
Boone	170	192	192	172	180	166	186
Dallas	147	189	181	164	167	171	187
Jasper	171	194	188	173	178	182	184
Marshall	179	185	191	184	182	180	181
Polk	165	183	174	171	176	154	182
Story	164	188	187	184	177	160	176
Madison	134	175	154	158	162	165	168
Marion	147	170	159	156	162	143	165
Warren	135	167	157	164	155	135	160

Source: USDA

Table 2.5: Total Corn Production for a Nine County Area in Iowa

County	2003	2004	2005	2006	2007	2008	2009
Boone	24,196,800	28,445,600	27,705,600	25,853,190	30,018,000	26,300,000	30,875,000
Dallas	18,597,600	23,889,600	23,984,400	20,866,100	23,802,000	22,400,000	26,085,000
Jasper	27,354,250	30,974,900	30,819,750	27,963,120	32,327,000	30,200,000	34,035,000
Marshall	24,695,000	26,376,750	27,345,750	26,096,880	28,809,000	25,400,000	27,965,000
Polk	14,546,400	17,239,600	16,247,100	15,350,670	17,365,000	13,900,000	16,925,000
Story	26,155,500	30,284,100	31,235,400	29,087,800	33,309,000	27,000,000	30,360,000
Madison	8,418,750	11,238,400	10,223,400	9,709,920	11,850,000	10,200,000	12,635,000
Marion	11,136,250	13,027,950	12,072,450	11,863,170	14,340,000	11,600,000	13,860,000
Warren	8,759,100	11,396,800	11,154,100	11,064,790	11,353,000	9,200,000	10,850,000
Total Production	163,859,650	192,846,700	190,787,950	177,855,640	203,173,000	176200,000	203,590,000

Source: USDA

Table 2.6: Average U.S. Corn Yields

2003	2004	2005	2006	2007	2008	2009
142.2	160.4	147.9	149.1	151.1	153.9	164.9

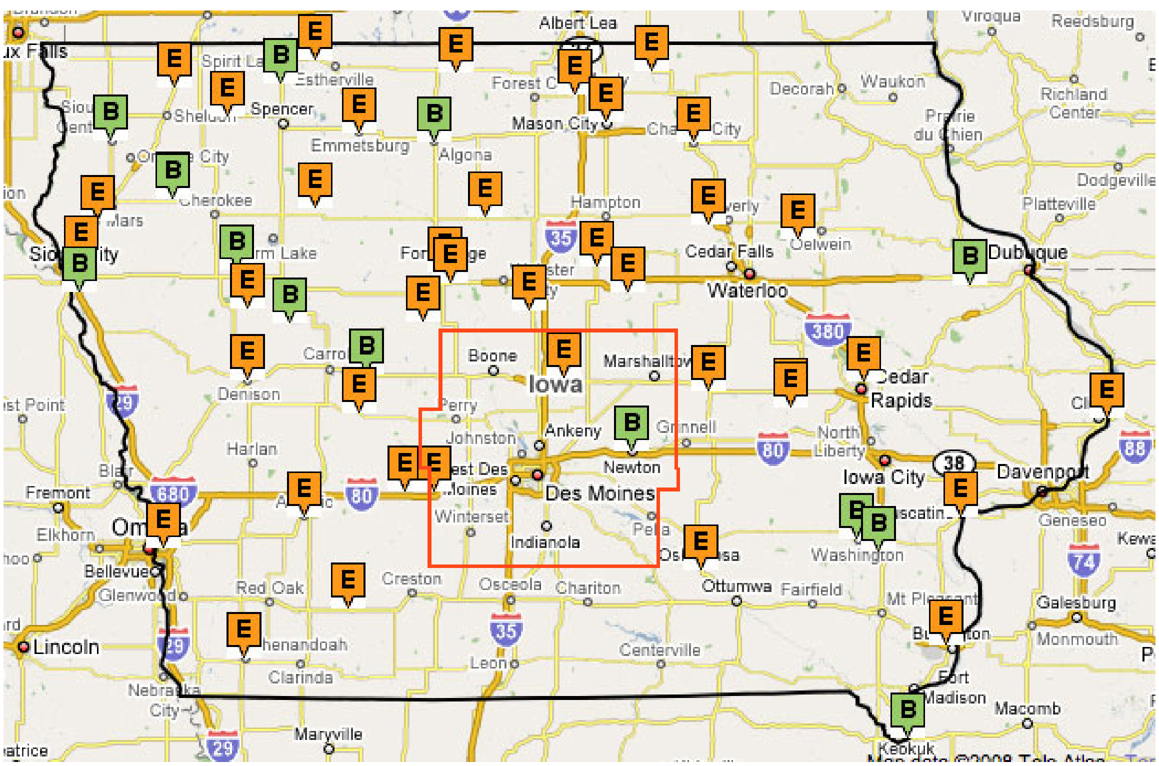
Source: USDA

Yields shown in table 2.4 for the nine-county area are above the national averages shown in table 2.6, and are slightly more volatile. Yields in the nine county area of study over the past seven years have had a range of 59.5 bushels per acre, while the U.S. average in table 2.6 has only had a 22.7 bushel per acre range with a high of 164.9 bushels per acre in 2009 and a low yield of 142.2 bushels per acre in 2003. Corn produced in Iowa is shipped via railroad to markets in the east and southwest with similar amounts marketed locally for feed and industrial use.

With the amount of corn produced in the nine county area, there should be no need to rail corn into the ethanol plant, thus all of the corn will be supplied by truck. The area will see decreased amounts of corn used for feed as it is replaced by DDGS and it will also see a decreased amount of corn sold out of the area via rail, which is the major competitor for corn in the area. In 2009, the nine-county area produced 203.59 million bushels of corn (Table 2.6). The ethanol plant will require 36 million bushels per year. This is 17.68 percent of the nine-county production.

The area under consideration does have other ethanol plants near by but not in the Des Moines area. Figure 2.1 show a map of ethanol plants (E) as well as biodiesel plants in the area (B).

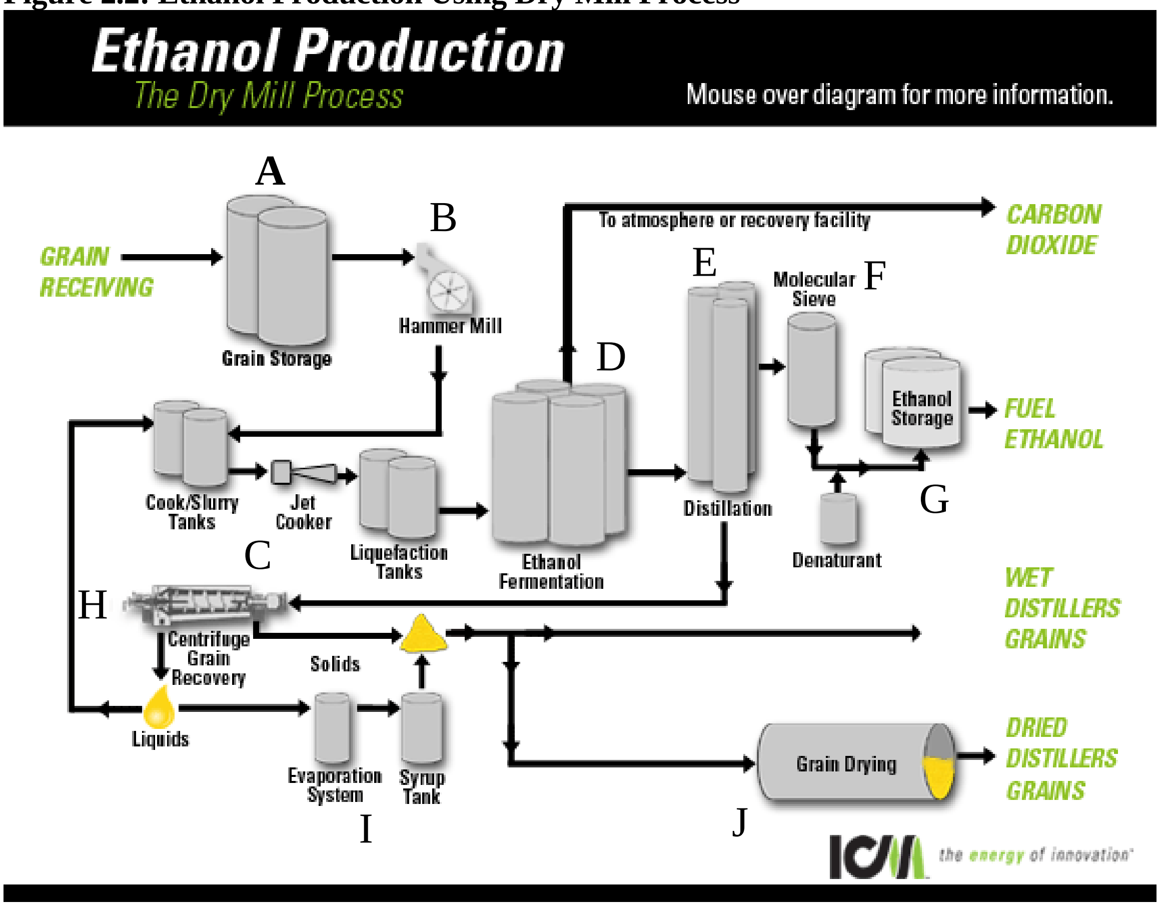
Figure 2.1: Iowa Ethanol Plant Map



2.4 Ethanol Production Process

Ethanol is commercially produced in one of two ways, using either the wet mill or dry mill process. Wet milling involves separating the corn kernel into its component parts (germ, fiber, protein, and starch) prior to fermentation. The plant type being researched in this study is the dry mill process, more specifically an ICM designed plant (Figure 2.2). The dry mill process is where the entire corn kernel is ground into flour. The starch in the flour is then converted to ethanol during the fermentation process, also creating carbon dioxide and distillers grain. (ICM, 2006)

Figure 2.2: Ethanol Production Using Dry Mill Process



Source: ICM

Delivery

Corn is delivered by truck or rail to the ethanol plant where it is loaded into storage bins. These bins normally have the capacity to hold up to 30 days worth of grind production (A, Figure 2.2).

Milling

The grain is screened to remove debris, such as corn stalks, and then ground into course flour by a hammer mill (B, Figure 2.2).

Cooking

The milled grain is mixed with process water, where the pH is adjusted to about 5.8, and an alpha-amylase enzyme is added. The slurry is heated to 180-190 degrees Fahrenheit for 30-45 minutes to reduce viscosity. The slurry is then pumped through a pressurized jet cooker at 221 degrees and held for 5 minutes. The mixture is then cooled by a vacuum condenser. After flash condensation cooling, the mixture is held for 1-2 hours at 180 to 190 degrees to give the alpha-amylase enzymes time to break down the starch into short chain dextrins. After pH and temperature adjustment, a second enzyme, glucoamylase is added as the mixture is pumped into the fermentation tanks (C, Figure 2.2).

Simultaneous Saccharification Fermentation

Once inside the fermentation tanks, the mixture is referred to as mash. The glucoamylase enzyme breaks down the dextrins to form simple sugars. Yeast is added to convert the sugar to ethanol and carbon dioxide. The mash is then allowed to ferment for 50 to 60 hours, resulting in a mixture that contains about 15% ethanol as well as the solids from the grain and added yeast (D, Figure 2.2).

Distillation

The fermented mash is pumped into a multi-column distillation system where additional heat is added. The columns use the differences in the boiling points of ethanol and water to boil off and separate the ethanol. By the time the product stream is ready to leave the distillation columns, it contains about 95% ethanol by volume (190 proof). The residue from the process, called stillage, contains non-fermentable solids and water, and is pumped out from the bottom of the columns into centrifuges (E, Figure 2.2).

Dehydration

The 190 proof ethanol still contains about 5% water. It's passed through a molecular sieve to physically separate the remaining water from the ethanol based on the different sizes of the molecules. This step produces 200 proof anhydrous ethanol (F, Figure 2.2).

Ethanol storage

Before the ethanol is sent to storage tanks, a small amount of denaturant is added making it unfit from human consumption. Most ethanol plants' storage tanks are sized to hold 7 to10 days of production capacity (G, Figure 2.2).

Co-Product Processing

During the ethanol production process, two valuable co-products are created: carbon dioxide and distillers grains. As yeast ferment the sugar, they release large amounts of carbon dioxide gas. It can be released into the atmosphere, but it’s commonly captured and purified with a scrubber so it can be marketed to the food processing industry for use in carbonated beverages and flash freezing applications.

The stillage from the bottom of the distillation tanks contains solids from the grain and added yeast as well as liquid from the water added during the process. It’s sent to centrifuges for separation into thin stillage (a liquid with 5-10% solids) and a wet distillers grain (H, Figure 2.2).

Some of the thin stillage is routed back to the cook/slurry tanks as makeup water, reducing the amount of fresh water required by the cook process. The rest is sent through a multiple effect evaporation system where it is concentrate into syrup containing 25 to 50% solids. This syrup, which is high in protein and fat content, is then mixed back in with the wet distillers grain (WDG) (I, Figure 2.2).

With the added syrup, the WDG still contains most of the nutritive value of the original feedstock plus the added yeast, so it makes an excellent feed for local feedlots and dairies. After the addition of the syrup, it’s conveyed to a wet cake pad, where it is loaded for transport.

Many ethanol facilities do not have enough nearby cattle to use all of the WDG. It must be used soon after it’s produced because it spoils easily. Often it is sent through a drying system to remove moisture and extend its shelf life. This dried distillers grain (DDG) is commonly used as a high-protein ingredient in cattle, swine, poultry, and fish diets. It’s also being researched for use in human consumption (J, Figure 2.2).

CHAPTER III: INITIAL INVESTMENT AND CAPITAL REQUIREMENT FOR CONSTRUCTION

Chapter three will examine the capital requirements for construction of an ethanol plant as well as the initial investment that will be needed to start up the proposed plant.

3.1 Plant, Buildings, and Equipment

The plant cost is a quoted amount from ICM/Fagen, the construction firm chosen. This figure includes the buildings and the equipment directly related to the ethanol production facility. This cost does not include site improvements, utility construction and hook-ups, or rail improvements. The cost for the plant construction is $200,000,000 (Fagen Inc., 2008).

3.2 Site Costs

Site improvements include dirt work, entry and exit access and other costs related to preparing the site for plant construction. Any additional buildings unrelated to the plant area are included in these costs. Road access costs are also included. The total costs for site improvements are assumed to be $1,500,000 (Heartland Coop, 2006).

Utilities are readily available. Costs associated with utilities include site infrastructure and connecting to providers. The estimated utility connection is $1,500,000 (Heartland Coop).

Rail costs make up the largest percentage of the site costs. A loop track will be installed for the purpose of loading both unit trains of ethanol and DDGS. A unit train consists of 100 cars that are pulled at one time. For this type of program 7,000 track feet will be needed plus an additional 2,000 feet worth of ladder track for single cars. This configuration will cost $6,000,000 (Union Pacific Rail Road, 2008).

Land is estimated at $10,000 per acre due to the proximity to the urban area of Des Moines. A quarter section of land (160 acres) will be needed for the 100 million gallon ethanol plant so the total land cost will be $1,600,000.

3.3 Organizational, Permitting, and Engineering Costs

Additional engineering costs are estimated at $350,000. Although most engineering costs are included in the plant price, there are some engineering costs associated with the site improvements.

Permitting costs are estimated at $150,000. These costs include legal and filing fees associated with the permitting process.

Organizational costs are estimated to be $1,500,000. This includes funds for raising equity and associated filing and legal costs.

A contingency of $1,500,000 is included to cover any unexpected cost during the planning and construction phases (Heartland Coop, 2006).

3.4 Working Capital

Plant start-up costs that include purchasing supplies and grain require working capital. Additionally, banks often require a certain amount of working capital in their loan covenants. A total of $11,000,000 will cover two month's expenses including inventories which is the total inventory required for efficient operation.

Total start-up for the construction of the facility is $214,100,000.

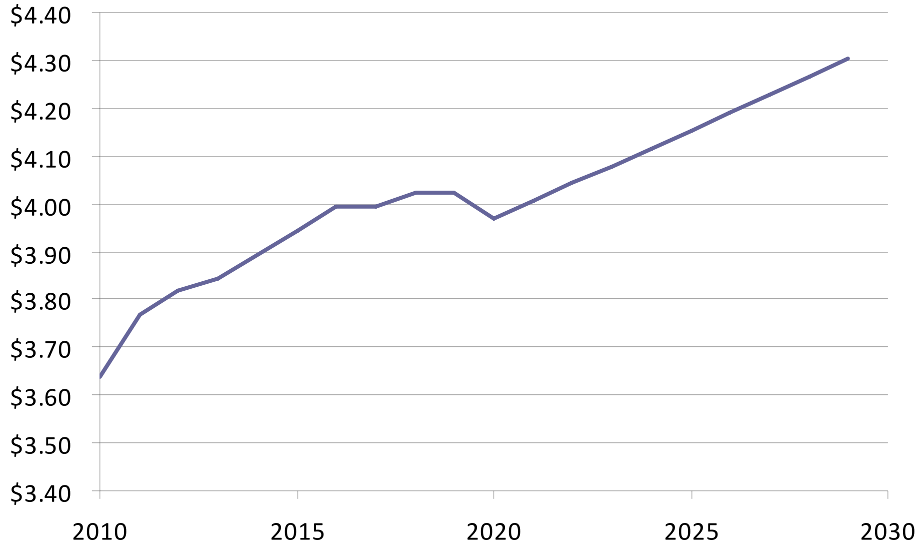
CHAPTER IV: PRODUCTION AND INPUT COSTS

The major input costs for an ethanol plant come from the purchasing of corn, natural gas, electricity, denaturant, chemicals and yeast, water and sewer, overhead, and administrative costs. All of these items will be discussed in greater detail.

4.1 Corn Price

Over the past 48 months, we have seen a wide range in corn values. Cash corn in Iowa has traded from as low as $2.50 per bushel to as high as $8.00 per bushel (Advance Trading). With a proper risk management team in place, the ethanol plant can minimize the affects of the wide ranges and violent swings in corn prices. With proper risk management in place, decisions such as selling ethanol and distillers grains at the time of corn purchases to lock up positive incomes is just one responsibility for the risk management team. The current price is a historically high price for corn, but due to the increase in demand and the very volatile market conditions over the past year, this is a realistic cost. According to Food and Agriculture Policy Research Institute (FAPRI), average corn prices are expected to increase from $3.65 per bushel in 2010 to $3.98 per bushel in 2020 (Food and Agriculture Policy Research Institute, 2010). The average rate of change is calculated to be 0.8% per year for the 11 year average. So for the purposes of this project we will assume an average annual price increase for the next nine years at a 0.8% increase annually. By 2030, the average corn price is expected to be $4.30 per bushel.

Figure 4.1: Projected Corn Price/Bushel 2010 to 2030

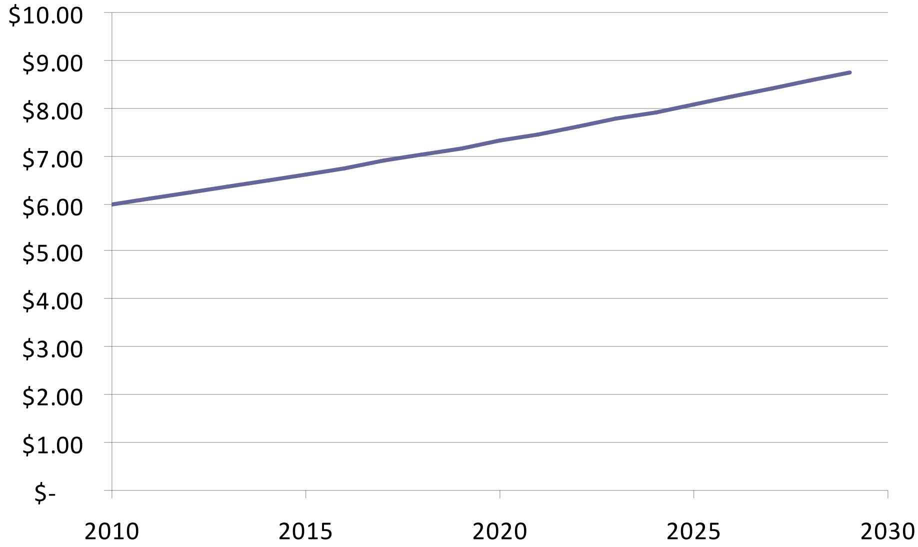


Source: FAPRI and author calculation

4.2 Natural Gas

Natural gas has been just as volatile as corn over the past 5 years. The market increased from an average price of $3/mcf to a high of almost of $16.00/mcf. With this type of price increase, the natural gas costs are estimated to run $0.21/gallon of production the first year (Pro Exporter, 2010). This is assuming that 80% of the distillers grains will be shipped as dry product and 20% will be shipped as modified wet feed. Natural gas prices will not remain at the same level. The average price increase from 2010 to 2030 is predicted to increase 2% annually by the author to account for inflation, from a level of $6/mcf to $8.74/ mcf.

Figure 4.2: Projected Natural Gas Cost Dollar per MCF Unit, 2010 to 2030

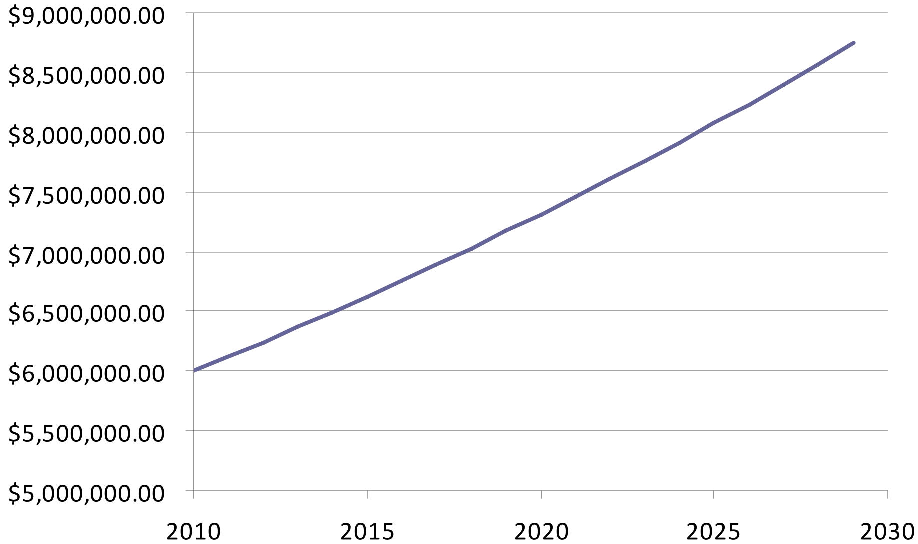


Source: Pro Exporter and author calculations

4.3 Electricity

Electricity prices in Iowa have been below other corn producing states. Average prices over the past 5 years have been just over $0.05/kWh (Heartland Coop, 2006). The Department of Energy forecast for U.S. electricity indicates that prices should remain steady to slightly increasing. Electricity prices are expected to increase 2% a year as well. The total electricity costs are expected to increase from $6.0 million dollars in 2010 to $8.74 million dollars in 2030.

Figure 4.3: Projected Annual Electricity Costs, 2010 to 2030

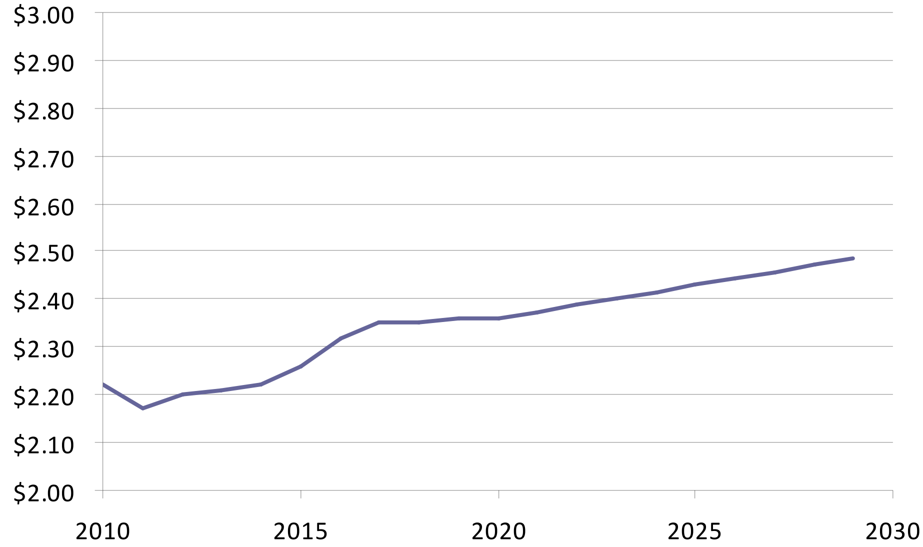


Source: Heartland Coop and author calculations

4.4 Denaturant

Denaturant is an additive (gasoline) that is used to make the alcohol unfit for human consumption. The denaturant will make up between 2% and 5% of the total blend. Management will adjust the percentage depending on the pricing of the denaturant and ethanol. Gasoline and ethanol prices have a correlation, so our denaturant prices will follow ethanol prices very closely. The historical average price spread for denaturant versus ethanol is a 43 cent premium according to Advance Trading. The denaturant for the purpose of this paper will be added to the ethanol at a rate of 3%.

Figure 4.4: Projected Denaturant Cost Dollars per Gallon, 2010 to 2030

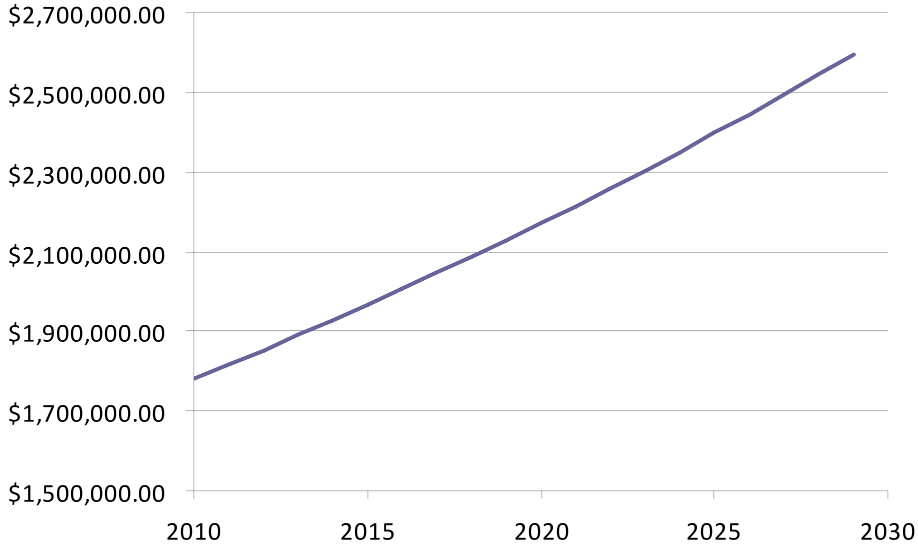


Source: FAPRI

4.5 Chemicals, Yeast and Other Costs

Yeast and chemicals including urea, ammonia, sulfuric acid, caustic soda, antibiotic, and corrosion inhibitors are expected to cost $0.017806 per gallon of ethanol produced the first year. We anticipate an annual increase in cost of 2% for these additives as well (ICM, 2006).

Figure 4.5: Projected Annual Yeast and other Chemical Costs, 2010 to 2030

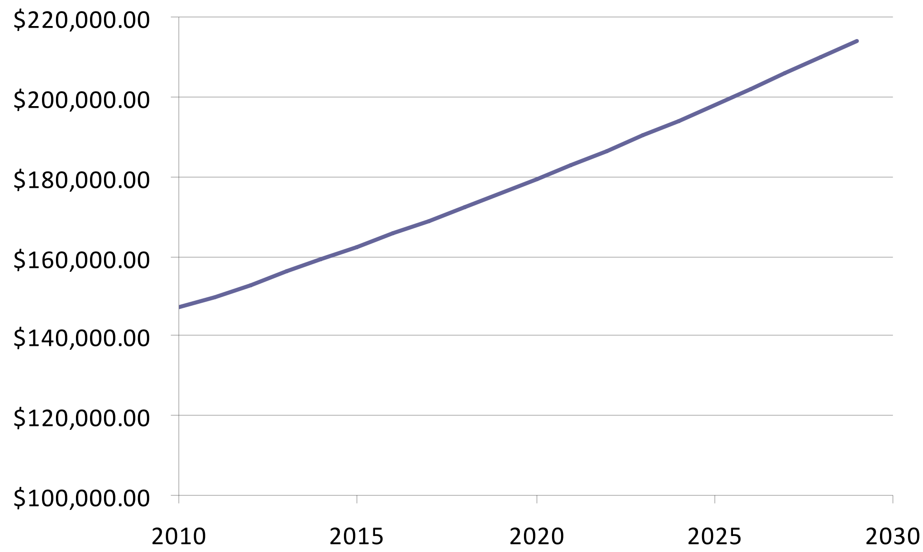


Source: ICM

4.6 Water and Sewer

Water and sewer costs will be $0.00147 per gallon of ethanol produced. The plant is expected to use fresh water at a rate of 670 gallons per minute with a discharge rate of 360 gallons per minute (ICM, 2006). This expense will also see an annual increase of 2%.

Figure 4.6: Projected Annual Water and Sewer Costs, 2010 to 2030



Source: Heartland Coop

Overhead Expenses

Labor

Labor costs are a major cost that makes up the plant's overhead. A 100-million gallon plant will employ 33 people. The breakdown of employment is as follows (Heartland Coop, 2006).

Production staff – 12

Maintenance – 7

Laboratory staff – 2

Material Handlers – 6

Administration – 6

The production staff will consist of four shift supervisors and eight general laborers. Each supervisor will be paid a salary of $50,000 per year and the general laborers will each make $40,000. Along with insurance and other benefits the total cost for the production staff will be approximately $750,000 annually at start up.

The Maintenance staff will consist of one manager, a boiler operator, a welder, an electrician, an electronic technician and two general workers. The pay for each will be as follows:

Manager $50,000

Boiler Operator $45,000

Welder $37,000

Electrician $43,000

Electronic technician $48,000 and

General laborers $32,000 each

The cost with insurance and other benefits is approximately $400,000 for the first year.

Laboratory Staff

The lab staff will consist of a lab manger and their assistant. The manager will be paid $47,000 and their assistant will be paid $33,000. So with their salaries, insurance and benefits, it will cost the company around $110,000 annually.

Material Handlers

The material handlers are the people responsible for loading the wet and dry distillers into trucks and rail cars, unloading rail cars of corn, manning the scale for inbound corn trucks and out bound distillers trucks, and other assorted tasks. The average salary for each of the six material handlers will be $25,000 each. This will be a total cost of about $210,000 annually with insurance and other benefits the first year.

Administrative Staff

The administrative cost will be as follows.

General Manager - $150,000

Production Manager - $85,000

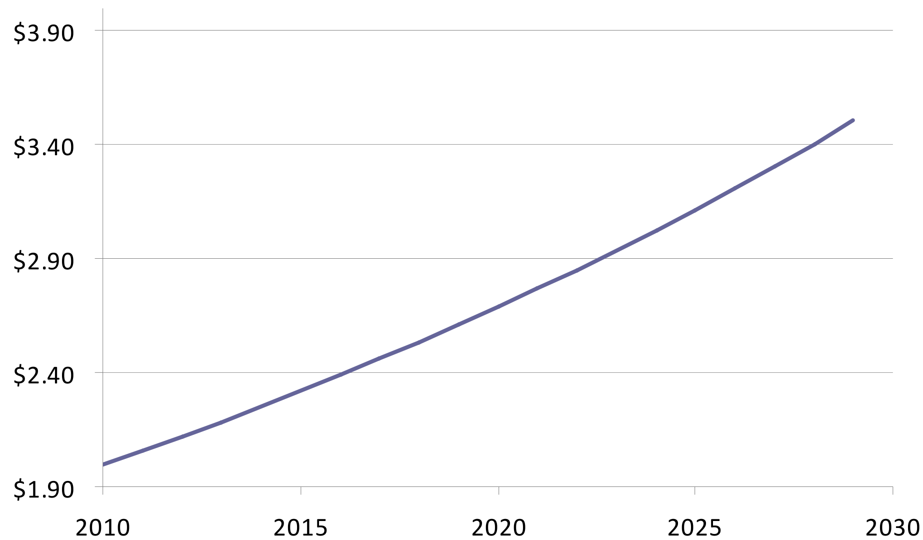
Corn Merchandiser - $55,000

3 Accounting Clerks - $30,000 each

The ethanol and distillers sales will be done by marketing firms that will take a percentage of the sales price, so no costs will need to be calculated for marketing. The total cost for the administrative staff with insurance and benefits included is $530,000 for the first year.

Figure 4.7 shows the annual cost of the labor force. A 3% cost of living raise was added each year for all employees. As in all business, some employees will get more than 3%, and other employees will leave the company and be replaced by new employees at the same starting salary.

Figure 4.7: Projected Annual Labor Costs in Millions of Dollars, 2010 to 2030



Non-Labor Administrative Costs

These costs will include such items such as taxes, insurance, legal fees, and other costs of operating an office. In this thesis, these costs are estimated as $0.03 per gallon of production for a total cost of $3,000,000 per year.

Miscellaneous Costs

These costs are any that do not fall into the above categories. These could be one-time expenses which will not be reoccurring. The estimate for these expenses is $0.008 per gallon of ethanol production for a total of $800,000 per year.

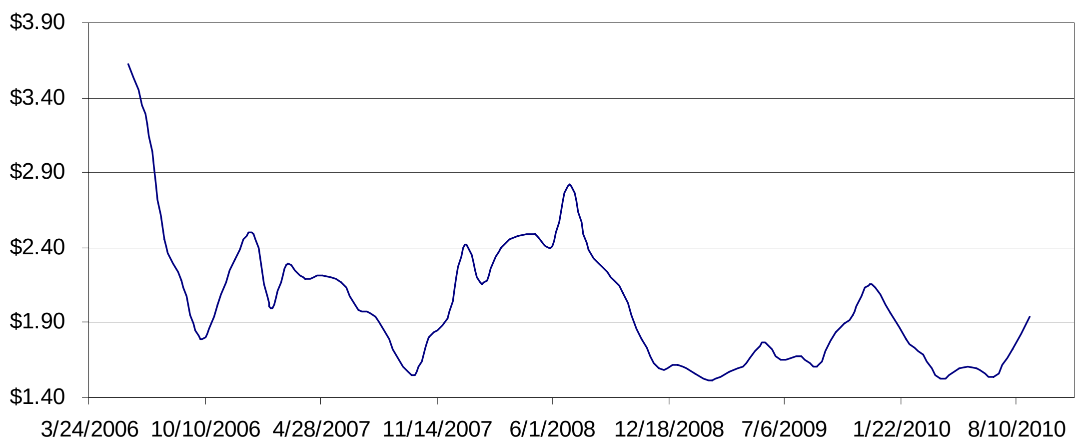
CHAPTER V: OUTPUTS AND INCOME

The ethanol and distillers outputs and income will be analyzed in the chapter along with total revenue, cost of goods sold, and net revenue.

5.1 Ethanol

Ethanol prices have been very volatile the past few years. As seen below in figure 5.1, since June 2006, ethanol prices have dipped down to the $1.50/gallon price three times (Advance Trading, 2010). Most generally ethanol values trade between $1.50 and $2.50 per gallon. The high point in ethanol pricing was during the early summer 2006 due to the ban of MTBE and the higher inclusion rates of ethanol blends.

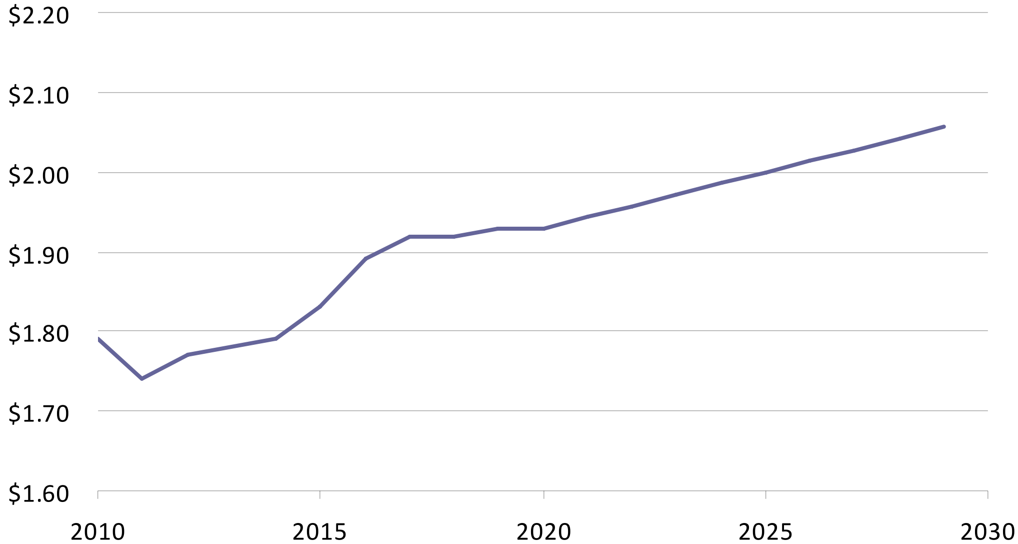
Figure 5.1: Historic Ethanol Prices per Gallon



Source: Advance Trading

FAPRI has forecasted ethanol prices through 2020 (Food and Agriculture Policy Research Institute, 2010). During this period ethanol prices are expected to increase at annual rate of 0.71%. For the purpose of this study, the last nine years will show a 0.71% annual price increase as well.

Figure 5.2: Projected Annual Ethanol Price in Dollars per Gallon, 2010 to 2030

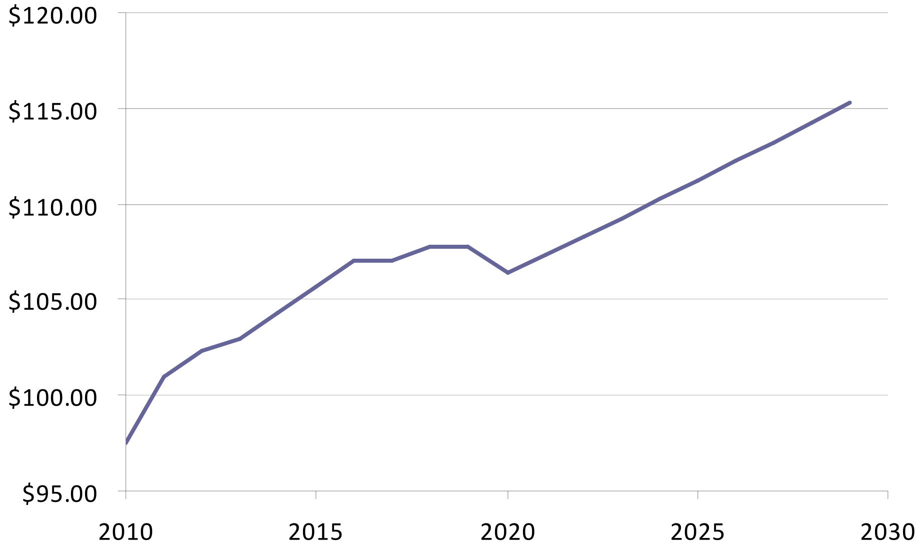


Source: FAPRI and author's calculations

5.2 Distillers Grains

Both Dried Distillers Grains with Solubles (DDGS) and Wet Distillers Grains with Solubles (WDGS) will be produced. Because of the plants proximity to the large pork producing areas of central Iowa, it can be estimated that approximately 80% of the plant's distillers production will be DDGS. Based on my experience trading this market as an employee of Hansen Mueller, 75% of the production will be sold locally to swine and cattle feeders. The balance of the DDGS production will be loaded onto rail cars and shipped out to the California market to be fed to dairy cattle in the Imperial Valley. DDGS is most commonly traded and priced based on the price of corn. The market in this area is normally able to buy and sell DDGS at 75% the value of corn (Figure 5.3). The WDGS is traded as the same value levels and then adjusted for moisture levels, so there will be no need for any price adjustments in the calculations for the WDGS. Total distillers grains production will be 300,000 tons annually.

Figure 5.3: Projected Annual Distillers Price in Dollars per Ton, 2010 to 2030



Source: FAPRI and author's calculations

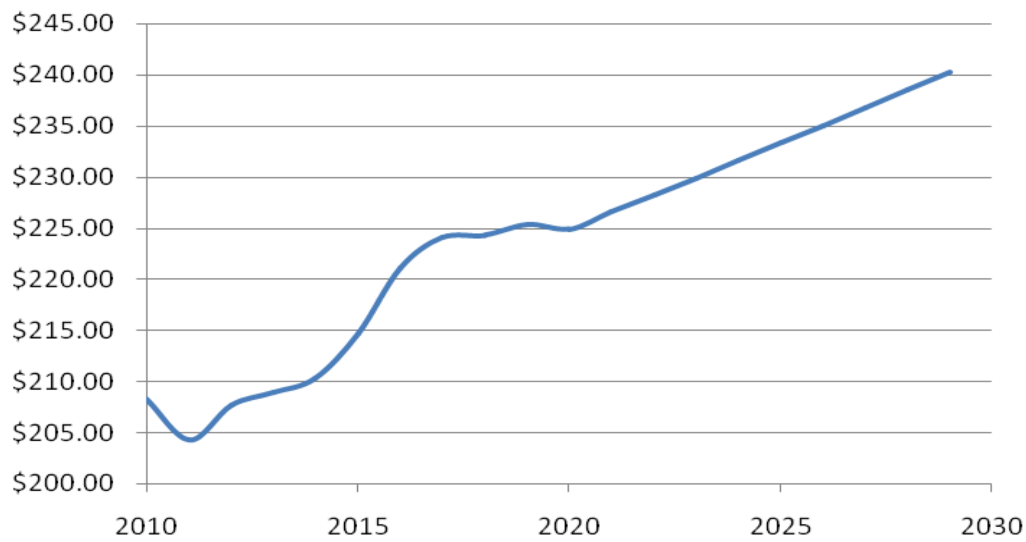
5.3 CO2

CO2 can be captured and sold as another co-product of the ethanol process. But due to the saturation of ethanol plants in the area and the lack of CO2 demand, no revenues are assumed from capturing CO2.

5.4 Revenue

With CO2 not a factor in the revenue stream for the ethanol plant, the projected revenue will be the ethanol sales along with the distillers grains sales (Figure 5.4). Revenue is expected to be $208.2 million in 2010, fall to $207.7 million in 2012 and then increase to $240.3 million in 2029.

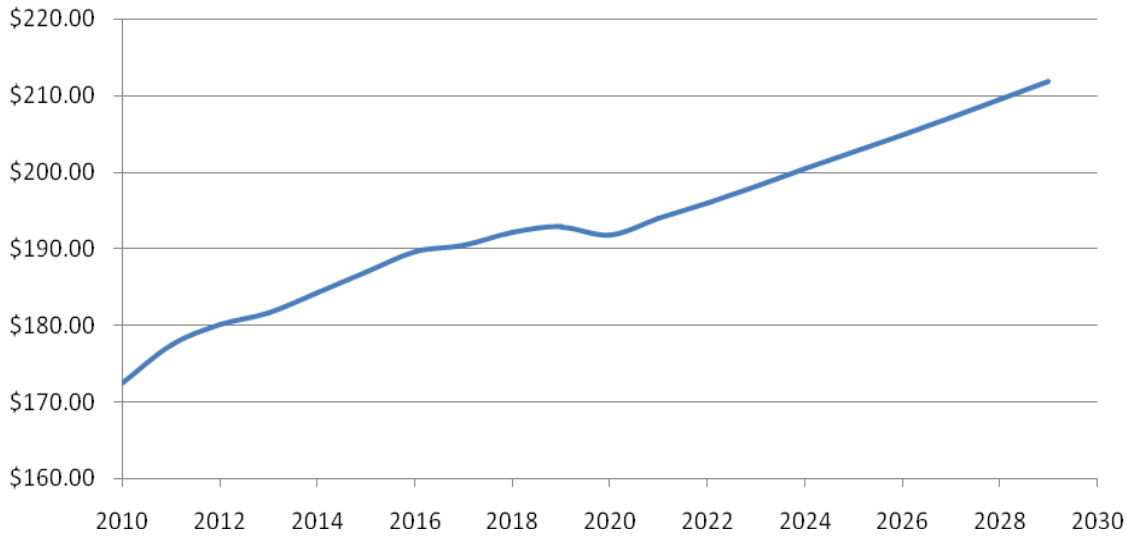
Figure 5.4: Projected Revenue in Million Dollars, 2010 to 2030



5.5 Cost of Goods Sold

The cost of goods sold will include all of the expenses examined in the previous chapter. They include the cost of corn purchased, natural gas, electricity, denaturant, chemicals and yeast, water and sewer, overhead, non labor administrative costs, and miscellaneous costs (Figure 5.5). Costs are expected to increase from $172.4 million in 2010 to $211.8 million in 2029.

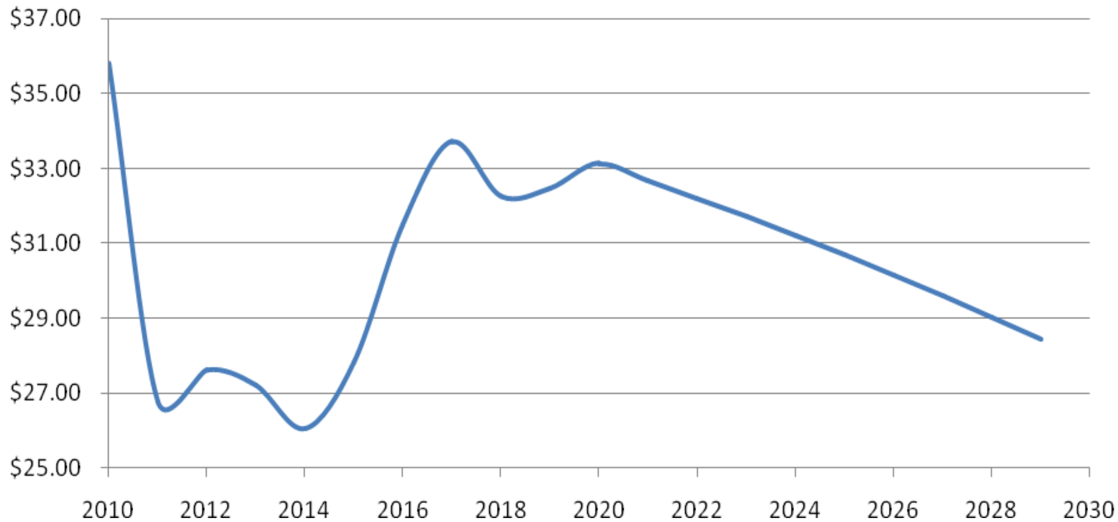
Figure 5.5: Cost of Goods Sold in Millions of Dollars, 2010 to 2030



5.6 Net Revenue

The net revenue is the revenue less the cost of goods sold. This figure excludes any debt repayment. Net revenue is expected to be $35.8 million in 2010, fall to $26.11 million in 2014, increase to $33.7 million in 2017 and at $28.45 million by 2030.

Figure 5.6: Net Revenue in Millions of Dollars, 2010 to 2030



CHAPTER VI: NPV RESULTS AND SENSITIVITY TESTS

The NPV for this project is $33,140,676 using a discount value of 10%. The 10% interest rate was used by the author is an assumed market interest rate. Interest rates in 2010 are much below that rate. Table 6.1 shows the cash flows for the life of the investment. An internal rate of return (IRR) was also calculated for the ethanol plant with a result of 12.08%. With a $33.14 million dollar NPV and a 12.08% IRR, this looks like a promising project.

Table 6.1: Projected Cash Flow for a 100 Million Gallon Ethanol Plant

Initial Investment	Sales	Cost of Goods Sold	Cash Flow	Year
$(225,600,000.00)	$208,253,484	$172,443,211	$35,810,273	2010
	$204,274,077	$177,504,021	$26,770,056	2011
	$207,682,315	$180,074,847	$27,607,467	2012
	$208,886,433	$181,684,878	$27,201,555	2013
	$210,294,671	$184,223,309	$26,071,362	2014
	$214,702,908	$186,865,986	$27,836,922	2015
	$221,111,145	$189,583,214	$31,527,931	2016
	$224,111,145	$190,396,400	$33,714,745	2017
	$224,315,264	$192,049,219	$32,266,045	2018
	$225,315,264	$192,833,091	$32,482,173	2019
	$224,907,027	$191,773,897	$33,133,129	2020
	$226,564,726	$193,888,441	$32,676,285	2021
	$228,234,453	$196,030,100	$32,204,352	2022
	$229,916,296	$198,199,316	$31,716,980	2023
	$231,610,343	$200,396,534	$31,213,809	2024
	$233,316,683	$202,622,212	$30,694,471	2025
	$235,035,405	$204,876,815	$30,158,590	2026
	$236,766,599	$207,160,816	$29,605,782	2027
	$238,510,356	$209,474,700	$29,035,655	2028
	$240,266,766	$211,818,959	$28,447,807	2029

Sensitivity Test #1

In sensitivity test #1, the discount rate increased from 10% up to 15%, with all other factors left unchanged. This resulted in a NPV of -$35,806,751. Fifteen percent was used because some investors use a 15% bench mark for their investments. In this case, for investors looking to make 15%, an ethanol plant near Des Moines, IA will not be a good investment for them.

Sensitivity Test #2

The second sensitivity test lowered the discount rate to 7%. This results in a NPV of $96,905,423. This is an excellent return as the opportunity to borrow money at 2010 levels does not occur often.

Sensitivity Tests #3 and #4

The third sensitivity test increased corn price by 10% each year. The initial NPV of $33,140,676 changes to a loss of $87,319,682. In the same way, the corn prices were decreased 10% each year in sensitivity test #4. This increased the project NPV to $153,601,035. This shows the need for risk management because corn purchasing is key to the success of an ethanol plant. In both sensitivity tests, when the price of corn changed so did the price of the distillers grains sold, as corn and distillers have a direct correlation. This is shown in table 5.3, as the distillers price is predicted to be 75% the value of corn price. The ethanol price however remained constant.

Sensitivity Test #5

The final sensitivity test looked at buying an existing ethanol plant as opposed to building a brand new one. During the past two years, many ethanol plants have been sold for various reasons, mainly financial. The prime buyers have been oil companies, Valero and Sunoco. They have been able to purchase them for $1/gallon to $1.50/gallon of production capacity. This sensitivity test looks at buying an operating plant at $1.50/gallon of capacity (150 million dollars) instead of building a new one. The NPV on this investment is $88,540,676 with an IRR of 17.04%. One factor that needs to be considered when buying a plant is the age of the plant. If the life span of an ethanol plant is decreased to 12 years as opposed to the 20 year life assumed for the new plant, the NPV is $36.4 million. So an eight year old plant is the oldest plant that potential investors should consider buying at $1.50/gallon of capacity as a nine year old plant NPV decreases to 26.02 million dollars.

Summary of Sensitivity Tests

Sensitivity tests consider different options that may arise in the decision making process. In this case, sensitivity test one and two considered different discount rate options. As seen in sensitivity test one, if a 15% interest is needed for the opportunity cost of using the capital, an ethanol plant in this environment wouldn’t be a good choice. However if success is based off the current cost of borrowing money and the investors are able to borrow the capital at 7%, then an ethanol plant at this time may be a good investment.

In the same way the volatility in corn price may be a determining factor in whether to build and ethanol plant or not. As with sensitivity tests one and two, tests three and four had different results. If corn input costs increase 10% annually the NPV turns negative, while a 10% decrease in corn costs creates a significant NPV increase.

The fifth sensitivity test may be the most interesting as it took all of the same input and output factors and looked at buying an existing ethanol plant versus building a new plant. This produced an increased NPV and a much more profitable investment as long as the plant was less than 8 years old.

CHAPTER VII: CONCLUSION

7.1 Conclusion and Recommendations

In this thesis the economic feasibility of building a 100 million gallon ethanol plant is examined. The economic model for the ethanol plant was explained as well as the need and availability of a local corn supply and the ethanol production process. The initial investment and capital requirements were defined. The production and input costs including corn, natural gas, electricity, denaturant, chemicals and yeast, water and sewer were estimated. Then the outputs and incomes were defined as well. These include ethanol and distillers grains. Finally, NPV results and sensitivity tests were examined to determine if this is a viable project.

When all of the variables are taken into consideration and based on the NPV of $33,140,676 for this project, the author would normally recommend that a new ethanol plant near Des Moines, IA be built. But the best investment at this time would be to buy an existing plant that is for sale. As seen in sensitivity test five, the NPV of buying an existing plant at a discounted value to building a new one, the NPV is $88,540,676. With the high risk associated with the ethanol industry, it doesn't make any sense to build a new ethanol plant when better returns can be made with the purchase of an existing ethanol plant.

The ethanol industry is a risky industry. So the reward must be enough to justify the risk. Many things can change in the industry that are outside the control of even the best management.

In the corn market, weather is always a driver for corn price and can be very tough to predict, and even with new seed corn research and varieties, varying yields continue to be a yearly issue. Relying on locally grown corn to be delivered by truck will always be a major concern. Government blending regulations are also another factor outside of management's control.

7.2 Future studies

In future studies, I would look into value added options for the purchased ethanol plants. Some of these options may be corn oil extraction from the DDGS. This will allow for corn oil to be sold separately and will also result in a higher protein DDGS. Corn oil trades in many areas for 22 to 28 cents per pound. This is equivalent to $440 per ton. That results in more than four times as much return than from leaving the oil in the distillers grains. The higher protein DDGS will also be worth more as the protein levels increase from 26% to 29%. This will increase the DDGS feed value on a per unit of protein basis.

A branded ethanol product may also be an option to distribute to blender pumps in the area. This may allow the plant to receive a premium for a branded product in the retail market as opposed selling ethanol in the wholesale market. This would allow the ethanol plant to differentiate its product from other plants. Involved in this could also be retail pumps with variable rate blends. This would allow consumers to blend ethanol with their gasoline at a rate to the consumers pleasing.

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