LOCATION OF AN AGRIBUSINESS ENTERPRISE WITH RESPECT TO ECONOMIC VIABILITY: A RISK ANALYSIS

A Dissertation

by

MICHAEL H. LAU

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2004

Major Subject: Agricultural Economics

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ABSTRACT

Location of an Agribusiness Enterprise with Respect to Economic Viability:

A Risk Analysis.

(December 2004)

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Chair of Advisory Committee: Dr. James W. Richardson

This study analyzes the economic and geographic effects of alternative locations on risky investment decisions in a probabilistic framework. Historically, alternative locations for multi-million dollar investments are often evaluated with deterministic models that rely on expected values or best case/worst case scenarios. Stochastic simulation was used to estimate the probability distribution for select key output variables, including net present value (NPV), of a proposed biomass to ethanol production facility in three alternative regions in Texas.

The simulated NPV probability distributions were compared using Stochastic Efficiency with Respect to a Function (SERF) to predict the location preference of decision makers with alternative levels of risk aversion. Risk associated with input availability and costs were analyzed for the proposed plant locations so each location resulted in different levels of economic viability and risk that would not have been observed with a traditional deterministic analysis.

For all analyzed scenarios, the projected financial feasibility results show a positive NPV over the 16 year planning horizon with a small probability of being negative. The SERF results indicate the Central Region of Texas is preferred for risk averse decision makers compared to the Panhandle and Coastal Bend Regions. Risk premiums were calculated for the alternative locations and are consistent for all risk averse decision makers, indicating the ranking of alternative locations are robust.

Positive community impacts and sensitivity elasticities for key variables were estimated in the model. The estimated positive economic gains for the local economy are quite large and indicate locating a production facility in the region could substantially impact the local economy. The calculated sensitivity elasticities show ethanol price, ethanol yield, and hydrogen price are the three variables that have the greatest affect on the feasibility of a biomass to ethanol production facility.

ACKNOWLEDGEMENTS

First and foremost I must thank Dr. James Richardson for his support and mentoring throughout my time at Texas A&M University. He gave me academic guidance, assisted with my employment throughout my graduate studies, and guided me to becoming a professional in the agriculture economic field. His support gave me a strong sense of self-fulfillment. Most importantly, Dr. Richardson showed me the patience, dedication, and friendship I truly admire and respect.

Thanks to Dr. Joe Outlaw, committee member, for helping to develop the idea to evaluate such an intriguing new process which could have a substantial affect on the fuel energy market. Dr. Outlaw always offered a humorous relief to stressful times and has been a continuous source of encouragement and assistance throughout my experience at Texas A&M University.

Thanks to Dr. Clair Nixon and Dr. Stephen Fuller, committee members, for their careful attention to detail and insight into assessing the needed additions, adjustments, and corrections that helped translate and properly interpret the economic results. They both have been helpful whenever I have needed assistance.

A special thanks to my friends and mentors, Dr. Joe Townsend and Edward Romero, for the support they gave me in my first position here at Texas A&M. It was a rough transition moving from California to Texas, but Dr. Townsend showed me the open arms Texans are known for. I have grown tremendously as a professional and human being and I owe a great deal of it to interacting with and watching these two individuals. They showed me that each and every person is unique and if you care enough, you can accomplish anything.

I would like to thank all my friends in California and Texas for their support, comic relief, and good times throughout my time at Texas A&M University. All the phone calls from home offered encouragement and support for me to obtain my degree. My friends in Texas have been tremendous, there are too many of you to name. The times I have had at Texas A&M were memorable ones that will stay with me forever. I am not sure what life would be like without all my third and fourth floor friends. I have to say special thanks to Stefphanie and Lindsey, I am not sure what I would do without you two here. You two have always been supportive and the best friends anyone could ever ask for.

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CHAPTER I

INTRODUCTION

Background

With recent increases in oil prices leading to an increase in gasoline prices, the demand for oxygenates as fuel extenders and octane boosters have grown tremendously (Energy Information Administration, 2004). Methyl tertiary butyl ether (MTBE) and ethanol have been the primary fuel oxygenates in gasoline. MTBE has been recently banned by many states as it is linked to water contamination in California and will more than likely be banned nationwide. Ethanol production has increased rapidly over the past few years due to the conflicts over oil in the Middle East, the need for reduction in air pollution, a proposed ban on MTBE, and suppressed commodity prices for corn (Herbst, 2003).

Production capacity for ethanol in the U.S. was 3.4 billion gallons for 2003 with 2.81 billion gallons of actual production (Renewable Fuels Association, 2004). Production is expected to increase to 3.3 billion gallons in 2004. Figure 1 presents the historical and projected ethanol production from 1980 to 2005. The U.S. is becoming more dependent on ethanol production as a renewable fuel source to decrease dependency on foreign oil. Increase in demand for renewable fuels and heavy subsidization of ethanol has led to new research in development of alternative renewable fuels using biomass as a fuel source.

This dissertation follows the style and format of the *American Journal of Agricultural Economics*.

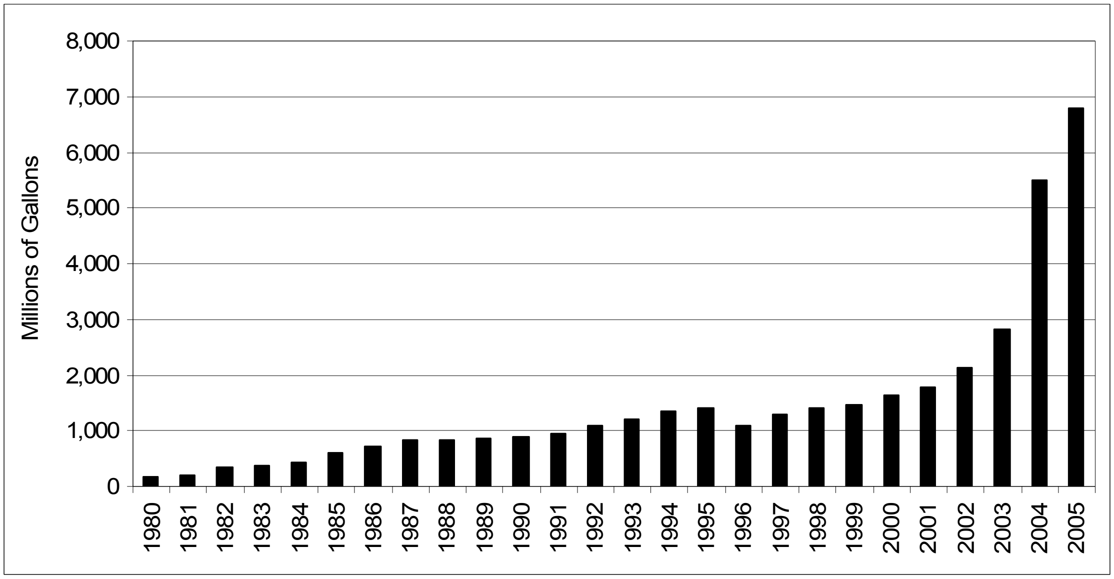

Figure 1. Historical and projected U.S. fuel ethanol production

Source: Renewable Fuels Association 2003

The MixAlco process has been developed from advancements in chemical engineering as an alternative to corn-based ethanol production. It produces carboxylic acids (e.g. acetic) and mixed primary alcohols (e.g. ethanol) that can be a direct replacement for MTBE and corn-based ethanol as a fuel oxygenate in gasoline (Holtzapple, 2004). For the MixAlco process to be a viable alternative, a production facility must be profitable and communities must have positive economic and social gains.

There is currently no commercialized MixAlco facility in production or construction. A feasibility analysis of a MixAlco facility at alternative locations using locally produced feedstocks is needed to determine if ethanol from MixAlco can be produced economically and competitively. The additional risk from alternative locations could significantly affect the probability of economic success.

The value and volume of ethanol in the U.S. motor fuel system is expected to grow in the next few decades. If MTBE is banned and the fuel oxygenates requirement remains, ethanol would be the only alternative. A recent study by the Renewable Fuels Association (2004) concluded that ethanol is currently holding down gasoline prices by as much as 30 cents per gallon. There is a market for acids but no one knows what the price is. If MixAlco facilities are viable, they could have a substantial impact on oxygenate, oil, corn, and gasoline markets in the U.S and become a direct competitor or replacement to corn-based ethanol.

MixAlco Process Overview

MixAlco converts cellulose biomass such as agriculture feedstocks, weed clippings, or rice straw, into acids and mixed alcohols with the use of microorganisms, water, steam, lime, and hydrogen. Two different versions of the MixAlco process are available. Version one is the original version which produces mixed alcohol fuels. Version two produces carboxylate acids and primary alcohols (ethanol). Version two is the newer process with improved efficiency (Holtzapple, 2004).

MixAlco is an anaerobic process which coverts biomass to carboxylate salts. These salts are converted to carboxylic acids which can either be sold as acids or hydrogenated to produce primary alcohols such as ethanol. Carboxylate acid production and hydrogenation does not have to occur on the same facility. Carboxylate acid production from a number of facilities can be pooled and shipped to refineries where mass hydrogenation can occur to minimize costs.

Ethanol produced from MixAlco can be a direct replacement for corn-based ethanol in gasoline and has higher energy content (BTU/gallon), 95,000 BTU/gallon for MixAlco versus 84,000 BTU/gallon for corn-based ethanol. A higher energy content and the ability to convert any type of biomass to ethanol makes MixAlco an intriguing alternative to corn-based ethanol production. The ability of MixAlco to convert any cellulose biomass source to ethanol creates an infinite number of location choices for production.

Location Science

The study of location science has been around for centuries. Vast literature has been developed out of the broad idea of where businesses and industries locate, why they locate, and what the optimal location should be. Using economic theory, location theory explains the distribution and location of economic activity. Minimizing cost has been the most important aspect of location theory. Greenhut (1974) represents this as the least cost theory of plant location. Changes in location with respect to rural areas face declining populations and limited economic growth (So, et. al. 1998). Public policy affects industry development and can benefit from knowing recent location trends in business (Isik 2003).

Purpose and Objectives of This Research

The purpose of this research is to analyze the effect of economic factors and incentive packages on the location decision and feasibility of a MixAlco facility. MixAlco is a new process, hence there have been no feasibility studies performed. Only version two of the MixAlco process is considered in this study to allow for direct comparison to corn-based ethanol production facilities. Most all ethanol plants are located in or near the Midwest Corn Belt as corn is the main fuel source in ethanol production (Bryan and Bryan International, 2002). MixAlco differs as it allows the use of any cellulose biomass material as a fuel-generating source without additional processing. This leads to a great number of alternative location choices for a MixAlco facility that must be evaluated before making a location decision. It is important to locate the facility in a region with the largest economic advantage.

Location choices of production facilities are dependent upon different economic costs and benefits to the business that affect profitability. Community incentive packages can directly effect location decisions and capital budgeting analyses. A feasibility study of alternative location choices with respect to risky economic factors and alternative incentive packages is needed before large amounts of capital are invested in an unproven MixAlco production facility.

The **specific objectives of this study** are as follows:

1. To find the key determinants or drivers affecting the *probability* of returning a positive net present value (NPV) for a MixAlco production facility.
2. To determine the effect of alternative incentive packages on location of a MixAlco production facility in a probabilistic framework.
3. To evaluate three alternative location choices for a MixAlco facility in Texas.
4. To determine the effect on a community of locating a MixAlco facility in the nearby region.

5. To determine the effect on agricultural production of locating a MixAlco facility in the nearby region.

Objectives one and two are accomplished by applying Monte Carlo stochastic simulation to a capital budgeting model. The purpose of simulation is to incorporate risk from stochastic variables and estimate distributions of economic returns so the decision maker can make better management decisions. Risk in input and output prices, crop yields, and process efficiency will directly affect the net cash income (NCI) and net present value (NPV). Alternative incentive packages affect the initial cost of investment for the production facility. Objective three is accomplished by using comparative scenario analysis in simulation. Scenario analysis allows incorporation of alternative control variables to evaluate alternative choices. Stochastic simulation combined with scenario analysis will return distributions of alternative NPVs for each plant location. The results will be used in identifying the most viable location for the MixAlco production facility and associated rankings when risk preferences are incorporated. Objectives four and five are achieved by measuring the economic gains to the community and commodity producers from a MixAlco facility located in the area. A MixAlco facility would increase jobs in the local economy, support the local economy through taxes, and increase demand for agriculture commodities.

These results allow for the identification and evaluation of target locations for building a MixAlco facility. The feasibility study will determine if MixAlco will be a major contributor to the renewable fuel market. The results of this study will provide interested parties an unbiased analysis of locating a MixAlco facility in Texas.

CHAPTER II

REVIEW OF LITERATURE

Since MixAlco is a new technology, very little literature is available for review. However, a large amount of literature exists on the ethanol and biomass industries. The review will focus on:

- ♦ Ethanol industry
- ♦ Biomass energy
- ♦ MixAlco process

Ethanol Industry

The U.S. ethanol industry has steadily increased since the 1970's to its current production capacity of 3 billion gallons in 2003 and is expected to exceed 4.4 billion gallons in 2005 (Renewable Fuels Association, 2004). The top five-ethanol producers have a 51.7 percent share of production capacity and include major corporations such as Archer Daniels Midland and Cargill. However, most corn based ethanol plants produce less than 20 million gallons per year (MMGY). Figure 2 shows the location of current ethanol plants that are operating in the U.S. Most are inside the Corn Belt with Nebraska and Iowa having the most plants in operation. All current ethanol plants use corn as the main fuel source for conversion.

There are currently no ethanol plants in Texas. Recently, three feasibility studies have been performed on ethanol production in Texas. Of the three, only one, Bryan and Bryan International (2001), concluded that ethanol production is feasible in Texas without state subsidies. The other two studies performed by Gill (2002) and Herbst (2003) have shown high investment cost and the high cost of corn have made ethanol production infeasible in Texas without government subsidies.

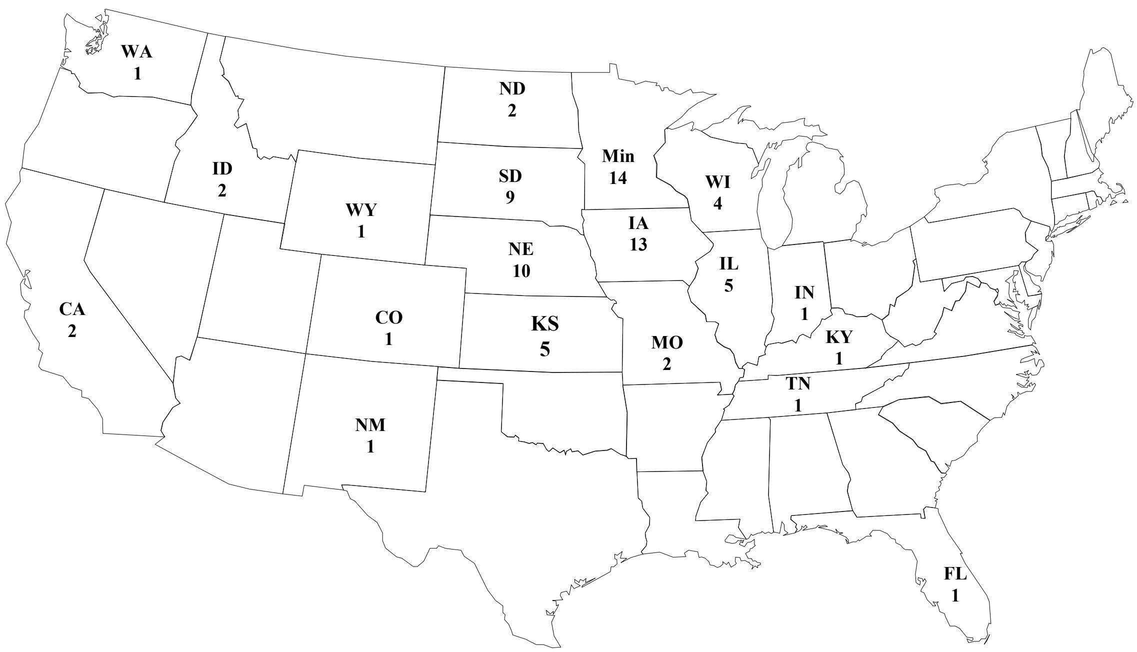

Figure 2. Number of ethanol plants in operation by state in 2004

Source: Bryan and Bryan International, 2004

Ethanol is highly corrosive and water soluble making shipment by pipeline infeasible. Ethanol transport involves trucks, railcars, and barges, which are expensive means for transporting liquid. Transportation costs for ethanol are estimated at \$0.07/gallon regionally and \$0.13/gallon from Midwest plants to California. Railcar shipments to California are limited due to infrastructure limitations (Coltrain, 2001).

Federal and state legislation have aided in the growth of the ethanol industry. The National Energy Act of 1978 exempted ethanol blended gasoline from the U.S. federal excise tax. The tax has been revised since then and the current tax exemption is $0.053 of the $0.183 total excise tax. This exemption is only for ethanol blended gasoline and no other renewable fuel. The impact of the excise tax exemption on tax revenue is minimal as it is only available for ethanol blended gasoline.

The Farm Security and Rural Investment Act of 2002 includes a $405 million energy title for development of resources used in production of ethanol and biodiesel. Currently, almost every state with ethanol production has an ethanol subsidy ranging from tax credits to producer incentives.

Current consumption of gasoline in the United States is approximately 126.5 billion gallons annually. The total U.S oxygenate supply is 5.38 billion gallons in 2003 (EIA, 2004). The total oxygenate supply includes ethanol and MTBE for blended gasoline and is collected from monthly phone surveys.

Table 1 represents individual state use of ethanol in 2000. Total ethanol use was 1.4 billion gallons in 2000. Illinois, Minnesota, and Ohio are the top three consumers of ethanol. Texas consumed 58.6 million gallons of ethanol in blended gasoline. The ban of MTBE in California is expected to increase ethanol demand. California currently produces 4 million gallons of ethanol, with forecasted demand at 600 million gallons for 2003 (Summer, 2003). Uncertainty in securing adequate supplies of ethanol to meet demand could lead to escalating ethanol market prices with resultant increases in cost of gasoline.

Table 1. Ethanol Use by State for 2000 (Thousands of Gallons)

State	Total Ethanol Used in Gasohol	Gasohol		
		10 Percent Gasohol	Less than 10 Percent Gasohol	Total
Alaska	1,848	11,844	932	12,776
Arizona	15,701	-	203,915	203,915
California	59,585	-	1,045,346	1,045,346
Colorado	54,102	220,161	416,703	636,864
Connecticut	3,620	26,309	12,845	39,145
Florida	1,661	16,611	-	16,611
Illinois	259,024	1,054,073	1,995,026	3,049,099
Indiana	106,200	971,685	117,290	1,088,975
Iowa	83,152	831,515	-	831,515
Kansas	2,309	23,093	-	23,093
Kentucky	2,527	25,269	-	25,269
Louisiana	252	2,519	-	2,519
Maryland	2,576	25,760	-	25,760
Michigan	85,007	850,065	-	850,065
Minnesota	209,605	1,048,027	1,361,074	2,409,101
Missouri	26,110	179,707	105,711	285,418
Montana	505	4,791	344	5,125
Nebraska	29,721	297,215	-	297,215
Nevada	25,843	72,494	241,481	313,976
New Jersey	8,305	7,186	98,529	105,715
New Mexico	23,910	239,104	-	239,104
New York	14,128	77,115	83,329	160,445
North Carolina	35,419	354,189	-	354,189
North Dakota	5,577	55,771	-	55,771
Ohio	211,878	2,118,781	-	2,118,781
Oregon	12,566	119,047	8,585	127,632
Pennsylvania	11,972	91,561	36,568	128,129
South Dakota	20,814	208,144	-	208,144
Texas	58,595	521,328	83,928	605,256
Utah	10,773	84,483	30,196	114,679
Virginia	33,407	334,068	-	334,068
Washington	29,996	299,956	-	299,956
West Virginia	288	2,879	-	2,879
Wisconsin	29,283	208,860	109,057	317,917
Total	1,476,261	10,383,611	5,950,848	16,334,459

Source: American Road and Transportation Builders Association, October 2001

Environmental Policy

The Clean Air Act Amendments of 1990 targeted oxygenated fuels and reformulated fuels to reduce air pollution. Legislation mandated the sale of oxygenated fuel during winter months and requires reformulated gasoline (RFG) to contain 2 percent oxygen by weight. In 1999, eighty-five percent of RFG contained MTBE and only 8 percent contained ethanol (Blue Ribbon Panel, 1999). However in 2004, MTBE and ethanol are equally used as oxygenates (EIA, 2004). RFG has been shown to reduce carbon monoxide by approximately 25 percent. The main reason for interest in renewable biofuels is the possibility of substantial reductions of noxious exhaust emissions from combustion (Renewable Energy World, 2000).

MTBE is currently an integral part of the U.S. gasoline supply in terms of volume and octane. Gasoline and MTBE prices do not reflect the external costs of burning fuel such as health and environmental affects (Shapouri, 2003). MTBE has shown to more likely contaminate ground and surface water due to its persistence and mobility in water. The main source of contamination is underground gasoline storage systems. Ethanol is extremely soluble in water but biodegrades much quicker, making it the preferred oxygenate.

Ethanol Economic Impacts

The inclusion of ethanol in the motor fuel supply has a positive economic impact on gasoline price and adds value to the American economy. Urbanchuk (2003, 2004) showed blending ethanol with gasoline at a 10 percent level will reduce the retail price of conventional gasoline by approximately 5 percent. A recent report by the Renewable

Fuels Association (RFA, 2004) states removing ethanol from the U.S. motor fuel supply would increase gasoline prices by as much as 30 cents per gallon. Additionally, the combination of spending for annual operations and capital spending for new ethanol plants in 2004 would add more than $15.3 billion in gross output to the American economy and $8.9 billion to the Gross Domestic Product (GDP).

The benefits to local communities of building and operating an ethanol plant have been analyzed in many feasibility studies. A local ethanol facility has been shown to increase local corn price and have a positive economic impact on local communities. Ethanol production is currently the third largest component of corn demand accounting for nearly 1.3 million bushels in 2004, or 13 percent of corn demand (Urbanchuk, 2004). Hudson (2002) estimated the local corn basis could increase by $0.06 to $0.07 per bushel. Van Dyne (2002) analyzed the addition of two ethanol production facilities in Missouri and found it would raise corn price by approximately $0.30 per bushel and add $24 million to the local economy.

Otto and Gallagher (2001) performed a comprehensive analysis for evaluating ethanol plants in Iowa producing 10, 18, 40, and 80 MMGY using the IMPLAN® Input-Output model. IMPLAN® is an economic impact assessment modeling system. IMPLAN® allows the user to easily build economic models to estimate the impacts of economic changes in their states, counties, or communities. Otto and Gallagher found an expansion if Iowa ethanol production by 193 MMGY would increase the price of corn by $0.43 per bushel in Iowa. They conclude an 80 MMGY facility in Iowa would add $14.5 million in additional labor income and $34.6 million in new value added. The primary impacts are labor and feed grain income. The secondary impacts include transportation, handling, energy purchases, and other inputs and services.

Urbanuck and Kapell (2002) estimated a 40 MMGY ethanol facility would increase the local basis for corn by 5 to 10 percent. They estimate a one time boost of $142 million to the local economy from a 40 MMGY ethanol facility. In addition, an expansion of the local economy by $110.2 million, increase in household income by $19.6 million, and increase in tax revenue for the state and local government of $1.2 million is also estimated.

Biomass Energy

Biomass is used to describe any organic matter from plants that derives energy from photosynthetic conversion. It is a unique resource which is the only renewable source of carbon. Biomass is a versatile energy source that can be easily stored and transformed into liquid fuel, electricity, and heat through various processes (World Energy Council, 1994). Biogas, biodiesel, ethanol, methanol, diesel, and hydrogen are examples of energy carriers that can be produced from biomass (Bassam, 2004).

Traditional sources of biomass include fuel wood, charcoal, and animal manure. Modern sources of biomass are energy crops, agriculture residue, and municipal solid waste (ACRE, 1999). Biomass fuels are produced mainly in countries that have surplus of agriculture commodities (Shapouri, 2003). Biomass can be divided into three categories; sugar feedstock (sugarcane), starchy feedstock (grains), and cellulose feedstock (fibrous plant material) (Badger, 2002). Estimates show 512 million dry tons of biomass residues is potentially available in the U.S. for use as energy production (Mazza, 2001).

Figure 3 represents consumption of U.S. renewable energy sources. Biomass energy contributes approximately 14 percent of today's primary energy demand worldwide (Veringa, 2004). It supplies approximately 30 times as much energy in the U.S. as wind and solar power combined. Biomass currently has a 10.5% share of the U.S. renewable energy mix (Sterling Planet, 2004). Renewable resources account for 7.7% of the U.S. energy consumption (OIT, 2001).

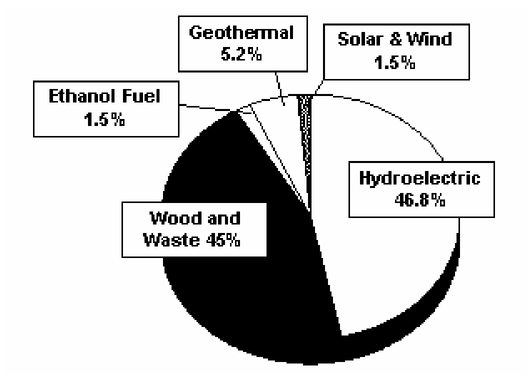

Figure 3. U.S. consumption of renewable energy

Source: Office of Industrial Technologies, 2001

Biomass could supply all current demands for oil and gas if 6 percent of contiguous U.S. land area is put into cultivation for biomass (Osburn, 1993). No net carbon dioxide would be added to the environment if biomass energy replaced fossil fuels (Osburn, 1993). Fuels derived from biomass are potentially renewable and are sufficiently similar to fossil fuels to provide direct replacement (Bassam, 2004). The

Department of Energy believes that biomass could replace 10 percent of transportation fuels by 2010 and 50 percent by 2030 (Sterling Planet, 2004).

Biomass has the potential to provide a sustainable supply of energy. Biomass has the following advantages over fossil fuels:

- Renewable source of energy that does not contribute to global warming as it has a neutral effect on carbon dioxide emissions,
- Biomass fuels have low sulfur content and do not contribute to sulfur dioxide emissions,
- Effective use of residual and waste material for conversion to energy,
- Biomass is a domestic source that is not subject to world price fluctuations or uncertainties in imported fuels.

However, an important consideration with biomass energy systems is that biomass contains less energy per pound than fossil fuels (Sterling Planet, 2004). Dried biomass has a heating value of 5,000-8,000 British thermal units (BTU) per pound with virtually no ash or sulfur produced during combustion (Osburn, 1993). Other estimates show the energy content of agricultural residues in the 4,300 to 7,300 BTU per pound due to moisture content (http://bioenergy.ornl.gov/index.html). Incomplete combustion of biomass produces organic matter and carbon monoxide pollution. There is also a social debate over the use of land and water for food production versus energy production (ACRE, 1999; Mazza, 2001). Biomass could have an important environmental impact on the socio-economic development of rural populations and the diversification of the energy supply (Renewable Energy World, 2000).

Combustion, gasification, liquefaction, and biochemical are the primary ways of converting biomass into energy. Combustion burns biomass to produce heat while gasification produces gas that can be combustible in a turbine. Liquefaction produces an oxygenated liquid that can substitute for heating oil. The biochemical process converts biomass to liquid fuel through a fermentation process (Veringa, 2004.; ACRE, 1999). Biodiesel and ethanol are an example of this process.

Ethanol from cellulose biomass material is still in the research and development phase (Mazza, 2001). Forestry residual and urban mass are the two largest potential feedstocks for ethanol production in California (Perez, 2001). There are currently no cellulose ethanol facilities in operation. The lack of real-world experience with cellulose biomass to ethanol production has limited investment in the first production facilities (California Energy Commission, 1999). Ethanol from cellulose has the advantage of a faster rate of reaction than the traditional fermentation process. However, ethanol production using cellulose is costly due to the need for acid hydrolysis of the biomass pricing it above the current market (Badger, 2002). MixAlco has the advantage as no extra processing of the biomass is needed for fuel conversion.

Agriculture Cellulose Feedstock

Stover is defined as all harvested plant material or residual other than grain including the stalk, stems, and leaves. The carbohydrates contained in stover can be used to produce consumable energy and plastics (Gallagher, et al., 2003; Wiedenfeld, 1984; Committee on Biobased Industrial Products, 2000). Stover is a lower cost input than grain which can be better utilized for human consumption and animal feeds.

Sorghum has been identified as a preferred biomass crop for fermentation into methanol and ethanol fuel (Miller and Creelman, 1980; Creelman et al., 1981). Sorghum is among the most widely adaptable cereal grasses potentially useful for biomass and fuel production (Hons, et al., 1986). The adaptation of sorghum to sub-humid and semiarid climates has extended sorghum production into larger regions than other warm-cereal grains.

Sorghum is relatively inexpensive to grow with high yields and can be used to produce a range of high value added products like ethanol, energy, and distiller dried grains (Chiaramonti, et al, n.d). Sorghum can produce approximately 30 dry tons/ha per year of bagasse on low quality soils with low inputs of fertilizer and 200 tons water per dry ton of crop, half of that required by sugar beet and a third of the requirement for sugar cane or corn. (Renewable Energy World, 2000).

Most stover or crop residue is plowed back into the ground to replenish nutrients and used to reduce soil erosion. However, only 30 percent (amount of residue plowed back into ground) is necessary to maintain the nutrient profile (Gallagher, et al., 2003). Small amounts are harvested for livestock feed. Studies to estimate sorghum residue yield for biomass production averages approximately 1.75 tons/acre (Franzluebbers, et al.,1995; Gallagher, et al., 2003; Hons, et al, 1986; Powell, et al., 1991).

Figure 4 shows a simplified diagram of alternative processes to convert sweet sorghum to energy fuel. Corn processing is very similar as the two crops are interchangeable. Sorghum production can be separated into grains (for consumption, livestock feed, ethanol production), sugar juice (extracted from the cane and used for ethanol production), and stover (used for energy production, plastics) (Chiaramonti, et al., 2004). Sorghum easily converts to other value added products making it a versatile input.

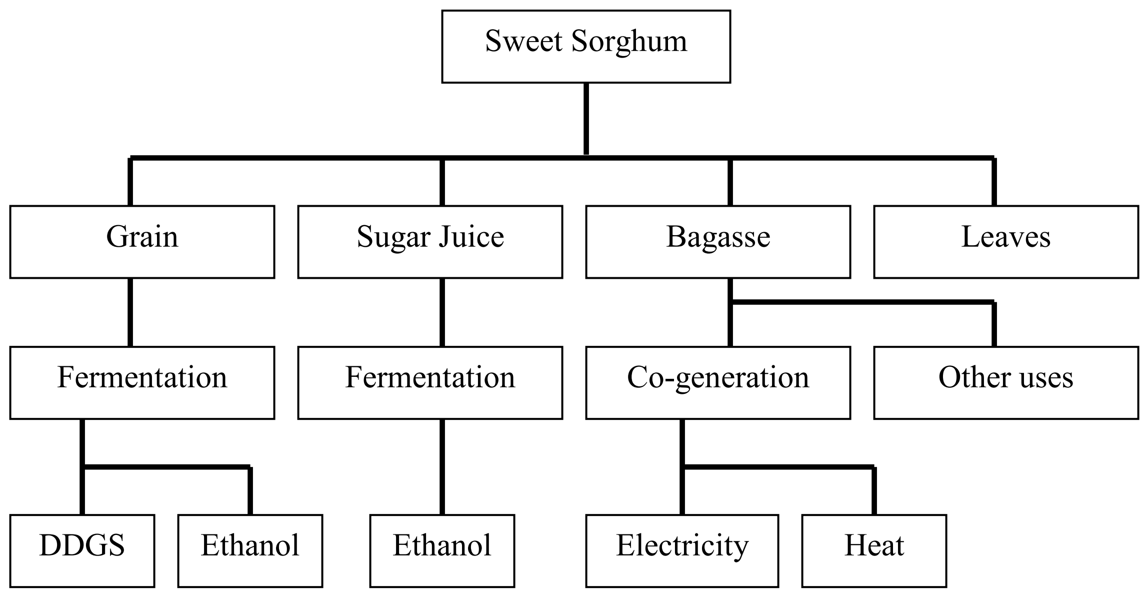

Figure 4. Simplified diagram of alternative processes to convert sweet sorghum to energy fuel

Source: Chiaramonti, et al., 2004

Although studies (Gallagher, et al., 2003; Wiedenfeld, 1984; Committee on Biobased Industrial Products, 2000; Miller and Creelman, 1980; Creelman et al., 1981) show sorghum stover is a good potential candidate for cellulose energy production, no historical values are available for residue costs and yields. Agriculture residue price for energy production is based on the opportunity cost for the grower plus harvesting and baling cost.

Residues are desirable raw materials for energy production because utilizing them does not require covering land cost which are included in the grain enterprise. Residue supply depends on opportunity costs at the farm level and the assumption that reasonable soil conservation practices will be followed. The amount of residue supplied is an approximation for acquisition cost by processing facilities. Growth is expected to occur in crop residue resource due to increase crop yields and declining livestock demand for forage (Gallagher, et al., 2003).

MixAlco Process

The MixAlco process can convert a wide variety of biomass material such as sewer sludge, manure, agriculture residues, agriculture crops, into acids and alcohol fuels using microorganisms, water, steam, lime and hydrogen through an anaerobic process (Holtzapple, 2004). Two different versions of the MixAlco process are available, version one and version two. Version one is the original version which produces mixed alcohol fuels. Version two produces carboxylate acids and primary alcohols (ethanol).

Figure 5 summarizes the MixAlco process. This process differs from the use of acid hydrolysis of biomass material to produce ethanol. Holtzapple's process calls for mixing biomass with a nutrient source such as manure or sewage sludge at a ratio of 80 percent to 20 percent. There are four phases to the process: pretreatment and fermentation, dewatering, acid springing, and hydrogenation.

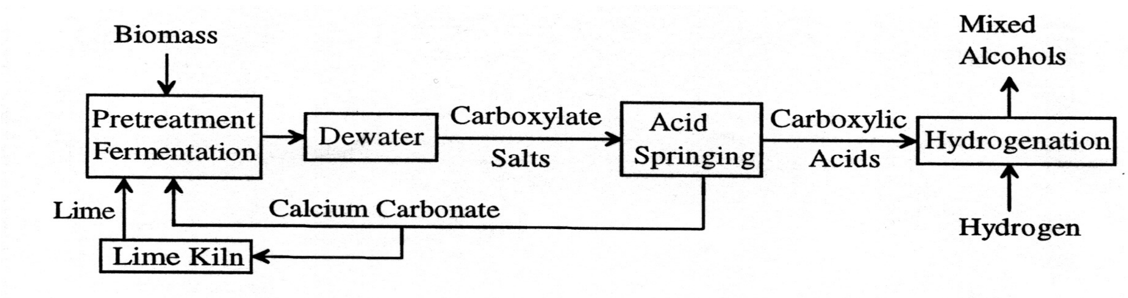

Figure 5. Schematic of MixAlco process

Source: Holtzapple, 2004

During the pretreatment phase biomass, lime, and calcium carbonate are blended and stored in a large pile. Air is blown up through the pile while water is trickled down through the pile. The combination of air and lime remove lignin from the biomass reducing the pH rendering the bio-matter digestible. The pile is than inoculated with anaerobic microorganisms from saline environments. The microorganisms digest the biomass forming carboxylic acids commonly known as volatile fatty acids (VFAs) such as acetic, propionic, and butyric acids. The VFAs combine with calcium carbonate to form carboxylate salts, which are extracted from the pile with water.

Four reactor piles are created of equal volume. Figure 6 and Figure 7 show the schematic of the pretreatment and fermentation facility. Each reactor is shaped like a cone to minimize material use. For a 44 ton/hour facility, each reactor has a base diameter of 397 feet and is 115 feet high. The fuel pile is covered with a geomembrane to resist the weather, wind, and sun. The base consists of a 1 meter thick layer of gravel that is divided by bermed walls to collect the VFA solution.

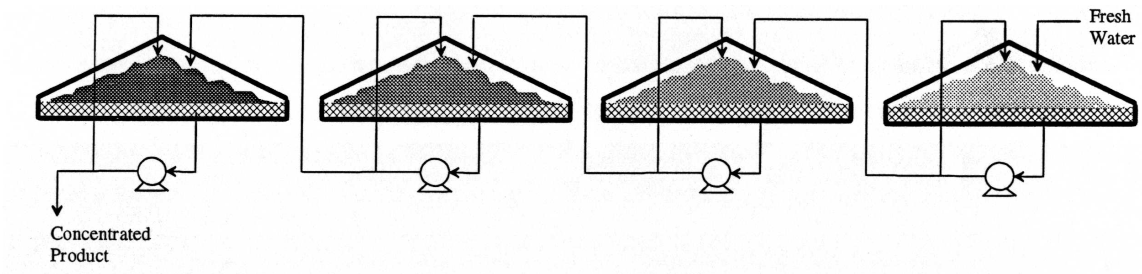

Figure 6. Schematic of fermentation facility

Source: Holtzapple, 2004

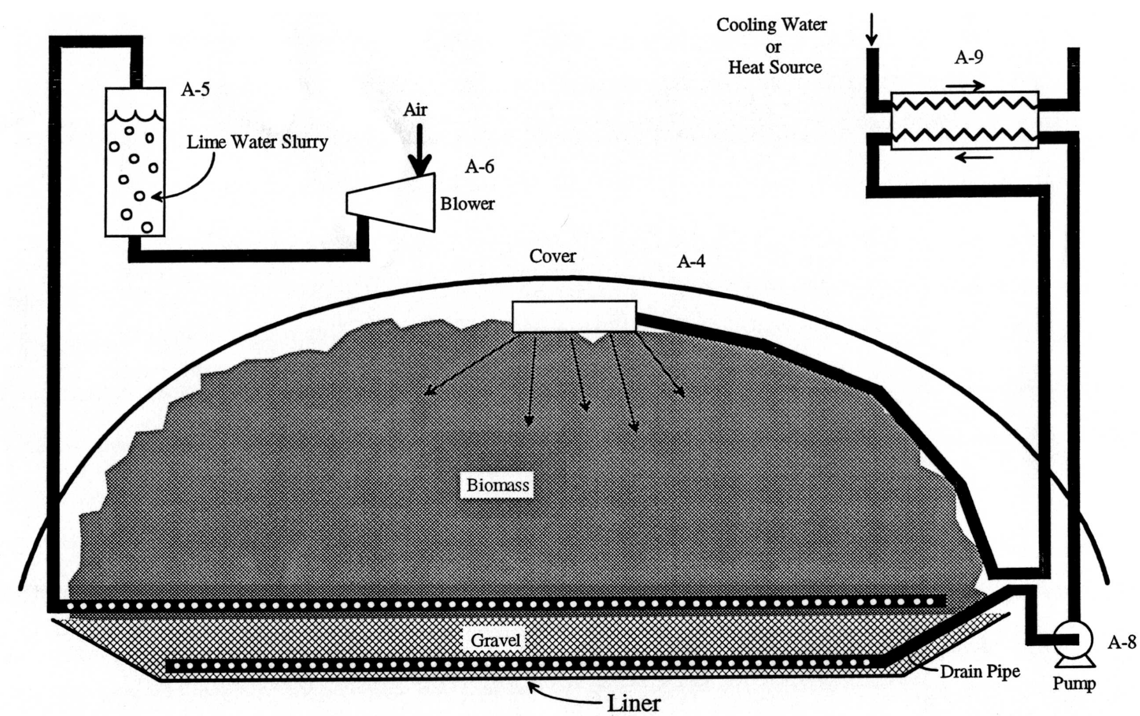

Figure 7. Schematic of MixALco pretreatment process

Source: Holtzapple, 2004

From fermentation, the VFA solution is concentrated using a vapor compression evaporator during the dewatering phase. The fermentation broth containing the VFAs are heated to 100°C and mixed with high-molecular weight acid (e.g. heptanoic) to acidify the fermentation broth. Steam and lime are than used to remove non-condensable gases and calcium carbonate. The treated fermentation broth is heated to 212°C and water is evaporated from the solution concentrating the salts.

Acid springing converts the carboxylate salts into carboxylate acid and calcium carbonate. The concentrated broth is blended with carbon dioxide and a low-molecular-weight tertiary amine (triethyl) to form insoluble calcium carbonates and amine carboxylates. Approximately 75% of the calcium carbonate removed can be used in the pretreatment and fermentation phase and the remaining 25 percent is converted to lime using a special lime kiln. Most of the water is than removed leaving a concentrated amine carboxylate.

The carboxylate acids are blended with high-molecular-weight alcohols to form esters and water. The water is evaporated and remaining esters are mixed with high-pressure hydrogen to form alcohols. The resulting ethanol fuel is cooled and stored for transportation to be mixed with gasoline fuel. Large storage tanks are used to hold the ethanol fuel until shipping.

MixAlco Byproducts

MixAlco produces water, heat, carbon dioxide, calcium carbonate, and residual biomass as byproducts. The MixAlco facility can be almost self-sufficient after the first year of operation if the necessary equipment for lime production, water recycling, and steam capture, and boilers, are in place. Water can be reused for the pretreatment and fermentation phase. Calcium carbonate can be manufactured into lime and used in the pretreatment and fermentation phase. The heat generated can be transferred to dryers to aid in the evaporation during the dewatering phase.

The MixAlco structure is completely sealed from the outside environment and all carbon dioxide gas produced can be collected. The carbon dioxide can be released once it is "scrubbed" to remove odor or sold to oil refineries to be pumped into oil wells and aid in the collection of oil. However, the carbon dioxide market is very limited.

Residual biomass is the largest byproduct produced. MixAlco differs from corn-based ethanol production in that it produces distiller dried grains with solubles (DDGS) that be can be sold to livestock operations for feed. Approximately 20 percent of the biomass feedstock is residual biomass when the MixAlco process is complete. The residual biomass can be used internally to generate power and steam for the facility or it can be sold to coal-fired power plants as a fuel source to reduce sulfur emissions.

Net Energy Balance of MixAlco

The net energy balance of MixAlco alcohol fuel is incomplete as it is dependent upon which feedstock is used as a fuel source. Dried biomass has an approximate heating value of 5,000-8,000 British thermal units (BTU) per pound (Osburn, 1993). The efficiency of the MixAlco process is also still under experiment. Version two of the MixAlco process has increased alcohol yield per ton of biomass from approximately 90 to 100 gallons/ton in version one to 130 to 140 gallons/ton. However, the ethanol produced from version two has a lower energy content than the alcohol produced in version one. In comparison to corn-based ethanol production, there has not been consensus on if the net energy balance is positive or negative. Recent studies by Lorenz and Morris (1995) and Shapouri, et al. (1995) found a net gain of 38 percent and 24 percent on average.

Initial testing has shown ethanol produced from MixAlco has a slightly higher energy content than corn-based ethanol. A gallon of gasoline contains approximately 125,000 BTU/gallon and corn-based ethanol contains 84,000 BTU/gallon (Holtzapple, 2004). The energy content of MixAlco produced ethanol is approximately 95,000 BTU/gallon. The energy content for the residual biomass byproduct is similar to coal. It is substitutable for coal in co-firing energy production facilities and can reduce sulfur emissions.

MixAlco Feedstock Requirements

Initial research into MixAlco used sugarcane bagasse as feedstock as it is widely available around the world. However, the supply of sugarcane in Texas is uncertain and the industry is not large enough to support large scale MixAlco production. The amount of feedstock required is dependent on the desired output size for the facility. The feedstock is decomposed at the same rate for all crops and all plant sizes.

MixAlco feedstock demand differs from ethanol feedstock demand as year-round supply is not necessary. The MixAlco process only requires feedstock input once a year to build the fuel pile. This is advantageous when compared to other forms of biomass energy production. Biomass can be used for other types of energy production (burning, digesting) but very few have been commercially successful. Current high processing costs for biomass has limited growth in alternative energy production.

Organization

The remainder of this dissertation will be organized as followed. Chapter III discusses location methodology, simulation modeling, and risk analysis. The first section presents literature on the history and theory of location science and incentives. The differences between static and dynamic location models are discussed. The second section presents literature on simulation modeling and risk analysis. The third section includes discussion on risk ranking procedures.

Chapter IV is divided into four sections. The first section describes the chosen locations for analysis in Texas. The second section describes model assumptions. Included are descriptions of the primary data collected for the construction and location of a MixAlco facility, production assumptions, and the secondary data sets containing historical input, output, yield, and price variables. The Third section describes the incentive packages offered by each community. The fourth section describes the financial statements and key output variables (KOV) for the model.

Chapter V presents the empirical results of the simulation model. The chapter is divided into four sections. The first section presents the results for the stochastic simulation. The second section presents a comparative analysis and ranking of the alternative scenarios and location choices for each plant size, initial investment level, and incentive package. The third section presents the impact of locating a MixAlco facility on the local community and adjacent agriculture producers. The fourth section describes the sensitivity analysis for key variables. Finally, the summary and conclusions of this study are given in Chapter VI.

CHAPTER III

LOCATION AND SIMULATION METHODOLOGY

Location Problems

Many feasibility studies do not incorporate alternative location choices for evaluation. This study differs as three location choices will be incorporated and analyzed to determine which location is preferred. It is important to understand how location science has evolved from deterministic to dynamic and how important choosing the right location is to the profitability.

Study in the field of agricultural economics in relation to location science has been minimal. Most research has been in the operation research and urban development fields. Operation research has developed mathematical programming models to represent and cover the wide range of location science problems. These problems have been formulated with multiple objective functions and various constraints to adapt these models to meet specific applications (Daskin 1998).

Outlaw (1988) studied the location of agribusiness centers and how they were relatively new and do not fit into typical growth center studies. He identified eleven factors that affect a community's chances of attracting new businesses. They are industry infrastructure, population, transportation, business environment, development action, education, raw materials, financial development assistance, medical facilities, quality of life, and taxes.

The Stollsteimer model continues to be the most widely used complete enumeration method for analyzing plant location problems (Beck, 1980) with application to agribusiness. The Stollsteimer model requires data for location of plant sites, transportation cost, processing cost, volume for supply centers, and plant capacities. Fuller (1975) presented a modified version of the Stollsteimer plant location model. The Stollsteimer model determines the least-cost number and the size and location of sub-industry's marketing facilities with a guaranteed a global minimum. Fuller modified the Stollsteimer model to where the long-run cost function is discontinuous and formulates the computational scheme to enable researchers to lower total cost. The modified version does not attain a global minimum through simultaneous variations. The feasibility of the model diminishes as the number of potential sites increases. Klingman, et al. (1976) examined the plant location problem with cotton gins. Past decisions on location of cotton gins were intuitive ones without sound economic justification. A network problem was formulated and it was shown that the cotton industry could improve its profit by at least 10% and as much as 15% by using the cooperative blueprint specified by the optimal solution.

Recently, Isik, et al. (2002) presented a paper on entry-exit and capacity decisions under demand uncertainty for an agribusiness. Sambidi and Harrison (2003) surveyed U.S. broiler industry executives to determine site-specific factors related to broiler location problems. They find that total cost factors are the main drivers, noting that industries tend to locate in regions with high unemployment and low wage rates. It is difficult to determine whether location decisions are made by accident, as a function of history, or as a function of economic variables that can be measured, such as wage rates, tax rates, urban size, utility cost, or cost of inputs.

Industry Clustering

Many firms locate individually, but industries have been shown to cluster together. Industrial parks have emerged recently in the U.S., some 3 digit manufacturing industries such as agriculture machinery, automobile components, electronic computing, tend to locate together. It is interesting to note that most of the cities where industrial parks locate have minimal or zero employment in that industry before investment was made (Henderson 1992). Henderson attributes these static location economies to:

1) Economies of intra-industry specialization where increased industry size permits greater specialization among industry firms,
2) Labor market economies resulting from a larger pool of trained workers,
3) Scale for networking or communication among firms to take advantage of complementarities,
4) Scale in providing public goods and services tailored toward specific industries.

Barkley, et al. (2001) created a probabilistic modeling approach to determine if manufacturing plants cluster across rural areas. They measured clustering tendencies based on a "dispersion parameter" of the negative binomial distribution and found nearly all-manufacturing industries cluster establishments in non-metro areas. Some cases of concentration come from natural advantages that include such things as climate, topography, proximity to inputs, etc. Many of the studies in the field of clustering industries have been limited to case studies of specific industries.

Industry clustering will normally provide greater economic benefits to the community and firm. Barkley and Henry (2001) show that clustering will strengthen localization economies, facilitate industrial reorganization, encourage networking among firms, and permit greater focus of public resources. The downside to clustering is that communities will have difficulty picking the proper firms and later investors may not be competitive in the market as the earlier firms gain an advantage.

Historically, it was believed that manufacturing products close to demand is optimal to reduce transportation cost, offer maximum coverage of demand, and maximize profitability with respect to controlling cost. Increased transportation cost from being located farther from demand points have forced businesses to operate at the highest level of efficiency and take advantage of economies of scale to reduce cost. Almost all location studies focus on three major factors important to location, assembly of the plant, processing, and distribution of products.

Location Study History

Looking back in time, Emperor Constantine was first interested in the problem of location and distance in the 4^{th} Century AD for strategic placement of Roman legions. In 1826, von Thunen studied the forces that affect agriculture prices and land use in the central city. Variation of cost was determined to be due to land rent and transportation cost. The 17th century mathematicians, Fermat and Torricelli, developed the first formal problem of location and distance, which is known as the Weber Problem or Euclidean minisum problem today. Studies then move forward into the 19th century where Sylvester, a mathematician, studied the infinite solution space minimax Euclidean distance problem (Sylvester, 1857). In the 20th century, Steiner expanded the three-node Weber problem into a general problem where multiple nodes were connected together with the shortest distance.

Location science then moves into modern economics. Weber (1909), Hotelling (1929), and Hoover (1948) have all contributed a great deal to economics and location science. Weber was an economist studying the location of industry and Hotelling and Hoover continued this idea. In the past, mathematicians were concerned with solving the problem of minimizing distance or maximizing coverage. Weber considered the positioning of a single warehouse to minimize the total distance between it and several customers. Hotelling's problem, known as "ice cream vendor on a beach," looks at capturing market share on a beach against a vendor who is located in the center of the beach. Today, this type of problem is known as a "competitive location" problem where companies compete for maximum market share. Hoover in 1948 expanded the Weber problem from a single source and demand to multiple demand and multiple supply locations.

Baumol and Wolfe (1958) were the first known economist to use a computer to solve a location problem. They solved a mathematical programming model for warehouse location on a network. Following this, in 1963 and 1964, Hakimi presented proofs of nodal sufficiency for optimal citing in a minisum problem on a network. These proofs became a foundation for location science. Hakimi concentrated on the location of switching centers in a communication network and police stations in a highway system. Since this time, location study has flourished and expanded to many fields of study.

Location science can be broken down into two different areas of study, static location models and dynamic location models. Static or deterministic models take constant known quantities of inputs and derive a solution to be implemented. The solutions to these static problems are solved according to certain criteria or objectives. In both cases, the goal is the same, to determine the number of facilities to be located, the size and location of the facility, and the market responsibilities of each facility (Randhawa, 1995). In the following sections, static or deterministic problems will be discussed followed by dynamic models. Both types of models fall into four broad categories: median, covering, capacitated, and competitive (Church, 1999).

Static/Deterministic Location Problems

Static or deterministic problems have been made easier with the invention of the branch and bound method (Lang and Dolg, 1960). Church and ReVelle (1974) present new techniques that enhance the performance of the branch and bound algorithms called branch and peg algorithms.

Distance from the selected location is a major factor; there are inbound cost, in-plant cost, and outbound cost for delivery of products to demand (Dohse, 1996). Hakimi first invented this problem, known as the P-median problem, where demands are not sensitive to the level of service. ReVelle (1986) presented a modified version of the P-median problem for locating retail facilities in the presence of competing firms.

Facility locations have fixed costs that are involved which must be accounted for. Neebe and Khumawala (1981) and Holmberg (1994) all present models that incorporate fixed cost associated with plant assignments in addition to transportation costs. Harkness and ReVelle expand on this problem saying that with every decision to invest in a new plant, there is a simultaneous location decision.

Averbakh (1998) consider a generalization of the traditional plant location problem where the setup cost of a facility is demand dependent, meaning that it depends on the number of customers served by that facility. The capacitated plant location problem includes a set of potential locations for plants with fixed costs and capacities and a set demand from customers from these plants (Sridharan, 1995; Sankaran and Raghavan, 1997). A simple capacitated problem using an econometric model could be used to determining the location of individual industries (Henderson, 1992).

Eiselt (1998) and Rhim, et al. (2003) look at a model where two competitors locate simultaneously to capture an unknown demand. Locations consider the positive effects of pulling the facilities toward demand or the negative effects of pushing the facility away from the places affected by the facilities nearness (Krarup, 2002, Zhou, 1998. ReVelle (1997) states that many of these formulations can be expanded to other industries, specifically industrial, environmental, and geographic industries.

Dynamic Location Problems

Dynamic location problems have moved into the forefront of location science problems, as static problems do not capture many of the characteristics of real world location analysis. Static models require that future information is given but in the real world sense of location science, future information such as demand and supply are uncertain, i.e. there is imperfect information (Murray, 2003). However, the best way to manage uncertainty is to postpone decision making for as long as possible (Daskin, et al., 1992).

Ballou in 1968 was the first paper that recognized the limited application of static or deterministic location models and used a set of suitable locations dynamic programming to determine the optimal subset of locations. Taperio (1971) extends the model to include capacities and shipping cost. In his model, supply and demand values are known and minimum cost is found. Sweeney and Tatham (1976) present a model that determines the location, size, and timing of plant facility construction.

Drezner in 1995 reformulated the P-median problem to a dynamic problem. Drezner and Wesolowsky (1991) and Wang et. al. (2001) considered a planning horizon where demand and population shift. Ermoliev and Leonardi (1982) also included stochastic features into a facility location problem to describe both demand for facilities and the trip pattern of customers. They show stochastic programming may be useful although difficult to solve. Wesolowsky (1973) and Wesolowsky and Truscott (1976) expand this idea to take into account predicted changes in demand.

Stochastic problems represent real world systems where parameters in a system are uncertain, such as travel time, construction cost, demand locations and quantity, and supply location and quantities. The objectives of these models are to find robust facility locations under a number of possible parameter realizations. There are probabilistic models, which consider probability distributions of the parameters, and there are scenario-planning models, which generate a future set of random variables.

One of the earliest works with stochastic inputs was by Manne in 1961. Bean (1992) expands this problem with stochastically growing demand and an infinite planning horizon. Mirchandani and Odoni (1979) showed that the previously stated proofs by Hakimi's can be applied to stochastic location problems. They evaluate the previous stated P-median problem and uncapacitated warehouse location problem with stochastic distances, supply patterns, and demand patterns.

Another approach to the facility location problem is presented by Hanink (1984), which uses portfolio theory from finance economics to solve a class of multiple plant location problems. This was followed with an option-value model (Isik, 2002).

Schilling (1982) uses scenario planning to analyze the problem of locating a number of facilities over time. Scenarios depict a range of future states through a quantitative characterization of various values for a problem's input parameters (Vanston, 1977). The difficulty is determining which solution is robust. Three common selection criteria are (Owen and Daskin, 1998); optimizing the expected performance over all scenarios, optimizing the worst-case performance scenario, and minimizing the expected or worst-case regret across all scenarios

Location Incentives

Incentive packages can directly influence location decisions of firms. Incentive packages are widely used by governments to attract business in investing in the local economy. With government involvement, the industry and community must recognize economic and social goals as well as private profit targets. Historically, it is believed that the attracting of businesses is a method of improving employment and income to the community and will have an overall positive economic impact (Barkley, et al., 2002). Many cities and counties have entered into "bidding wars" for companies to relocate and invest in their community. The effectiveness of giving these incentives is up for debate and has been the center of many economic studies (Peters, 1995). Dye (2000) states that there are four general reasons why incentives are offered; market failure, blighted areas, bidding wars, and intergovernmental revenue shifting.

Difficulty arises in how to measure the benefits from the business investment against the cost of attracting that business to the community. The true costs are difficult to measure, as the business will change the welfare distribution patterns of individuals in the community and among different classifications of residents. Some individuals may experience a positive effect from the industrialization while others may bear the cost of this gain (Reinschmiedt, 1976).

Peter and Fisher (1995) provide one of the most complete analyses of incentives. They measure the cost benefit of tax incentives as well as discretionary incentives. They assumed large and small plant sizes and modeled the effects of these incentives on both the business and community. Plant capacity was not considered to be stochastic in their model.

There has been no conceptually sound method of measuring alternative incentives offered by communities (Peters and Fisher, 1995). Part of the reason is there are a large number of incentives to consider and that these incentives are mainly analyzed as cost and benefits to a community rather then to a firm. Previous studies have indicated that better information is needed to assess the impact of industrialization on the community and surrounding areas.

Risk and Simulation Modeling

Risk analysis is a tool that can be used to deal with risk and uncertainty in decision-making (Pouliquen, 1970). Most investments and decisions are made under the conditions of risk and uncertainty. Uncertainty in input variable prices or future demand states can cause an investment to go from favorable to unfavorable depending on which state of nature occurs. However, most analyses assume perfect knowledge for simplicity in modeling.

Several examples in location science realized perfect knowledge is not feasible and incorporated uncertainty through the use of dynamic programming, portfolio analysis, and scenario analysis to account for risk. Difficulty arises when there are multiple sources of input risk and uncertain future states are incorporated into the model. Stochastic simulation is an alternative tool for analyzing investment and location problems under conditions of uncertainty and risk. Simulation allows for evaluation of risk from stochastic input variables and alternative scenario choices.

Ragsdale (1998) states that simulation is a technique that is helpful in analyzing models where the value to be assumed by one or more independent variables is unknown. Because of unknowns, simulation is a useful tool for analyzing risky decisions (Hardaker, 2004; Jones, 1972). According to Richardson (2003), the purpose of simulation in risk analysis is to estimate distributions of economic returns for alternative strategies so the decision maker can make better management decisions. Decision makers can use an analytical model to make optimal business decisions based on given input and control variables (Winston, 1996).

Law and Kelton describe techniques for simulating operations of various real world systems. Simulation has been used at the firm level for farms since the early 1970s (Eidman, 1971). Richardson and Nixon (1986) describe the basic equations required to simulate a farm or agribusiness enterprise. Their basic equations were defined to simulate financial statements for a given planning period. Gray (1998) described a similar framework for simulation of an agribusiness enterprise. His model did not include evaluation of alternative location choices affecting the probability of return.

Monte Carlo simulation can be used to evaluate location problems and investment decisions when information is available regarding the sources of variability for a business at multiple locations. Simulation can be done deterministically or stochastically. Deterministic results only give "on average" results, meaning the best case, worst case, median case results can be compared ignoring all aspects of risk. A deterministic simulation would be equivalent to a static location model where each simulation returns a representation of the outcomes without the likelihood or probability of the outcome.

Richardson and Mapp (1976) describe the methodology for building a stochastic feasibility model with probability distributions defined for variables where risk is a factor. They suggest the use of probabilistic cash flows. Stochastic variables are incorporated into a deterministic capital budgeting model to generate probability distributions for key output variables. Random sampling is used to estimate empirical cumulative distributions for the key variables. The probability distribution is a distribution of all possible values associated with a stochastic variable. A probability density function (PDF) represents the complete distribution of a stochastic variable and empirically measures values of the random variable producing a histogram depicting relative frequencies of output ranges, this histogram resembles the random variable's probability density.

Very few studies in location science apply simulation to incorporate risk and uncertainty. Some studies include risk with stochastic variables while others performed scenario analysis. Feasibility studies using Monte Carlo simulation include Richardson and Mapp (1976), Gill (2002), and Herbst (2003). Only Herbst considered alternative location choices for an agribusiness enterprise and its affect on input prices. Simulation can incorporate both stochastic input variables and alternative location choices for evaluation.

Correlating Random Variables

Simulation of correlated random variables is used in simulation to maintain historical relationships between random variables. The goal is to “appropriately correlate” variables so simulation does not change the significant relationships among random variables. Ignoring correlation will bias the simulation results.

Clements, Mapp, and Eidman (1971) demonstrated how to simulate correlated random yields and prices for a simulation model. Their simulation procedure only works with random variables that are normally distributed. Problems arise as most variables such as price and yield are not normally distributed. Richardson and Condra (1978 and 1981), King (1979), and Taylor (1990) demonstrate methods to simulate correlated non-normally distributed variables. Van Tasell, Richardson, and Conner (1989) demonstrate a mathematical restrictive method to inter-temporally simulate non-normal distributions for random variables.

Richardson, Klose, and Gray (2000) describe a generalized method for simulating correlated non-normally distributed random variables using a multivariate empirical distribution. Their work demonstrates and outlines the steps for estimating the parameters for a MVE distribution. MVE is the preferred distribution as it provides for full correlation of non-normally distributed stochastic variables and can be used with limited data.

Deviates from a mean or trend are used to quantify the variation of each variable to develop stochastic deviates. The stochastic deviates from the MVE distribution are combined with the annual forecasted deterministic values to simulate stochastic variables. This procedure is analogous to simulating random values from a frequency distribution made up of the actual historical data and is a closed form distribution which eliminates the possibility of values exceeding reasonable variabled observed in history.

Ranking Scenarios

Barry, Hopkin, and Baker (1983) show four methods for evaluating potential profit: simple rate of return, payback period, net present value, and internal rate of return. The net present value is the most comprehensive method, using the discounting formulas for a non-uniform or uniform series of payments. Richardson and Mapp (1977) suggest the use of probabilistic cash flows as an approach for analyzing investments under conditions of risk and uncertainty. They define the probability of economic success as the probability of returning a positive net present value (NPV). Stochastic simulation is used to analyze the investment and estimate the distribution for NPV rather than using a mean NPV like Barry et. al. (1983).

Ragsdale (1998) lists three methods used to analyze risk, best case/worst case, what if analysis, and simulation. With deterministic models, ranking alternatives is based on a single output. To maximize profitability, the highest value would be chosen. To minimize risk, the scenario with the lowest standard deviation would be chosen. By applying simulation to evaluate alternative scenarios with stochastic variables, the analysis will show a complete representation of possible outcomes.

Ranking alternative location choices under risk can be difficult. Simulation estimates an empirical distribution for key output variables (KOVs) that can be compared across locations. Each location and plant size can be compared and ranked to determine which is most viable.

Mean variance, stochastic dominance (SD), and certainty equivalence (CE) are three methods used to rank risky scenarios when simulation is used (Richardson, 2003). Mean variance analysis does not account for a decision maker's risk preference. Hadar and Russell (1969) and Hanoch and Levy (1969) describe first order and second order stochastic dominance with respect to a utility function. Stochastic dominance only provides partial ordering of risky alternatives with respect to the decision maker's risk preference. Mean variance and stochastic dominance can lead to inconclusive results and rankings by decision makers with varying risk levels (McCarl, 1998). The incorporation of a decision maker's risk preferences requires alternative methods to ranking scenarios.

Stochastic dominance with respect to a function (SDRF) is an alternative to first and second-degree stochastic dominance (Meyer, 1977). SDRF allows the ranking of risky scenarios for decision makers whose absolute risk aversion falls within a determined upper and lower bound. SDRF does not give a closed form solution so numerical evaluation of the optimal control problem is used.

Freund (1956) and Hardaker (2004) suggest that certainty equivalent be used for evaluating risky decisions. Certainty equivalence can be defined as the amount of money a decision maker would be willing to pay for a fair bet versus a risk free alternative with the same mean return. Certainty equivalence can convert utility to expected monetary value through the inverse utility function for comparison. Certainty equivalents allows for the comparison of a range of risk aversion preferences by a decision maker.

Stochastic efficiency with respect to a function (SERF) is a new procedure for ranking risky alternative scenarios. It overcomes problems in ranking scenarios when mean variance, stochastic dominance, and certainty equivalence give inconsistent results (Hardaker, Richardson, Lien, and Schumann, 2004). SERF varies risk aversion over a defined range and ranks risky alternatives in terms of certainty. SERF can be used with any utility function and can identify a smaller efficient set than stochastic dominance with respect to a function (SDRF).

SERF will provide an ordinal ranking of the three alternative location choices for the MixAlco facility within feasible risk aversion boundaries. A complete evaluation of alternative locations can be presented before a decision is made. This will give the decision maker a cardinal ranking to determine which location and investment is most suitable based on their risk preferences defined by the risk aversion coefficient (RAC). RAC or *r(x)* is defined as a function of wealth *(x)* as the negative ratio of the second and first derivatives of a utility function *u(x)*, where $r(x) = -u''(x)/u'(x)$ (Pratt, 1964; Arrow, 1965). Meyer (1997) suggests using a range of RACs so that ranking of risky alternatives could be made for policy applications.

Comparisons between risk averse agents, risk neutral agents, and risk-preferring agents are possible with SERF. Finding the risk preference for a decision maker is can be difficult. Mathematically, the shape or slope of an individual's utility function reflects the decision makers' attitude toward risk. However, attempts to elicit specific utility functions from decision makers have been difficult (Hardaker, Richardson, et al., 2004).

Anderson and Dillon (1992) proposed a rough classification of degree of risk aversion based on the magnitude of the relative risk coefficient. The relative risk aversion coefficient is defined as the $r_a(x) = r(x)/x$ where $r(x)$ is the RAC stated above and x is wealth. They classify the relative risk aversion coefficient range from 0.5 for a decision maker who is hardly risk averse to 4.0 for a decision maker who is extremely risk averse. The decision make's risk preference is a matter of individual preference. The exact form of the utility function is not important provided the degree of risk aversion is consistent (Hardaker, et al. 2004). For this analysis, McCarl and Bessler's (1989) work is used to define a range of consistent RACs to evaluate and rank the alternative scenarios for risk aversion preferences.

Concluding Remarks

Some important conclusions can be gleaned from the firm location literature review. First, many of the studies in location science emphasize the importance of minimizing cost or maximizing coverage of a given location. Very few focus on analyzing long-term profitability of a business. Second, most studies (until recently) did not consider the effects of stochastic inputs, outputs, and alternative scenarios when considering location choices. Deterministic models did not incorporate risk and uncertainty into the modeling of location choices. This limited the determination of optimum location choices, as unknown future states were not accounted for.

Risk and uncertainty is usually investigated by incorporating uncertain planning horizons and finding robust solutions. Some dynamic programs incorporated unknown future states in an infinite planning horizon. These studies were difficult to solve and solutions are dependent upon which robust criteria is chosen. There are very few location studies with stochastic inputs and outputs that incorporate scenario planning. .

The Distinct Contribution of This Study to the Literature

This study contributes to the literature both empirically and methodologically. Empirically, this study is a useful addition to the literature because it presents a unique discussion of the location of a MixAlco facility affecting the fuel oxygenates market in the United States. MixAlco could change the renewable fuels market.

Another unique contribution is a demonstration of stochastic simulation to solve location problems. Most published works take input variables as given. Very few published works incorporate stochastic variables into the evaluation of location choices. This study will incorporate stochastic variables and alternative scenario choices and locations using simulation. This allows for sensitivity analysis and comparison of key control variables which directly affect the probability of economic success.

There are also two methodological contributions of this study:

1. This study extends the works of Richardson and Mapp (1976), Gill (2002), and Herbst (2003) of building a stochastic feasibility model for an agribusiness enterprise.
2. The study also extends the work of Vanston (1977), Schilling (1982) and Owen and Daskin (1998) in using scenario planning to analyze location problems.

CHAPTER IV

SIMULATION MODEL AND DATA

Framework for MixAlco Production Facility Model

This chapter describes the framework and data for the stochastic simulation model used to evaluate the feasibility of a MixAlco production facility with alternative sizes and locations. The model simulates the economic activity for a 44 ton/hour and a 176 ton/hour plant in Panhandle, Central, and Coastal Bend Regions of Texas using sorghum silage as feedstock from 2005 to 2019. The 44 tons and 176 tons represent the amount of biomass consumed per an hour by the process. Feedstock costs and availability, variables inputs, and incentive packages will directly affect the feasibility and location of the MixAlco production facility.

Scenario Summary

Figure 8 presents a flow chart to summarize all alternative scenarios for analysis. A total of 24 alternative scenarios are evaluated; 3 location choices, 2 plant sizes at each location, 2 initial capital investment levels for each plant size, and incentives or no incentives for each initial investment level for each plant size at each location. The 24 scenarios encompass a diverse economic background so the most viable location and management decisions can be made.

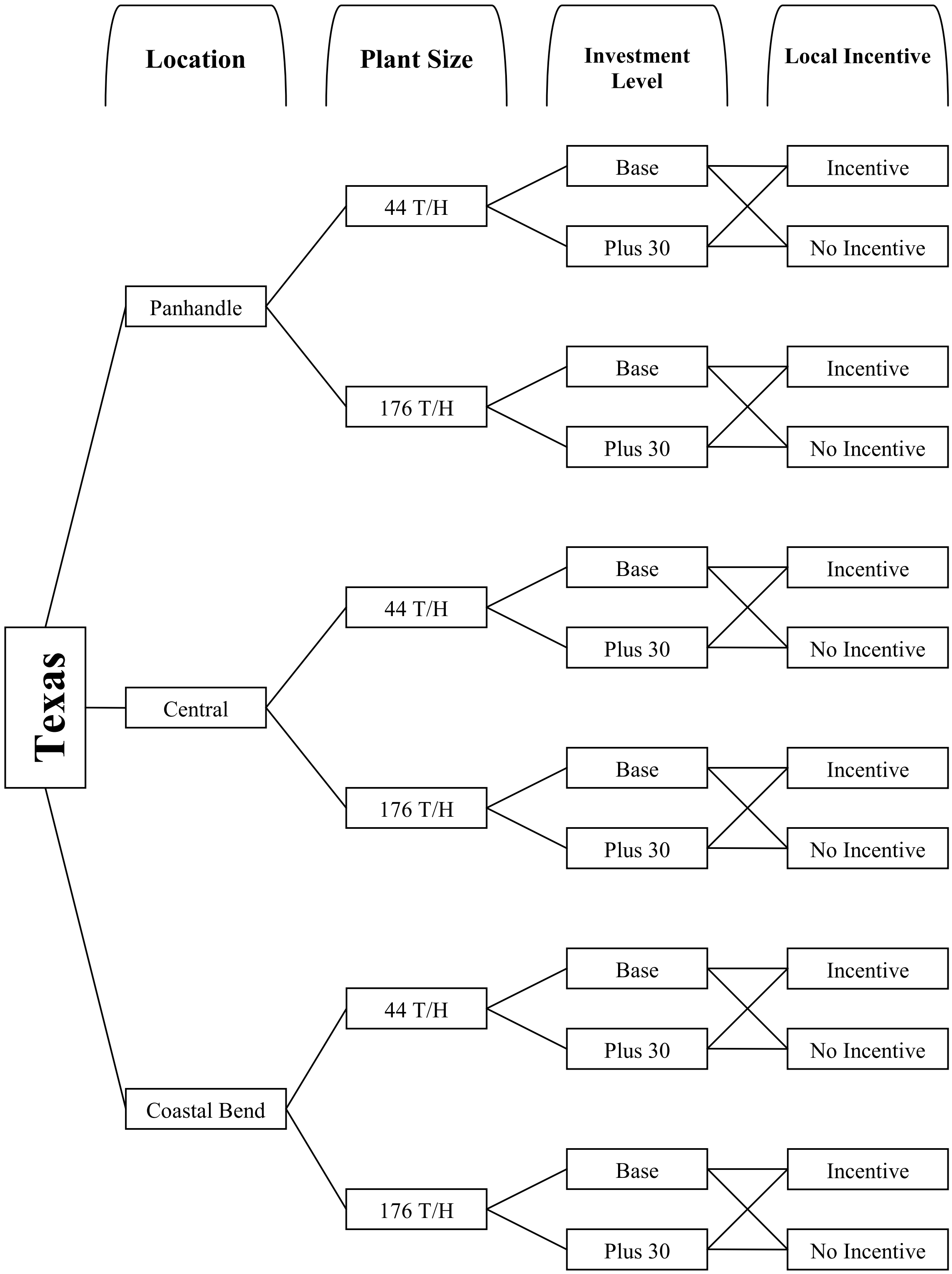

Figure 8. Flow chart of alternative scenarios

Location Choices

Site-specific factors are key determinants in choosing a location for a production facility. Texas is favorable for locating a business because it is only one of seven states without a personal income tax. There is also no state property or unitary tax. The state sales tax rate is 6.25 percent with a majority of local sales taxes being 2 percent for a total sales tax of 8.25 percent.

The property tax rate varies between regions. All incorporated businesses in Texas are subject to state franchise tax. The franchise tax is the greater of either 0.25 percent of taxable capital or 4.5 percent of earned surplus. Taxable capital includes stated capital, surplus, deferred income taxes, and non-current employee benefits. Earned surplus is federal taxable income plus officers' and directors' compensation allocated on a gross receipt business. This amount is paid annually to Texas and is adjusted for depreciation of equipment and buildings and appreciation of land.

A MixAlco production facility will have strict environmental constraints in Texas. The Texas Commission on Environmental Quality (TCEQ) is the primary regulatory industry in Texas. The TCEQ streamlines the regulatory process and focuses on promoting voluntary compliance with regulations. The current MixAlco production facility design complies with all environmental regulations in Texas. Current plans for the MixAlco production facility employ scrubbers to remove odors and particles on all vapor that is ventilated to the environment. The fuel pile is also completely sealed from the ground contact to prevent any seepage and contamination of groundwater.

Texas Regions

Regional economic advantages and disadvantages can affect the success of a business. Table 2 contains a matrix of advantages and disadvantages for three different regions in Texas the Panhandle Region, the Central Region, and the Coastal Bend Region. Advantages are denoted by "+" and disadvantages by "-" signs.

Table 2. Regional Advantages and Disadvantages for MixAlco Production

Region	Main Crops	Livestock Feeding	Petroleum Infrastructure	Market & Transportation
Panhandle	Corn/GS	+	-	-
Central	Corn/GS	+	-	+
Coastal Bend	GS/Rice	-	+	+

These three regions were chosen because of their large agriculture industries, varying growing conditions, income, input costs, and diverse economic backgrounds and would provide a broad analysis encompassing most agriculture, economic, and regional variations in Texas. Other regions in Texas were considered for this analysis. However, many of these regions would be similar in terms of agriculture production and economic diversity. Also, some regions do not have the required agriculture production necessary for alcohol production.

Figure 9 shows the location of each region in Texas defined by the Texas Agriculture Extension Service. The Panhandle Region is located closest to the west coast (California) where demand for oxygenates is expected to grow. The Coastal Bend Region could potentially benefit from port access for shipping alcohol fuel and is located closer to many power production facilities along the Lower Colorado River which could potentially benefit MixAlco production by reducing steam costs and transportation costs of residual bio-matter.

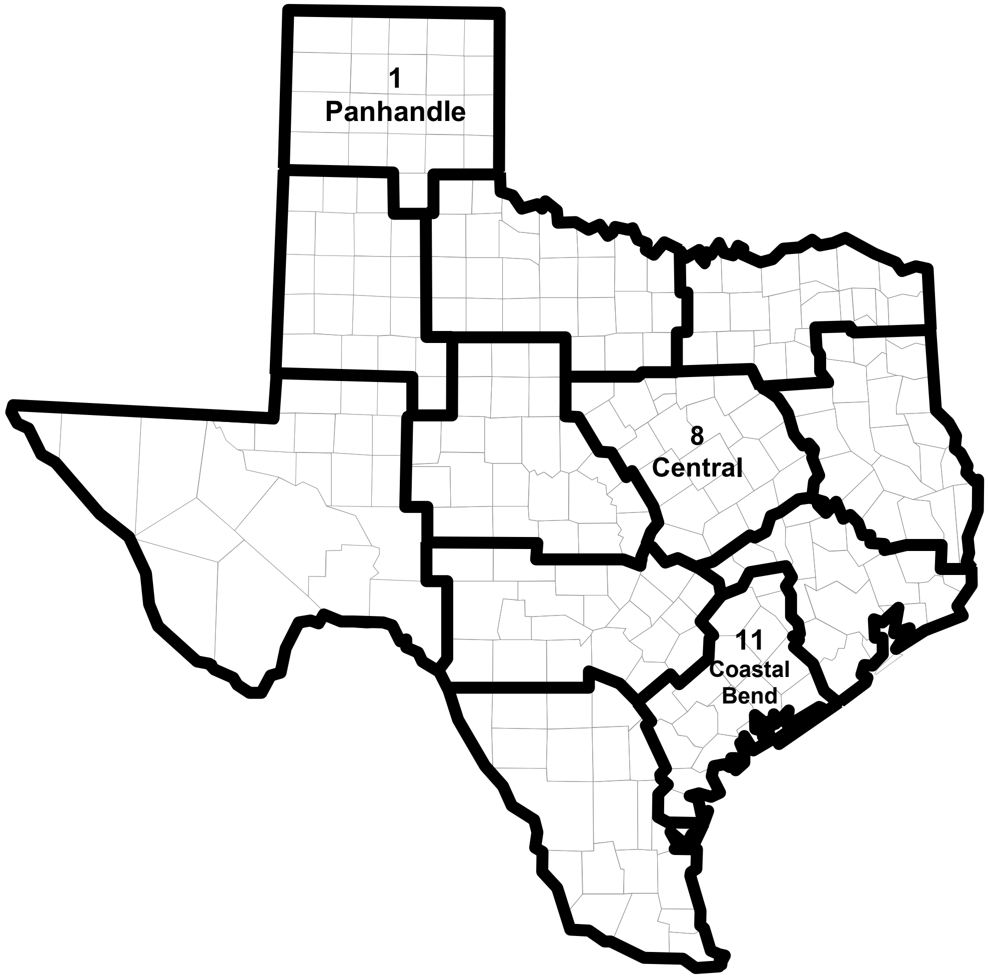

Figure 9. Map of Panhandle, Central, and Coastal Bend Regions in Texas

Source: Texas Agriculture Extension Service, 2004

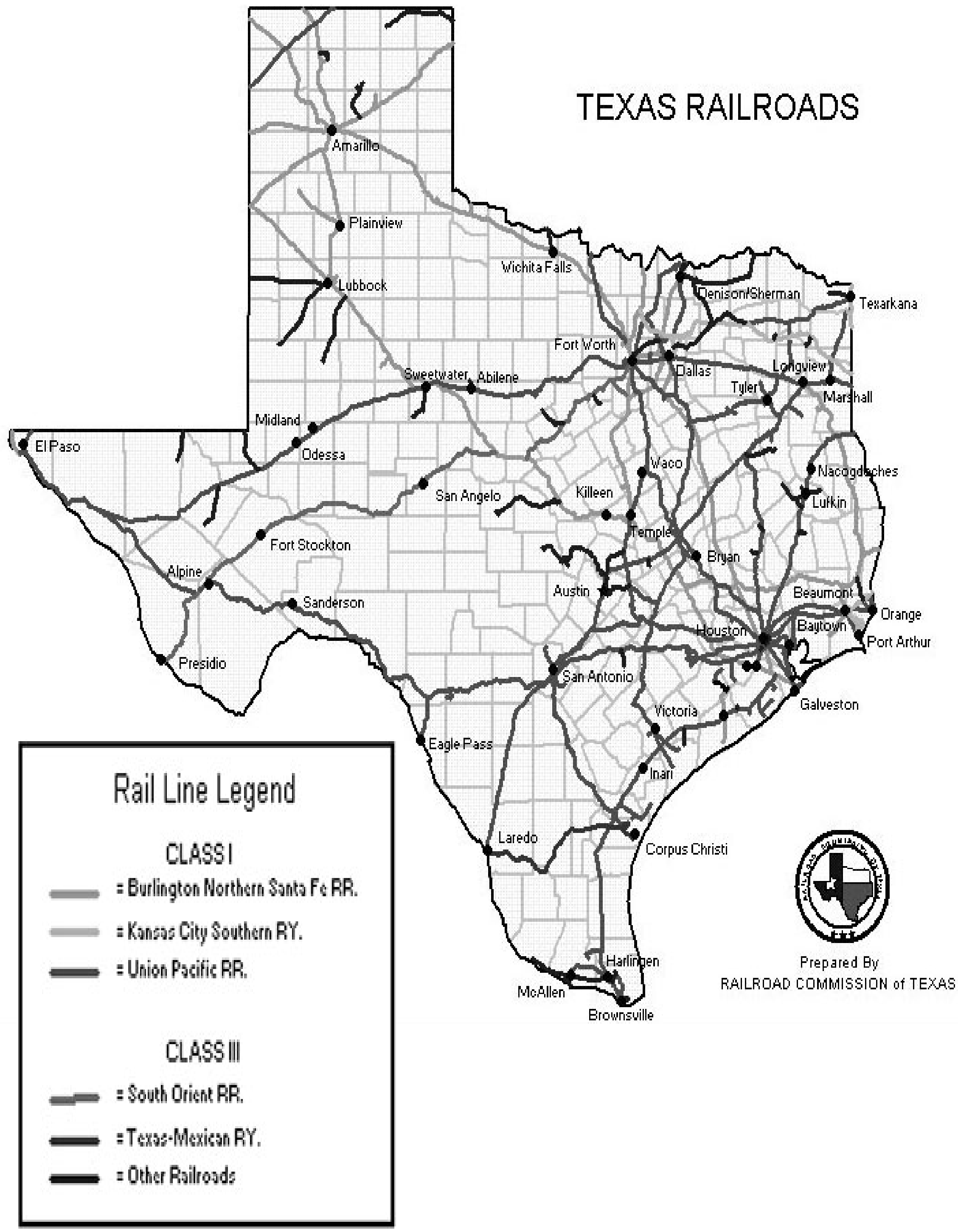

Figure 10. Map of active railroads in Texas

Source: Texas Railroad Commission, 2003

Figure 10 shows major railways in Texas. All three regions have interstate highways and railway access. Union Pacific Railroad Corporation is the major railway operator in Texas (Texas Railroad Commission, 2003). One major system runs north/south and supplies coal to major power generation plants from Montana, Wyoming, North Dakota, and South Dakota. The other Union Pacific rail system runs east/west into the city of Houston and gulf coast harbors. It transports fuel from Houston to the western states, particularly California. Burlington Northern Santa Fe Railroad system runs North/South from Houston to northern Texas. There may be distribution advantages for a production facility located close to a railway for purchasers of output from the MixAlco production facility.

The following sections describe the agriculture industry and local economic backgrounds for each region. All three regions have sufficient sorghum acreage to supply the necessary feedstock for a 44 ton/hour and 176 ton/hour MixAlco plant.

Panhandle Region

The Panhandle Region includes all the Texas Panhandle and extends south past Amarillo. It encompasses the primary cattle feeding in Texas. The limited and growing dairy industry in the Panhandle Region can supply the necessary nutrient feedstock source for MixAlco production. However, this region has two distinct disadvantages. One, it is distant from petroleum refineries which increases the shipping cost of the ethanol fuel. Two, the location is distant from the major metropolitan areas of Houston, San Antonio, and Austin where potential for air quality attainment is greatest.

Figure11 presents planted acres for corn for grain, corn for silage, cotton, sorghum, and wheat grown in the Panhandle Region. Planted acres corn for grain, corn for silage, cotton, and sorghum, are measured on the left axis and wheat acres are measured on the right axis. Acreage for all crops has remained stable or increased slightly from 1990 to 2003. Corn for silage is grown in small amounts in the Panhandle Region for cattle feed. It should be noted although wheat acreage is approximately 2.5 million; a large proportion of the acreage is not harvested and is grazed for cattle feeding in the Panhandle Region. MixAlco production would have to compete for wheat production with cattle feeding operations.

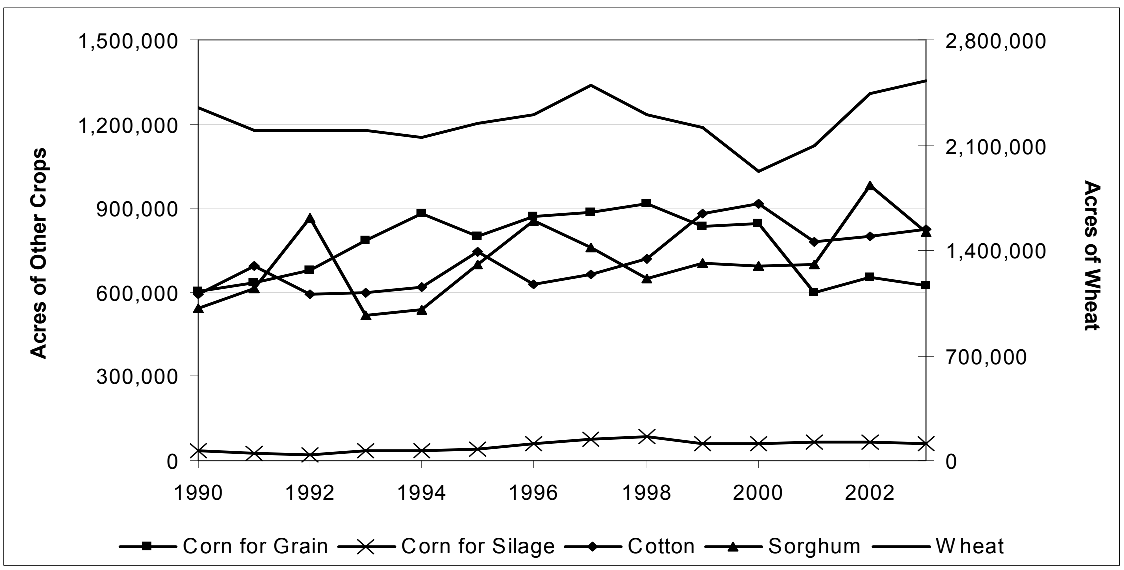

Figure 11. Acreage for corn for grain, corn for silage, cotton, sorghum, and wheat in the Panhandle Region of Texas from 1990 to 2003

Source: National Agriculture Statistics Service, United States Department of Agriculture, 2004

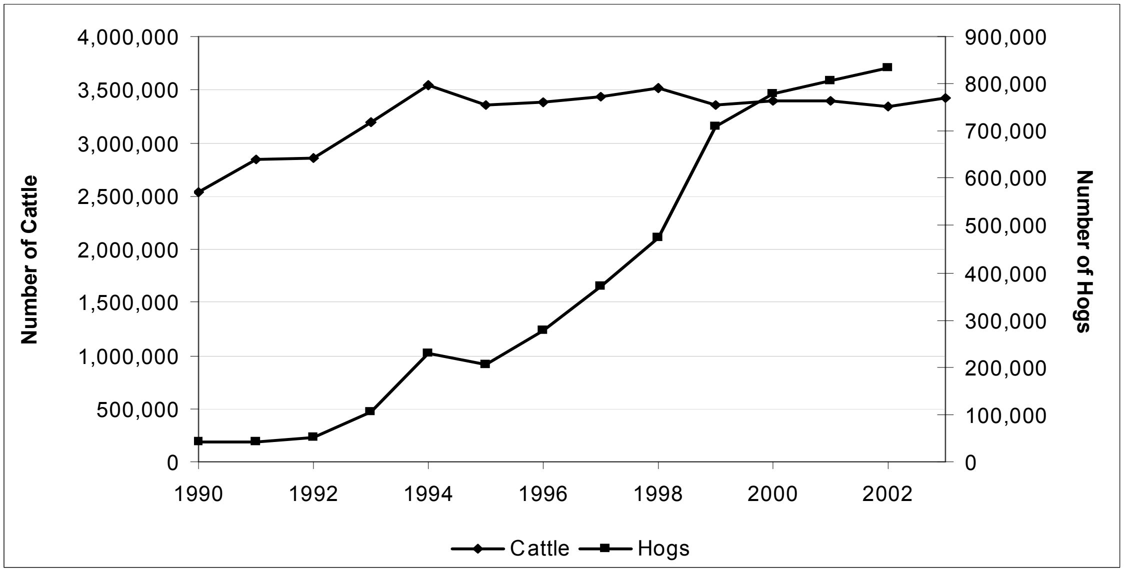

Figure 12. Total number of cattle and hogs in the Panhandle Region of Texas from 1990 to 2003

Source: National Agriculture Statistics Service, United States Department of Agriculture, 2004

Figure 12 presents total head cattle and hogs in the Panhandle Region. Total cattle numbers are measured on the left axis and total hog numbers are measured on the right axis. Number of cattle increased from 1990 to 1994 than remained relatively stable from 1995 to 2003 at approximately 3.4 million head. Numbers of hogs have increased dramatically from 1990 to 2003 from approximately 200,000 head to approximately 850,000 head in 2002. In 2004, there are approximately 34,000 head of milk cows in the Panhandle Region to supply manure as a nutrient source (NASS, 2004).

According to the Potter County Chamber of Commerce, the Panhandle Region is an inexpensive region to operate a business. The estimated utility costs, especially electricity, are among the lowest in the nation. Water is available from groundwater sources but restrictions apply to the amount of which can be withdrawn. The Panhandle Region is also a large producer of natural gas.

The cost of living in the Panhandle Region is consistently 8 to 10 percent below the national average with a mean income of $12.96/hour (Amarillo Economic Development Corporation, 2004). Local property tax is $2.15491/$100 of property valuation for incorporated businesses. This amount includes the county property tax, education tax, and water district tax. There is also a half cent economic development sales tax.

Central Region

The Central Region includes the area from Cameron north through the major dairy producing area of Stephenville. The large dairy industry in the Central Region can supply the necessary nutrient feedstock source for MixAlco production. The Central Region has a disadvantage of being distant from petroleum refineries in the southeast area of Texas. However, the Central Region is closer to the Texas metropolitan areas of Dallas, Fort Worth, and Houston where demand for oxygenates would be greatest.

Figure 13 presents planted acres of corn for grain, corn for silage, cotton, sorghum, and wheat in the Central Region. From 1990 to 2003, corn for grain, corn for silage, and sorghum acreage has remained steady while cotton and wheat acreage has decreased during the same period. Corn for grain and wheat are the predominant crops grown with approximately 700,000 acres for wheat and 600,000 acres for corn for grain in 2003.

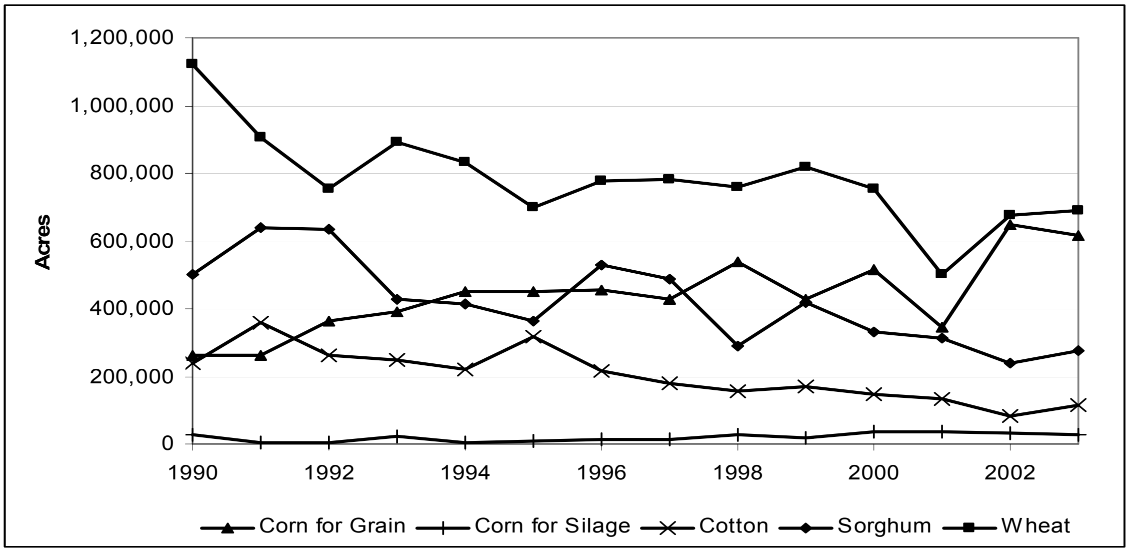

Figure 13. Acreage for Corn for Grain, Corn for Silage, Cotton, Sorghum, and Wheat in the Central Region of Texas from 1990 to 2003

Source: National Agriculture Statistics Service, United States Department of Agriculture, 2004

Figure 14 presents total head of cattle in the Central Region. Number of cattle peaked in 1995 at 1.9 million head but decreased to 1.7 million head in 2003. Recently, many dairies are relocating into the Central region. In 2004, approximately 31,000 head of dairy cattle are present. However, in the neighboring counties of Erath and Comanche, there are over 93,400 head of dairy cows.

Water, electricity, natural gas, and labor are readily available in the Central Region at reasonable rates (Hillsboro Chamber of Commerce, 2004). TXU Energy Services supplies electricity and natural gas to most of the Central Region. Water is supplied by the Aquilla Water Supply District and is supplied by surface water sources.

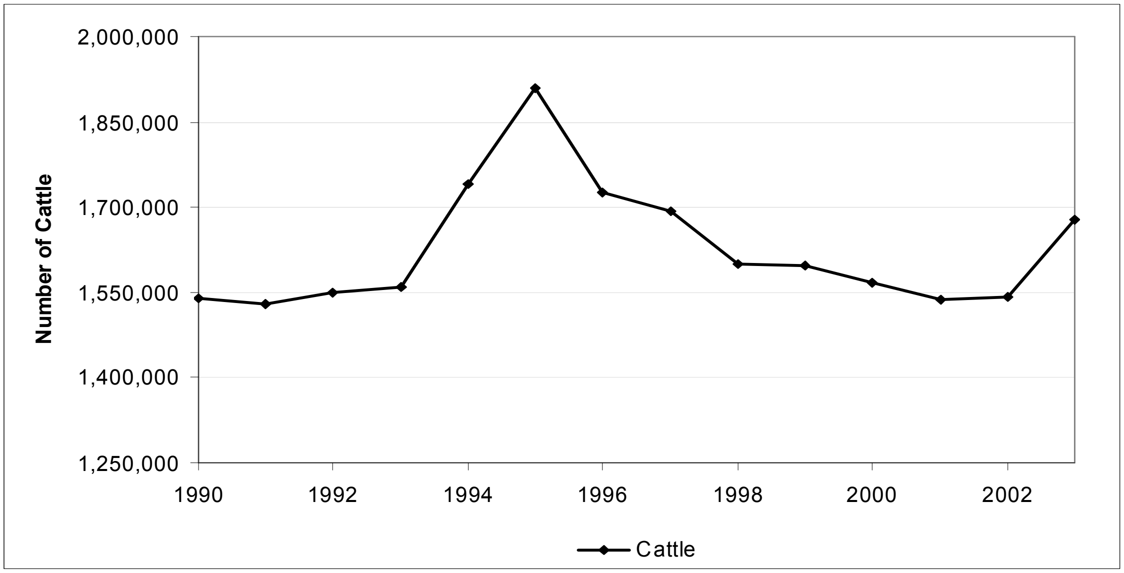

Figure 14. Total number of cattle in the Central Region of Texas from 1990 to 2003

Source: National Agriculture Statistics Service, United States Department of Agriculture, 2004

The regional taxes are $3.040776/$100 of property valuation. This amount includes the county property tax, education tax, and special district taxes. There is an economic development sales tax of 1/8 percent and other sales tax of 1/2 percent. The average income per hour is $11.04 (Hillsboro Chamber of Commerce, 2004). There is an extensive job training program in partnership with the Job Training Partnership Act (JTPA) of Texas.

Coastal Bend Region

The Coastal Bend Region includes the area around Corpus Christi north to Matagorda County. This region receives heavy annual rainfalls and is a major grain sorghum and rice production area in Texas. The Coastal Bend Region has the advantage of being located close to petroleum refineries and the large metropolitan areas of Austin, Houston, and San Antonio, reducing the shipping costs of the alcohol fuel to its intended markets.

Figure 15 presents planted acres for corn for grain, cotton, rice, and sorghum grown in the Coastal Bend Region of Texas. Acreage for corn for grain, cotton, and sorghum has remained stable or from 1990 to 2003. Rice acreage has steadily declined from 300,000 acres in 1990 to less than 150,000 acres in 2003. Cotton and sorghum are the two most grown crops at approximately 600,000 acres each in 2003.

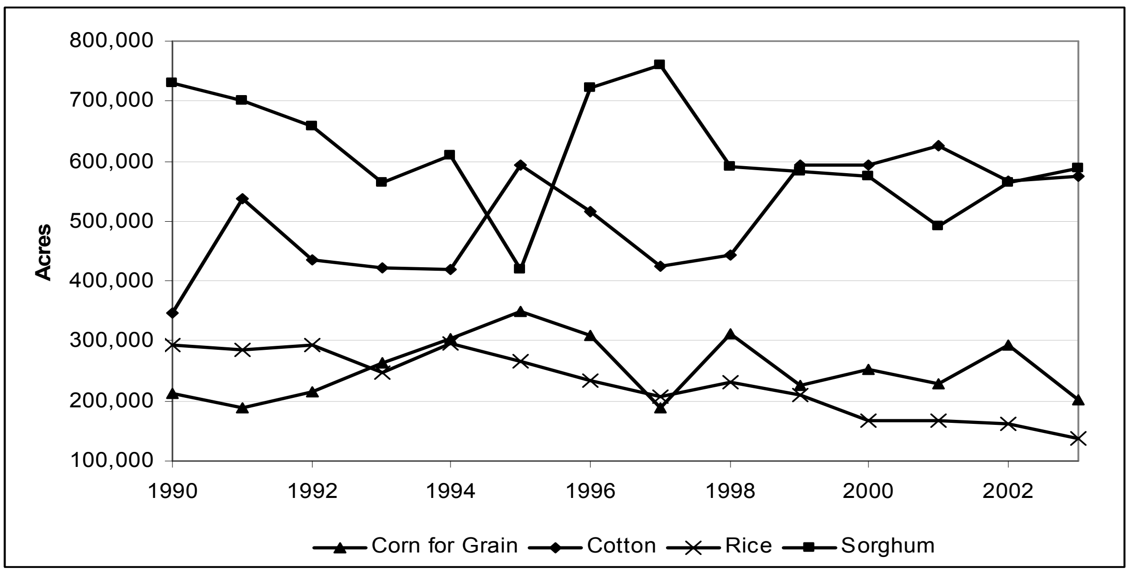

Figure 15. Acreage for corn for grain, cotton, rice, and sorghum in the Coastal Bend Region of Texas from 1990 to 2003

Source: National Agriculture Statistics Service, United States Department of Agriculture, 2004

Figure 16 presents total head of cattle in the Coastal Bend Region. Number of cattle has steadily increased from 650,000 in 1990 to 830,000 in 2003. No dairy cows are reported in the Coastal Bend Region and hog numbers have decreased to less than

2,500 head in 2001. The United States Department of Agriculture does not record hog numbers after this period.

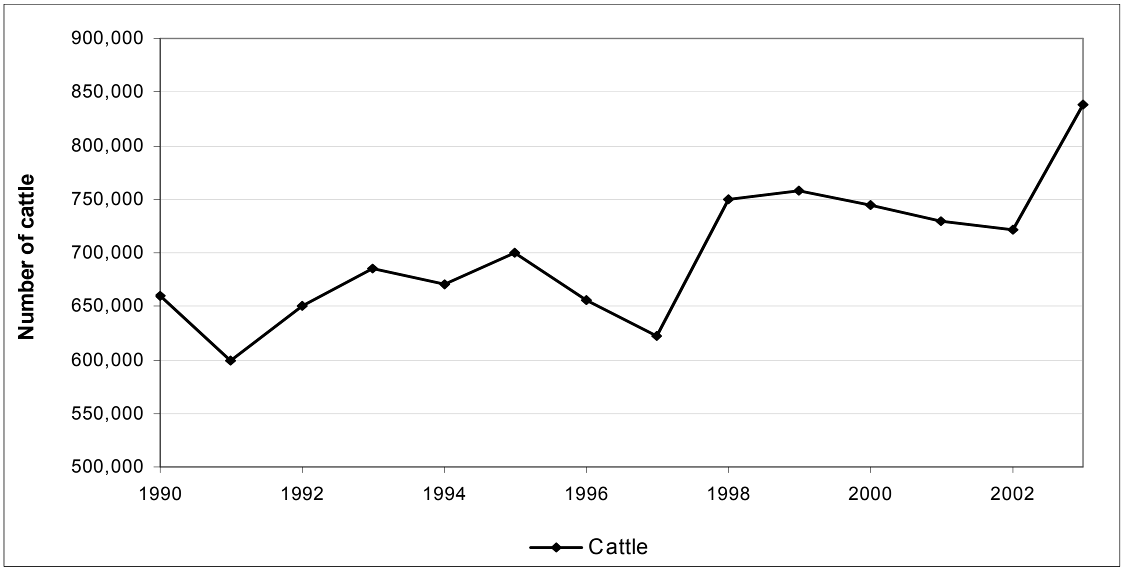

Figure 16. Total number of cattle in the Coastal Bend Region of Texas from 1990 to 2003

Source: National Agriculture Statistics Service, United States Department of Agriculture, 2004

Water is readily available from surface sources (Lower Colorado River) through the Lower Colorado River Association (LCRA). The Inter-coastal canal to the Port of Bay City is available for shipping fuel. The Port offers a turning basin, warehouse space, dock, and liquid storage facilities for transportation of ethanol. Electricity is also readily available from the LCRA. The regional taxes are $2.54858/$100 of property valuation. This amount includes the county property tax, education tax, conservation district, and hospital taxes.

Model Assumptions

Costs and investment requirements vary for each plant size in each alternative region. Land cost, construction cost, feedstock cost, and transportation cost of feedstock are variables which could dramatically affect the feasibility of MixAlco production. The comparison of differences will determine which region in Texas is most feasible for MixAlco production.

A competitive market structure is assumed for the input and output markets. Because of the business size, prices for inputs can be negotiated from suppliers to obtain the lowest cost. However, the average market price in Texas for utility inputs is used for analysis as specific contracts are not available. Ethanol and residual biomatter from the production process is sold freight on board (FOB). The transportation of each is dependent upon the purchaser of the output and their respective location. Railways are present in each region and there may be production and distribution advantages for locating the production facility adjacent to a railway. However, the advantages depend on the purchaser of the ethanol and residual biomatter and their respective location to the MixAlco production facility.

Plant construction will take approximately one year for completion. A 44 ton/hour facility takes 1 month to build the fuel pile and operate 11 months or 8,040 hours annually. The 176 ton/hour requires 3 months to build the fuel piles and operates 9 months or 6,600 hours annually. This is the amount of time needed to haul in the required amount of silage. The pile building time is calculated based on 25 tons per truckload of silage and 10 truckloads per day. To build the fuel pile for a 44 ton/hour facility in 30 days, 38 trucks are necessary. For a 176 ton/hour facility, 42 trucks are needed to build the fuel pile in 90 days. These amounts vary slightly depending on the availability of feedstock during the pile building time frame. Fuel pile size is stochastic depending upon actual yields for sorghum silage and number of contracted acres.

The first year of the analysis is for construction of the facility. Production begins at half capacity in the second year of the analysis, 2005, and reaches full capacity in the third year. The plant operates at full capacity from 2006 to 2019.

The following sections describe the feedstock requirements, business structure, capital requirements, business structure, production assumptions, non-stochastic and stochastic variables, financial statements, and key output variables for analysis.

Feedstock Requirements

Two different plant sizes are considered for evaluation, 44 ton/hour and 176 ton/hour. An 896 ton/hour facility was considered in the initial study by Holtzapple (2004), but is not considered because of land and cellulose feedstock requirements.

This analysis uses sorghum silage as feedstock in the Panhandle, Central, and Coastal Bend Regions of Texas as it can be readily grown in all three regions. Sorghum is adaptable to varying growing conditions and is inexpensive to grow with adequate grain and residue yields (dependent on variety grown). Research by Creelman (1981), Gallagher, et al. (2003), and Hons (1986) suggest sorghum is a suitable and reasonable source of cellulose feedstock for energy conversion.

Table 3 presents the required deterministic tons of cellulose feedstock, nutrient biomass (sewage sludge, manure), and annual average output for 44 ton/hour and 176 ton/hour MixAlco production facilities. The amount of cellulose feedstock used, fuel pile size, depends on the current year's stochastic silage yield and the number of contracted acres. Cellulose and nutrient feedstocks are mixed at a ratio of four parts cellulose feedstock to one part nutrient feedstock for conversion. The sum of cellulose and nutrient feedstock is the total biomass amount for conversion.

Table 3. Required Tons of Cellulose Feedstock, Nutrient Feedstock, and Annual Ethanol Output by Plant Size

Plant Size	Hours Operation	Total Biomass Requirement	Tons Cellulose Biomass	Tons Nutrient Biomass	Output
44 ton/hour	8,040	353,760	283,008	70,752	46 MMGY
176 ton/hour	6,600	1,161,600	929,280	232,320	151 MMGY

Table 4 presented the planted sorghum acres for 2003 in each region, estimated contract acres for a 44 ton/hour and 176 ton/hour production facility based on cellulose requirements, and estimated yield silage yield per acre. Sorghum acreage in each region is sufficient to supply 44 ton/hour and 176 ton/hour production facilities.

Sorghum for silage yields for Texas is recorded by the National Agriculture Statistics Service (NASS) of the United States Department of Agriculture (USDA). Most sorghum planted is harvested for grain and the remaining residue matter (stover) is tilled into the ground for conservation and organic matter purposes. Most all the sorghum produced is dryland farmed in Texas. Harvesting index studies for sorghum have suggested a ratio of one ton of grain harvested to one ton of stover produced when considering bio-matter residue for harvest (Gallagher, et al., 2003; Prihair and Stewart, 1983; Xie et al., 2001; and Hammer, et al., 2003).

Table 4. Grain Sorghum Acres in 2003, Estimated Contract Acres, and Estimated Silage Yield in Tons per Acre

Region	Grain Sorghum Acres in 2003	--Estimated Contract Acres-- 44 Ton/Hour	176 Ton/Hour	Yield Tons/Acre
Panhandle	816,000	50,161	164,708	8.06
Central	274,000	31,481	103,369	12.84
Coastal Bend	588,000	29,329	96,305	13.78

Business Structure

This analysis assumes a generic business structure. Profits are taxed at corporate level consistent with 2003 federal income tax codes. Dividends withdrawn are paid at 30 percent of after-tax net income. An operating loan to cover feedstock costs and variable costs is available using the non-real estate interest rate from the Wharton Economic Forecasting Associates (WEFA) (2004) forecast from 2005 to 2013. Interest rates from 2014 to 2019 are held constant at the 2013 rate. A table of all interest rates and inflation rates used is available in the Appendix A.

If the facility experiences a loss, the analysis assumes unlimited financing of cash flow deficits using the same interested rate to finance deficit and remain in operation. This assumption is important for evaluation purposes so the facility operates without shutdown.

Capital Requirements

Table 5 shows the estimated costs percentages when using the Lang Factor to estimate capital requirements for equipment, installation, and buildings. Lang Factors are used to calculate installation, engineering, and construction costs as a percentage of the original equipment cost. For instance, a machine costing $100 would require $39 for installation, $26 for instruments and controls, and so on based on the Lang Factor Method. The Lang Factor is accurate to within “plus” and “minus” of 30 percent (Peters, et al., 2003). According to Nopsingers, constructors of many ethanol plants across the U.S., the estimated capital requirement costs for equipment and construction are appropriate with industry standards using the Lang Factor method.

Table 6 presents capital investment requirements for equipment, construction, land, and the alternative investment cost scenarios for a 44 ton/hour and 176 ton/hour in the Panhandle, Central, and Coastal Bend Regions of Texas. There are economies of scale advantages with a larger production facility. Standard capital investment indexes for construction and equipment are used to inflate the 44 ton/hour costs to176 ton/hour. These indexes are available from *Plant Design and Economics for Chemical Engineers* (Peters, et al., 2003). An equipment list is presented in the Appendix A for each plant size.

Two different initial investment scenarios, base and plus 30 percent, are analyzed using scenario analysis. The Lang Factor suggest a range of plus or minus 30 percent of the expected costs. However, the minus 30 percent rule was not considered because MixAlco is a new technology with no production facility in existence, the minus 30 percent rule is an overly optimistic estimate. Following the ethanol industry standard, 5 percent of the initial investment for equipment and building is required for cash reserves (CoBank).

Table 5. Costs Included in Lang Factor

	Percent of Equipment Costs For	
Item	**Solid-Fluid Processing**	**Fluid Processing**
Delivered Equipment	100	100
Installation of Purchase Equipment	39	47
Installed Instrumentation and Controls	26	36
Installed Piping	31	68
Installed Electrical System	10	11
Buildings (Including Services)	29	18
Yard Improvements	12	10
Service Facilities	55	70
Engineering and Supervision	32	33
Construction	34	41
Legal Expenses	4	4
Contractor's Fee	19	22
Contingency	37	44
Total Capital Requirement Percent	428	504

* Estimated from *Plant Design and Economics for Chemical Engineers*, 2003

Storage tanks are needed to hold the ethanol before shipping by truck, railway, or barge. It is assumed storage for seven days of ethanol production is sufficient for continued operation. This accounts for weather problems such as ice storms in the Panhandle and Central Region and hurricanes in the Coastal Bend Region. The costs of storage tanks are included in the Lang Factor.

Shipping acids or ethanol by pipeline is an alternative to shipping by truck, railway, or barge and would eliminate the cost of a storage tank. According to Scott Wellington of Shell Oil Company, the cost of a dedicated pipeline for shipping alcohols or acids is multidimensional based on many factors including land rights, permits rights environmental permits, existing capacity, time of use, length and size of pipe, and the cost of installation. Because of these factors, there is no set price for a pipeline that can be quoted. For comparison to existing ethanol facilities, it is assume that truck, railcars, and barges are used for transporting the fuel.

A concrete road is necessary for transportation of feedstock and ethanol. The most efficient layout is a matrix grid for each fuel pile with adequate spacing for truck and equipment movement. With the facility 100 feet from the road, approximately 850 feet by 24 feet of concrete is needed for a 44 ton/hour production facility and 4,400 feet by 24 feet for a 176 ton/hour facility. A width of 24 feet is used so trucks and enter and exit without having to wait. The cost for concrete driveways is included in the Lang factor.

Table 6. Capital Requirement Scenarios for a 44 ton/hour and 176 ton/hour MixAlco Production Facility in the Panhandle, Central and Coastal Bend Regions of Texas

						--Scenarios--	
Region	**Plant Size**	**Construction & Building Cost**	**Equipment Cost**	**Land Cost**	**Cash Requirement**	**Base**	**Plus 30 Percent**
				--In Millions--			
Panhandle	44 ton/hour	15.33	4.34	0.01	0.98	20.67	26.87
Panhandle	176 ton/hour	50.15	14.51	0.05	3.24	67.95	88.34
Central	44 ton/hour	15.33	4.34	0.02	0.98	20.68	26.88
Central	176 ton/hour	50.15	14.51	0.08	3.24	67.99	88.38
Coastal Bend	44 ton/hour	15.33	4.34	0.02	0.98	20.68	26.88
Coastal Bend	176 ton/hour	50.15	14.51	0.08	3.24	67.99	88.38

The required capital for the cost of construction and equipment are similar in each region but land costs will vary. The initial investments for a 44 ton/hour facility in all three regions are $20.67 million at the base level and $26.87 million in the Plus 30 Percent scenario. A 176 ton/hour facility requires $67.95 to $67.99 million in the base scenario and $88.34 to $88.38 million in the Plus 30 Percent scenario.

A 44 ton/hour facility requires 20 acres of land and a 176 ton/hour facility requires 80 acres of land. This land is only for the production facility structures, additional land is needed for storage of feedstock if necessary. Land costs are determined from the Representative Farm Project of the Texas A&M Agriculture and Food Policy Center (AFPC) and are based on farm land value per acre for each region. Land values are appreciated using U.S. land inflation rates from FAPRI for 2005 to 2013. The 2013 rate is held constant from 2014 to 2019. Land is not depreciated because land does not wear out, become obsolete, or get used up.

These initial capital requirements for construction and startup of a MixAlco production facility are lower than corresponding corn-based ethanol plants of comparable size. A 44 ton/hour facility produces 46 MMGY of ethanol and a 176 ton/hour facility produces 151 MMGY. A feasibility study developed for the city of Dumas, Texas by Bryan and Bryan International (2001), list capital requirements for various corn-based ethanol plant sizes. Their report shows a 40 MMGY ethanol facility requires $55 million for construction and startup and an 80 MMGY facility requires $100 million. These amounts are higher than the Plus 30 Percent scenario, where a 46 MMGY MixAlco plant requires $26.88 million and a 151 MMGY requires $88.38

million. MixAlco has a significant advantage of lower required initial capital investment for construction and startup.

It is assumed that 50 percent of the capital requirements are borrowed funds financed at 8 percent and the remaining 50 percent is contributed from prospective investors. This ratio of borrowed to owned equity is the industry standard for ethanol production and is applicable to MixAlco. Commercial banks normally require 50 percent of total capital borrowed consist of owned equity. The interest rate of 8 percent is approximately equal to the real estate interest rate reported by Food and Agriculture Policy Research Institute (FAPRI) January 2004 Baseline Projections.

Production Assumptions

Table 7 presents the summary of variable inputs required per ton of feedstock. Lime, hydrogen, and water are the three largest variable inputs. No MixAlco facility is in operation, so production assumptions are based on laboratory experiments reported by Holtzapple (2004). An energy yield of 189 grams of VFAs per gallon of fermentation broth or an equivalent 238 grams of carboxylate salt per gallon of broth can be achieved. This concentration level is sufficient for production of ethanol containing 95,000 BTU/gallon. The concentration levels are dependent on two factors, vapor compression evaporation during dewatering and the conversion of carboxylate salts to carboxylic acid.

Pile size does not affect the production efficiency, i.e. the alcohol conversion rate is independent of the amount of feedstock available. The difference is a smaller pile will finish conversion in less than a year and a larger pile will take longer than one year for conversion. However, the process can be stopped at one year's time if needed. Total ethanol output for the facility is dependent on the amount of feedstock and time allowed for conversion (Holtzapple, 2004).

Ethanol fuel yield from MixAlco conversion ranges from 120 gallons to 140 gallons per ton of biomass feedstock (Holtzapple, 2004). This level of ethanol fuel yield was achieved using sugar bagasse in lab experiments. Other sources of cellulose feedstock may cause slight yield variations but Holtzapple states ethanol yield is relatively stable and may increase as the technology advances. However, because of the uncertainty in fuel yield, a GRKS distribution developed by Gray, Richardson, Klose, and Schumann is used to stochastically simulate ethanol yield with a minimum of 110 gallons/ton feedstock, mean of 130 gallons/ton, and maximum of 140 gallons/ton (Richardson, 2004). A minimum value of 110 gallons/ton is used to simulate higher downside variability associated with unproven technology. The minimum, mean, and maximum returned from the GRKS distribution is 100 gallon/ton, 125 gallon/ton, 145 gallon/ton, with a standard deviation of 15 gallon/hour. A cumulative density function (CDF) graph of the GRKS distribution for ethanol yield is included in the Appendix A.

Table 7. Summary of Variable Inputs per Ton of Feedstock

	Units	Utility Requirements
Lime	Lbs/ton	200
Inhibitor	Lbs/ton	0.334
Hydrogen	hcf/ton	101.5
Steam	Ton/ton	0.65
Cooling Water	acre feet/ton	0.0515
Natural Gas	Mcf/ton	0.776
Electricity	kWh/ton	33.73

Source: Holtzapple, 2004

Non-Stochastic Costs

The plant will require 4 percent of the initial investment amount for annual capital improvements and maintenance of the production facility. The annual capital improvement costs are calculated by multiplying the capital requirements for construction and buildings, equipment, water pumps, and storage tanks by 4 percent for the two alternative initial investment scenarios, Base and Plus 30 Percent. The capital improvement costs are inflated annually using the fixed costs inflation rate reported by WEFA from 2005 to 2013 to adjust for inflation over the planning horizon. The 2013 rate is held constant from 2014 to 2019.

Table 8. Base Non-Stochastic Variable Cost for MixAlco Production ($/ton Feedstock)

Input	Unit	44 Ton/Hour	176 Ton/Hour
Inhibitor	$/ton	0.91	0.91
Labor	$/ton	3.43	3.20
Administration Cost	$/ton	1.19	0.36
Harvesting	$/ton	2.48	2.48

Sources: Holtzapple, 2004
Texas Agriculture Statistics Service, 1999

Table 8 presents the average non-stochastic variable costs used in the analysis. These mean values for the non-stochastic variable costs (inhibitor, labor, administration, cooling water, and harvesting cost) are used as the annual deterministic forecasts. Inhibitor cost per ton is calculated by multiplying the inhibitor price of $2.72/lb by 0.334 lbs./ton feedstock (Holtzapple, 2004) and are inflated annual using WEFA's chemical inflation rate. Harvesting costs per ton are determined from the Texas Agriculture Statistic Service (1999) based on silage harvest costs rate. Harvesting costs are paid by

MixAlco to offer a greater incentive to farmers for growing sorghum silage for energy production. Inhibitor is inflated annually using the chemical inflation rate from WEFA.

The required labor, management, and salaries for a 44 ton/hour and 176 ton/hour facilities are presented in Table 9. Administrative costs include the plant manager and supervisors. Labor, administration, and harvesting costs are inflated annually using the labor inflation rate defined by WEFA from 2005 to 2013. The 2013 rate is held constant from 2014 to 2019.

Because of the uncertainty in labor with turnover, a GRKS distribution is used to stochastically simulate wages. A minimum of minus 5 percent, mean of 0 percent, and a maximum of 10 percent are used to distribute the wage rate for each year (Richardson, 2004). Both administrative and labor costs per ton of feedstock are lower for the 176 ton/hour facility because of economies of scale.

A pile building cost of $0.69/ton for a 44 ton/hour facility and $0.79/ton for a 176 ton/hour facility is included in the labor expense. Pile building costs are calculated based on the leased cost of 100 ton load dump trucks, fuel, and labor, to build the fuel pile. Sorghum silage and nutrient feedstocks are mixed with lime, water, and calcium carbonate to create the fuel pile for conversion. This mixture is assumed to have a weight of 5 times the required biomass amount, i.e. one ton of feedstock is equal to five tons of mixture for pile building purposes (Holtzapple, 2004).

Table 9. Number of Labor, Management, and Salaries for 44 Ton/Hour and 176 Ton/Hour MixAlco Production Facility

Labor	44/Ton/Hour Number	176 Ton/Hour Number	Annual Salary
Plant Manager	1	1	$120,000
Supervisors	5	5	$75,000
Sales	1	1	$65,000
Clerical	3	4	$35,000
Workers	20	65	$40,000

Cooling Water

Cooling water prices are determined independently in each region. Approximately 18,000 acre feet for a 44 ton/hour facility and 60,000 acre feet for a 176 ton/hour facility is required. The available water is dependent on the local source, either ground (well), or surface (reservoir, river).

Panhandle Region

According to the High Plains Underground Water Conversation and the Amarillo Water District, majority of the water used in the Panhandle Region is ground water. The current water district does not have the capacity to supply the required amount of water for production. Existing wells will have to be used to supply the necessary water.

Current regulations in the Panhandle Region state only one acre foot of water can be removed annually per one surface acre land owned. The required land for MixAlco production facility is below this and owning 18,000 acres or 72,000 acres of land is not feasible. Water rights can be purchased for approximately $300/land acre (High Plains Underground Water Conservation, 2004). A one time cost for water rights to supply a 44 ton/hour facility is $5.46 million and for a 176 ton/hour facility the cost is $17.9

million. Water rights cost significantly increases the initial investment level required for the Panhandle Region. However, it will decrease the variable costs of production as water does not have to be purchased. Electricity is the only required fuel to provide water.

A well depth of 350-500 feet is required in the Panhandle Region depending on the location. Randy Taylor of Les Taylor Drilling Company provided information on the installation costs for wells. A 500 foot deep well costs approximately $40,000 to drill. The largest pump available, 3,000 gallon per minute (gpm), costs approximately $150,000. A 44 ton/hour facility requires 5 pumps and a 176 ton/hour facility will require 17 pumps to supply the required amount of water. The total installed well cost for a 44 ton/hour facility and 176 ton/hour facility is $950,000 and $3.23 million, respectively. This amount is added to the initial capital plant and equipment cost for the Panhandle Region.

The required fuel for water wells are dependent upon the power unit and pump efficiency. Tests performed by the Texas Agriculture Experiment Service (TAES) show large electric motors attain efficiencies of 90 to 92 percent and properly matched pumps can achieve 80 percent. Interpolating the results from the field study, a 3,000 gallon per minute electric pump would require approximately 1,038 kWh electricity to supply one acre foot of water. The variable cost for operating a pump is determined by multiplying the required acre feet of water times 1038 kWh times the stochastic electricity price defined later in the stochastic variables section.

Central Region

Unlike the Panhandle Region, surface water is available in the Central and Coastal Bend Regions. The Aquilla Water Supply District supplies water to Hill County and most of the Central Region. The source of water is Aquilla Lake. The price of industrial water from the Aquilla Water District is $45.75/acre foot. The price of water is inflated annually using the fertilizer/fuel inflation rate from WEFA.

Coastal Bend Region

A large amount of surface water is available in the Coastal Bend Region. Most all water is from the Lower Colorado River and is regulated by the Lower Colorado River Association (LCRA). The LCRA's purpose is to provide low-cost reliable water and manage the water supply and environment of the lower Colorado River basin. LCRA guarantees water to municipals, industrial, irrigation, and recreational uses through water sale contracts.

LCRA today operates nine major pumping plants that supply water through a 1,100-mile network of irrigation canals in portions of Matagorda, Wharton and Colorado counties. Matagorda County is within LCRA's Gulf Coast District for water supply. LCRA prices water for each region based on use. The highest base price is for rice irrigation. The projected LCRA rates for water are $32.90 in 2005, $41.55 in 2006, $44.05 in 2007, and $46.69 in 2008. The 2008 price is inflated annually using the fertilizer/fuel inflation rate from WEFA.

Nutrient Feedstock

Manure is used as the nutrient feedstock source in the Panhandle and Central Regions of Texas. A derivative of sewer sludge, houactinite, is used in the Coastal Bend Regions. Manure is available in the Panhandle and Central Regions because of the large number of dairies in close proximity. No dairy cows are available in the Coastal Bend Region to supply manure.

Only small amounts of manure are sold for commercial purposes. Most manure is either composted or digested to produce methane gas and fertilizer using special bio-matter digesters. The compost, fertilizer, and methane gas produced can be sold for additional income to feedlots, dairies, or hog farms.

The value of manure is determined and calculated by the available nutrient content of nitrogen (N), phosphorous (P), and potassium (K). Fresh manure contains approximately 1.3 percent N, 1.69 percent P, and 2.21 percent K by weight (Texas A&M, 2004). The value of N, P, and K as fertilizer is $0.29, $0.23, $0.15 per pound respectively. Based on the available nutrient amounts and value, one ton of fresh manure is worth $14.90 as fertilizer.

A manure cost of $15/ton is used and is inflated annually by the fuel cost inflation rate reported by WEFA from 2005 to 2013. The 2013 rate is held constant from 2014 to 2019. One dairy cow is estimate to produce 115 lbs/day of manure. The manure is composed of 30 percent solids and 70 percent water. Approximately 65 percent of the water is lost from evaporation, scraping, and compiling. The total available manure for use is 62.5 lbs/dairy cow/day (Texas A&M, 2004). Based on these values, approximately 8,250 head of dairy cows are adequate to supply the required amount of manure for a 44 ton/hour MixAlco facility. For a 176 ton/hour facility, 27,000 head of dairy cows are required to supply the necessary amount of manure. A manure capture rate of 75 percent is used i.e. 25 percent of all manure produced cannot be collected.

Manure is transported via truck to the production facility. Dump trucks have a capacity of 24 tons of wet manure. The commercial rate for loading and hauling is $17.025/ton and the additional hauling rate is $0.10/ton/mile (Schwartz, 2004). The commercial rate for loading and hauling is inflated annually using the labor inflation rate from WEFA. The hauling rate per ton mile is inflated annually using the fuel inflation rate reported by WEFA from 2005 to 2013. The 2013 rate is held constant from 2014 to 2019.

In the Panhandle Region, the largest dairy counties in terms of 2004 numbers are Deaf Smith, Parmer, and Lamb County with 8,500, 7,600, and 16,200 head, respectively (NASS, 2004). Hauling distances are calculated from the each county to Amarillo in the middle of the Panhandle Region. The required travel distance from Hereford in Deaf Smith County to Amarillo is 50 miles, from Bovina in Parmer County to Amarillo is 85 miles, and from Littlefield in Lamb County to Amarillo is 110 miles. A 44 ton/hour facility could be adequately supplied by dairies in Deaf Smith County. For a 176 ton/hour facility, manure will have to be hauled in from all three counties.

For facilities in the Central Region, manure is hauled in from Stephenville in adjacent Erath County. Erath County is one of the largest dairy producing regions in

Texas with approximately 65,800 head in 2004 (NASS, 2004). This is adequate to supply both the 44 ton/hour and 176 ton/hour facility. The travel distance is 95 miles to Hillsboro located in the middle of the Central Region.

Houactinite is used as nutrient feedstock in the Coastal Bend Region because of the low number of dairy cows in the region. Houactinite is a fertilizer made from sewage sludge by decay and heat. Houston currently has two facilities producing houactinite. All houactinite is marketed and distributed through Synagro and its subsidiaries.

Bill Kahla of Vital-Cycle in Bryan, a subsidiary of Synagro, provided costs information for houactinite. The price for the lowest grade houactinite is $10 per ton. Shipping cost is $15 per ton delivered anywhere within a 100 mile radius of Houston with a surcharge for longer distances. The distance from Houston to Bay City in Matagorda County is approximately 100 miles so no extra surcharge is required. The delivered cost per ton of houactinite is $25 and is inflated annually using the fuel/fertilizer inflation rate reported by WEFA from 2005 to 2013. The 2013 rate is held constant from 2014 to 2019.

Stochastic Variables

The following section describes the stochastic variables used in the model. The stochastic variables for the MixAlco production facility are ethanol price, annual yield for sorghum silage, electricity price, lime price, steam price, hydrogen price, coal price, and natural gas price.

Ethanol Price

There is currently no price for ethanol produced from the MixAlco process. Because of the compositional advantages of the ethanol produced from MixAlco, Holtzapple (2004) hypothesized that the ethanol produced from MixAlco will have a higher price than corn-based ethanol. However, until petroleum blenders derive a real price for MixAlco ethanol, corn-based ethanol price is used for the analysis. The ethanol price includes the excise tax exemption for petroleum blenders due to expire in 2007. However, the exemption is included in the new energy bill and includes ethanol produced from biomass sources.

For this analysis, the current excise tax exemption is included in the price of ethanol. This allows for direct comparison to corn-based ethanol production facilities. Also, ethanol is sold freight on board (FOB) where the purchaser is responsible for transportation costs to the blending facility. It is assumed all ethanol produced will be purchased by refineries to be blended with gasoline.

Price data (in dollars/gallon) for ethanol and MTBE from 1990 to 2003 are available from *Hart's Oxy-Fuel News*. The reported weekly prices are averaged to create annual prices for ethanol and MTBE. Ethanol prices are comprised from 33 cities and MTBE prices are for Houston, TX. MTBE prices are reported for Los Angeles, CA and New York City, NY as well but the available data was limited from 1997 to 2003.

Figure 17 shows the annual average price for ethanol and MTBE from 1990 to 2003. Both prices have remained relatively stable over this period with increased volatility from 2000 onward. Ethanol and MTBE prices exhibit volatility ranging from a minimum of $1.01 for ethanol and $0.64 for MTBE to a maximum of $1.51 for ethanol and $1.14 for MTBE. The mean price and standard deviation for ethanol are $1.20/gallon and $0.14/gallon and $0.90/gallon and $0.16/gallon for MTBE.

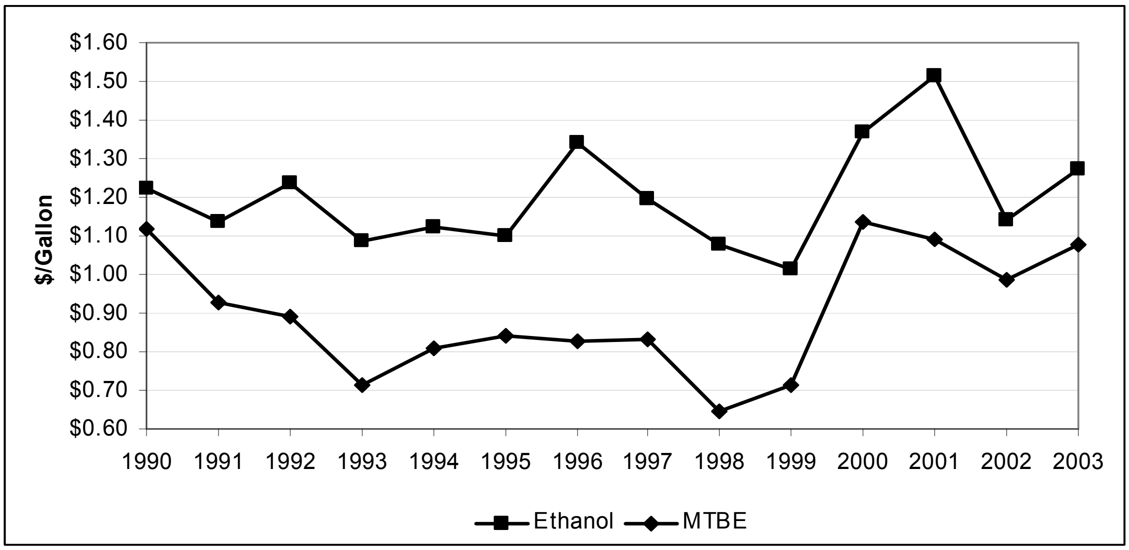

Figure 17. Historical annual average ethanol and methyl tertiary butyl ether prices from 1990 to 2003

Source: Hart's Oxy-Fuel News, 2004

Annual ethanol prices are forecasted from 2004 to 2019 using an error correction procedure following the Engle and Granger (1987) two-step method. The first step of the procedure consists of determining the order of integration for ethanol and MTBE prices. The second step consists of estimating the error correction model. This procedure requires that all variables have the same order of integration for the co-integrated regression to be significant, i.e. a linear combination of two or more non-stationary series may be stationary. If such a combination exists, the series are said to be co-integrated. The stationary linear combination is called the co-integrating equation and is interpreted as a long-run equilibrium relationship between variables. A Johansen (1991) co-integrating test is used to determine if a co-integrating relationship exists between ethanol and MTBE prices.

If no co-integrating relationship exists, Ordinary Least Squares (OLS) can be used to estimate each price equation. However, if the variables are co-integrated, than the model can be formulated using an error correction procedure. The co-integrating relationship provides additional information that may reduce forecast errors. Estimation of the vector error correction (VEC) model allows for inferences regarding the long-run and short-run relationship between variables. Specifically, the VEC has co-integrating relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their co-integrating relationships allowing for short-run adjustment dynamics.

Ethanol and MTBE prices are endogenous variables in the VEC model. Wholesale gasoline price (in dollars per gallon) is included as an exogenous variable in the VEC model. The inclusion of wholesale gasoline price was suggested by earlier work on ethanol pricing (Coltrain, 2001; CFDC, 2004; NDLC, 2001). Inclusion of the exogenous variables are important because forecasting ethanol and MTBE prices using only a perpetual autoregressive process will result in straight-line forecasts. However, the forecast for ethanol price is considered a conditional forecast based on the forecasted price for wholesale gasoline.

Wholesale gasoline price is available from the Energy Information Agency (EIA) of the U.S. Department of Energy (DOE). Other exogenous variables, ethanol subsidy rate, retail gasoline price, ethanol fuel demand, gasoline production, diesel price, diesel production, gasoline stock, diesel stock, oil production, oil imports, oxygenated gasoline production, reformulated gasoline production, oxygenate stock, corn prices, and corn production (NASS, 2004) were tested for significance. However, none were statistically significant and did not improve the forecasting abilities of the VEC model when evaluating in sample Mean Absolute Percent Error (MAPE) defined as:

$$(1)\ MAPE = \frac{1}{M}\sum_{t=1}^{M}\left|\frac{F_t - A_t}{A_t}\right| * 100$$

where M is the number of periods forecasted, F_t is the forecasted value in time *t*, and A_t is the actual value in time *t*. The calculated MAPE for the within sample forecasted for ethanol price and MTBE price from 1990 to 2003 is 5.84 percent and 6.52 percent, respectively.

Table 10 presents the Augmented Dickey Fuller test results with an intercept for the variables included in the model. The results of the Johansen co-integration test with intercept are presented in Table 11. Results show that all prices are non-stationary and integrated of order one. Since all prices are integrated of the same order, a test of co-integration is performed for the two endogenous variables, ethanol and MTBE price. Based on the Johansen test, ethanol and MTBE prices are co-integrated at the 0.05 significance level. Since the two series are co-integrated, the use of a VEC model is justified.

Table 10. Augmented Dickey-Fuller Test for Stationarity of Ethanol and Methyl Tertiary Butyl Ether Baseline Price

Variable	Levels*	First Difference**	Critical Value***
Ethanol Price	-3.08033	-3.921992	-3.11991
MTBE Price	-2.134377	-3.384734	
Wholesale Gas Price	-1.175852	-4.344914	

* Fail to reject "Ho: Data series is non-stationary" at 5 % significance level.
** Reject "Ho: Data is non-stationary at 5 % significance level.
*** Based on small sample (20) critical value

Table 11. Johansen Unrestricted Co-Integration Rank Test of Ethanol and Methyl Tertiary Butyl Ether Baseline Price

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None *	0.761757	20.03899	15.41	20.04
At most 1	0.209788	2.825448	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 1 cointegrating equation(s) at the 5% level
Trace test indicates no cointegration at the 1% level

A pair-wise Granger causality test shows MTBE price precedes ethanol price, i.e. MTBE price helps in the prediction of ethanol price. The VEC model is formulated with MTBE price preceding ethanol price and the differenced exogenous variables. The co-integration regression from the error correction procedure is:

$$(2)\quad MTBE\ Price_t = \underset{(-2.84788)}{1.5207}\ \ Ethanol\ Price_t - 0.94939$$

The coefficient on ethanol price is statistically significant with a t-statistic of -2.84788. If ethanol price or MTBE price deviate from the long-run equilibrium, the error correction term adjusts each variable to partially restore the equilibrium relation. The appropriate VEC model is formulated by incorporating the co-integration equation into a Vector Autoregressive (VAR) model.

The results of the VEC model are presented in Table 12. All variables not statistically significant are removed and the system re-estimated using Seemingly Unrelated Regression (SUR). SUR estimates the parameters of the system accounting for heteroskedasticity and continuous correlation in the errors across equations.

The results show all coefficients are significant. It should be noted that all variables (except the co-integrating equation) are in differenced terms. MTBE price is dependent only on wholesale gasoline price in time *t*. Wholesale gasoline price has a positive affect on MTBE price. Ethanol price is dependent on the co-integrating equation, MTBE price in time *t-1,* and wholesale gasoline price in *t*. For ethanol, MTBE price and wholesale gas prices have positive affects on current price.

The 'velocity of adjustment parameters' (coefficient for the co-integrating equations_{t-1}) is significant for ethanol price confirming the results of the Johansen Co-integrating test. However, the coefficient is difficult to interpret. For ethanol price a 1 percent increase in the difference between MTBE price and ethanol price in the previous time period would lead an increase in ethanol price by .9061 percent in the current period.

Table 12. Vector Error Correction Results for Ethanol and Methyl Tertiary Butyl Ether Prices*

MTBE Price	**Coefficient**	**Std. Error**	**T-Statistic**	**Probability**
Whole Sale Gas Price	1.1019	0.1643	6.7057	0.0000
R-squared	0.7705	Mean Dependent Var.		-0.0031
Adjusted R-squared	0.7705	S.D. Dependent Var.		0.1632
S.E. of Regression	0.0782	Sum Squared Resid.		0.0733
Durbin-Watson Stat.	2.0770			

Ethanol Price	**Coefficient**	**Std. Error**	**T-Statistic**	**Probability**
Co-Integrating $Eq._{t-1}$	0.9061	0.1625	5.5767	0.0000
MTBE $Price_{t-1}$	0.3153	0.1240	2.5430	0.0189
Whole Sale Gas Price	0.5457	0.1935	2.8193	0.0103
R-squared	0.8332	Mean Dependent Var.		0.0114
Adjusted R-squared	0.7962	S.D. Dependent Var.		0.1986
S.E. of Regression	0.0896	Sum Squared Resid.		0.0723
Durbin-Watson Stat.	2.2003			

* Estimated using Eviews Statistical Analysis Software, 2003

Figure 18 presents the historical prices and deterministic forecasts for ethanol, MTBE, and wholesale gasoline prices from 2005 to 2019. The prices to the left of the vertical dashed line are historical values and the prices to the right are forecasted values. The VEC model's annual forecasts are the deterministic component of the multivariate empirical distribution for simulating stochastic ethanol price from 2005 to 2019. Wholesale gas prices are forecasted using equation (3) to convert EIA's nominal forecast for retail gasoline price to wholesale gasoline price.

(3) $WGP = \underset{(-3.380)}{-.814} + \underset{(6.442)}{1.197}\, RGP + \varepsilon$

where *WGP* is the wholesale gas price and *RGP* is retail gas price. The intercept and coefficient are statistically significant and the R-square and MAPE are 0.776 and 7.4 percent.

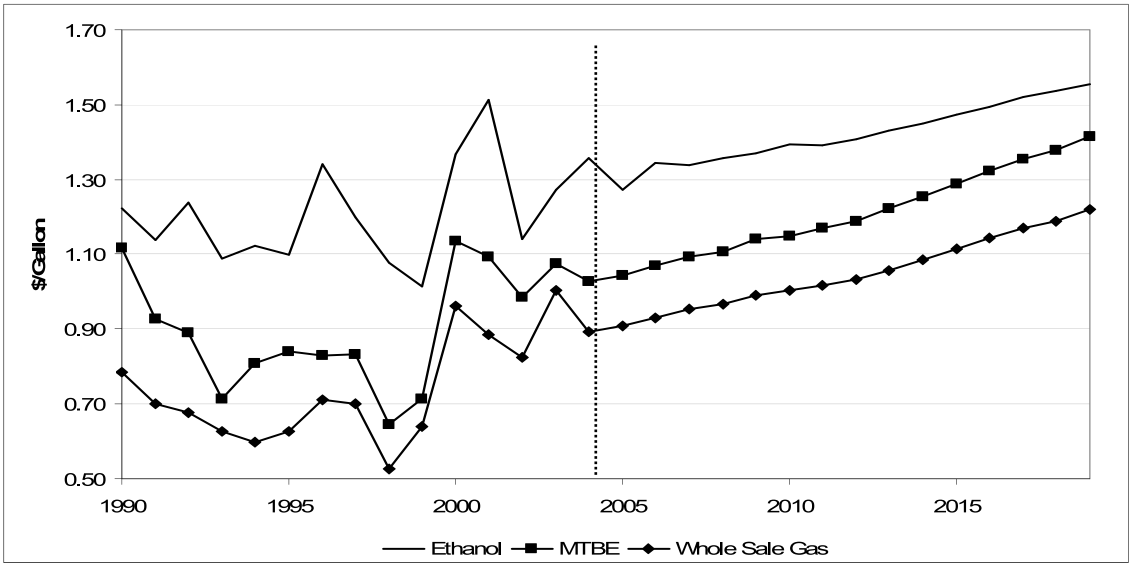

Figure 18. Historical and forecasted ethanol, methyl tertiary butyl ether, and wholesale gasoline prices from 1990 to 2019

Because of the inclusion of exogenous variables, the forecasted prices for ethanol and MTBE are conditional forecasts based on the forecasted values for wholesale gasoline price. Wholesale gasoline price is expected to remain steady over the 15 year forecasted period. The VEC model can be adapted for different forecast values of wholesale gasoline price.

Sorghum Silage

Although studies (Gallagher, et al., 2003.; Wiedenfeld, 1984; Committee on Biobased Industrial Products, 2000; Miller and Creelman, 1980; Creelman et al., 1981) show sorghum stover is a good potential candidate for energy production, historical prices and yield have not been recorded. Regional price differences, costs of production, and yield are different for the Panhandle, Central, and Coastal Bend Regions.

Table 13 presents the average historical grain sorghum gross income, calculated sorghum silage price, and calculated silage yields for each region. Historical feedstock costs are determined from annual farm budgets for grain sorghum from 1990 to 2003 from the Texas Crop Enterprise Budgets prepared by the Texas Extension Agriculture Economics. Gross income per acre is calculated as farming receipts for grain sorghum plus loan deficiency payments received. To entice farmers to grow sorghum silage for alcohol production instead of sorghum for grain, farmers are contracted on a per acre basis and offered a guaranteed price per ton of sorghum silage produced. The guaranteed price greatly reduces risk for farmers. In addition, a 20 percent premium is included in the guaranteed price to entice farmers to participate and guarantee the required acreage is contracted for energy production. Also, silage harvesting costs are not included in this price and are covered by MixAlco.

Table 13. Historical Gross Income, Estimated Silage Price, and Estimated Sorghum Silage Yields for the Panhandle, Central, and Coastal Bend Regions of Texas

Region	Commodity	Grain Sorghum Gross Income	Silage Price*	Yield
		($/Acre)	($/Ton)	Tons/Acre
Panhandle	Grain Sorghum	94.27	14.04	8.06
Central	Grain Sorghum	158.20	14.78	12.84
Coastal Bend	Grain Sorghum	203.24	17.69	13.78

Source: Texas Extension Agriculture Economics, 2004
NASS, United States Department of Agriculture, 2003
* Includes 20 percent premium

The price for sorghum silage in each region is calculated by dividing the mean gross income from 1990 to 2003 by the mean sorghum silage yield during the same time period and multiplied by the 20 percent premium. This average price for sorghum silage is used as the forecast value and inflated annually using an inflation rate derived from the forecasted grain sorghum price reported in FAPRI January 2004 Baseline Projections. The annual inflation rate ranges from 0.0016 in 2005 to 0.0579 in 2019.

The source of historical yields for grain sorghum for the period of 1990 to 2003 is the National Agriculture Statistics Service (NASS) of the United States Department of Agriculture (USDA). Sorghum for silage yields are not recorded for each region by the USDA. However, sorghum for silage yields and sorghum for grain yields are recorded for the state of Texas. Sorghum silage yields in each region are interpolated using equation (4) where historical sorghum silage yields are a function of historical grain sorghum yields and prices. The resulting regression is:

(4) $SilageYield = \underset{(-1.087)}{-7.576} + \underset{(2.224)}{0.197}\,GrainYield + \underset{(2.606)}{1.978}\,Price + \varepsilon$

where the t-statistic is in parenthesis. The calculated within sample Mean Absolute Percent Error and R-square is 9.04% and 0.420. It should be noted all three regions are dry-land farmed. Irrigated sorghum silage has been shown to produce 20 plus tons of silage per acre (National Grain Sorghum Producers, 2004). Silage yields are forecasted by substituting the forecasted grain yield and sorghum price using the sorghum price inflation rate and sorghum yield inflation rate from 2005 to 2013 reported in FAPRI January 2004 Baseline Projections into equation (4). Inflation rates from 2014 to 2019 are held constant at the 2013 rate.

To help farmers transition from grain production to silage production, MixAlco will pay the harvesting cost for silage. This offers further incentives to farmers as it reduces the farmers' variable costs by not having to harvest grain and pay for sorghum harvesting. Harvesting costs per ton of sorghum are determined from the Texas Agricultural Statistic Service (1999) based on silage harvest costs rate. The actual price of silage per ton for MixAlco is the silage price plus harvesting cost.

Table 14 presents the required contracted acres needed for cellulose feedstock production and the percent of sorghum acreage in each region for a 44 ton/hour and 176 ton/hour production facility. Initial required contracted acres are calculated using average historical silage yields in each region from 1990 to 2003 and a conservation percentage of 30 percent. Contracted acres are adjusted each year for the required feedstock amount as sorghum silage yields are forecasted to increase. Sorghum acre percentages are calculated by dividing contracted acres by total sorghum acres in each region for 2003. The Central Region requires the highest percentage of sorghum acres for MixAlco production. Because of the large acreage requirements, an additional supervisor is also included in labor costs. This person manages and monitors all contracts to ensure the necessary feedstock is available.

Table 14. Required Acres for Cellulose Feedstock Production and Percentage of Sorghum Acres by Region

		44 ton/hour		176 ton/hour	
Region	**Commodity**	**Acres**	**Percent***	**Acres**	**Percent***
Panhandle	Sorghum Silage	32,552	6.15	164,708	20.18
Central	Sorghum Silage	31,487	11.49	103,369	37.73
Coastal Bend	Sorghum Silage	29,339	4.99	96,305	16.38

* Percent of Grain Sorghum Acres in 2003

Feedstock Transportation Cost

Transportation cost for cellulose feedstock is dependent on plant capacity, density of the contracted acres, and local hauling rates. Plant capacity determines the amount of feedstock required. Density of the crop is determined by the amount of acres harvested in a square mile and the yield per acre. As density decreases, transportation cost increases as greater distances are traveled to secure supply. Gallagher et al. (2003) calculated the cost of residual biomass for energy production. The physical relationship between distance from the plant, *r*, and available supplies, *Q*, can be approximated by:

(5) $Q = (\pi r^2)dy$

where *d* is the density of planted crops per a square mile and *y* is the biomass yield per acre. Setting $\tilde{Q}$ as the maximum plant capacity, the maximum distance required by the plant can be obtained by rearranging and solving:

(6) $r^* = \sqrt{\tilde{Q}/(\pi dy)}$

The production from a circle of a given distance from a plant is given by the product of the circumference of the circle, the width of the ring, and the density of biomass production. The total cost function can be calculated by:

(7) $C(r) = \int_0^{r*} P(r)(2\pi r)(dy)dr$

where *P(r)* is a linear price gradient. The average biomass cost per ton is:

(8) $AC = P_0 + \frac{2tr^*}{3}$

where P_0 is the farm cost of biomass per ton. Transportation cost (TC) can then be calculated as average cost per ton of cellulose feedstock using the equation:

$$(9)\quad TC = \frac{2tr^*}{3}$$

where t is the transport cost in dollars/ton/mile and r^* is the maximum distance needed to supply the production facility. A full ring area is used in the Panhandle and Central Regions and a half ring is used for the Coastal Bend Region because of the coastline. Because of a half ring, r^* is larger for the Coastal Bend Region. A transportation cost of $2.21/ton/mile is assumed (Texas Agriculture Statistic Service, 1999) and is inflated annually using the fuel cost inflation rate reported by WEFA from 2005 to 2013. The 2013 rate is held constant from 2014 to 2019.

The hauling cost of feedstock is based on seasonal contracting of haulers and trucks. Because harvesting of silage and building of the fuel pile only occurs once a year, trucks would only be utilized for one month to three months depending on plant size if they are owned by the MixAlco production facility.

Other Stochastic Variables

Table 15 presents the summary statistics for annual steam price, hydrogen price, electricity price, natural gas price, and lime price. Historical data for 1990 to 2003 were collected or calculated for each stochastic variable. The summary statistics show lime has the highest relative variability among the stochastic variables. Lime prices are reported by the Economic Research Service (ERS) of the USDA. A Dickey Fuller test shows lime price is non-stationary. Prices are forecasted using equation (10).

(10) $Limeprice = \underset{(-3.646)}{-313.78} + \underset{(3.854)}{0.166} Year + \varepsilon$

The trend variable, *Year*, is statistically significant indicating price follows an upward trend. R-square is 0.553 and the within sample MAPE from 1990 to 2003 is 2.44 percent.

Table 15. Summary Statistics for the Historical Values of the Stochastic Variables

	Steam	Electricity	Natural Gas	Bituminous Coal	Lime
Unit	$/Ton	$/kWh	$/Mcf	$/Ton	$/Ton
Mean	5.78	0.043	4.89	25.79	15.67
St. Dev.	0.67	0.005	1.08	3.01	6.12
95 % LCI	5.43	0.041	4.32	24.22	12.47
95 % UCI	6.13	0.046	5.45	27.37	18.88
CV	11.68	10.747	22.04	11.68	39.06
Min	5.06	0.039	4.01	22.59	1.20
Median	5.53	0.042	4.43	24.67	17.65
Max	7.11	0.053	7.66	31.71	19.40
Autocorr.	0.98	0.587	0.68	0.98	0.43

Steam Price

Steam prices are derived from bituminous coal price, the largest energy production fuel used in Texas for steam and electricity generation. Steam production costs are calculated using equation (11) from the Office of Industrial Technology (OIT) of the DOE. The formula is:

$$(11)\ SteamCost/Ton = \frac{Cost/Ton\ Coal}{27{,}000{,}000 Btu/Ton\ Coal} * 2000lb * 1{,}178 Btu/lb * \frac{100}{87.6}$$

where 1,178 Btu is the energy requirement to convert 50°F feed-water into 150 psig steam and 87.6 is the combustion efficiency of coal. Bituminous coal prices are reported by EIA of the DOE. The steam price for purchase is normally double the cost of production after condensation loss and transportation. Nominal coal price forecasts from 2005 to 2019 are available from EIA's *Annual Energy Outlook 2004* and are expected to increase slightly. The stochastic bituminous coal prices are incorporated into equation (11) to simulate stochastic steam prices.

Hydrogen Price

Hydrogen prices are not reported as very little is directly consumed as fuel. However, refiner demand has increased by 10 to 15 percent annually over the past 10 years (Energy Efficiency and Renewable Energy, 2004). Future growth for total hydrogen marketing and capturing is expected to increase 4 percent per year till 2006 (Innovation Group, 2004). Retail hydrogen demand is expected to continue to grow due to advancements in hydrogen fuel cell technology for automobiles and increasing regulations on automotive clean air regulations.

Hydrogen can be produced in many ways but steam reforming and coal gasification are the two most widely used procedures. Hydrogen from natural gas, the most widely used method accounting for 95 percent of all hydrogen production, is made by a reaction of natural gas (methane) or other light hydrocarbons (ethane or propane) with steam in the presence of a catalyst (Ramage, 2004). Coal gasification creates hydrogen through amine scrubbing, pressure swing absorption, or temperature swing absorption (Collot, 2003). Because of inefficiencies in the current methods, there have been considerable investments in new technology using gas separation and gas absorption membranes to capture hydrogen from coal gasification (EIA, 2004). Currently, over 145 facilities have the ability to capture hydrogen for distribution

(Innovation Group, 2004). The U.S. hydrogen industry produces 9 million tons of hydrogen per year (National Hydrogen Association, 2004).

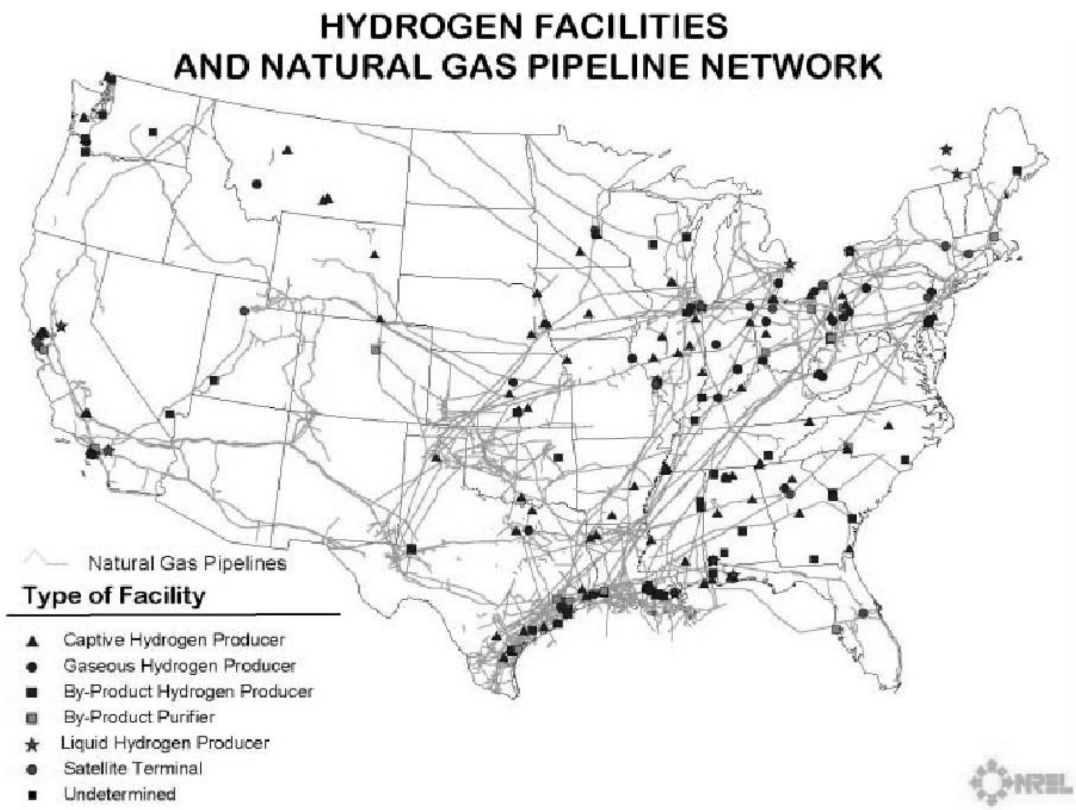

Figure 19. Hydrogen production facilities and natural gas pipelines in the U.S.

Source: National Renewable Energy Laboratory, 2002

Figure 19 shows hydrogen production facilities and gas pipelines in Texas. There are currently several hydrogen pipelines in Texas and over 1,600 miles of natural gas pipeline along the Gulf Coast of Texas, most notably Houston, Bay City, and Texas City (Ohi, 2002; Air Liquide, 2004)). All hydrogen pipelines are owned by three manufacturers, Air Liquide, Air Products, and Praxair.

The most efficient method of shipment and acquisition of hydrogen for distribution are pipelines. The high volatility and low boiling points of hydrogen also make pipelines the preferred transportation method for production. Some natural gas pipelines can be used to transport hydrogen. However, the addition of commercial or industrial pipelines for individual manufacturing facilities is costly. According to Lance Shiffert at Air Products, dedicated hydrogen pipelines cost approximately $1 million/per mile for installation. The cost of hydrogen delivered using a pipeline is approximately 30 percent lower than by truck, but unless a production facility is located adjacent to a major pipeline, a dedicated hydrogen pipeline is infeasible.

Gas storage cylinders are an alternative to pipelines. The largest available tank holds 20,000 gallons or 22,700 hundred cubic feet (hcf). Both Air Supply and Air Liquide will install the required number of tanks at no cost if a five year contract is signed. The maintenance cost charged by Air Products is $4,000/month for each tank. MixAlco uses approximately 95,000 gallons of hydrogen a day for a 44 ton/hour facility and 380,000 gallons hydrogen for a 176 ton/hour facility. The 44 ton/hour production facility would require five 20,000 gallon tanks and the 176 ton/hour facility requires nineteen 20,000 gallon tanks to be refilled each day for continuous production. The annual maintenance cost for hydrogen storage tanks is $240,000 for the 44 ton/hour facility and $912,000 for the 176 ton/hour facility if tanks are used.

The two remaining feasible alternatives are to ship acids to a central hydration facility located in the Gulf Coast of Texas or use an onsite hydrogen production facility. If acids are shipped, hydrogen costs are lower as the hydration facility can be located close to a hydrogen pipeline to minimize shipping. However, according to Scott Wellington of Shell Oil Company, hydrogen prices can vary dependent upon spare capacity in the pipeline, how much is used, how long it is used for, and the price of natural gas. Most hydrogen pricing is based on contracts and companies like Shell Oil could receive a lower price than individual firms. If a central hydration facility is used, the cost of shipping acids must be included.

To compare MixAlco with corn-based ethanol production facilities, hydration must be done on-site so a finished ethanol fuel is produced. A steam methane reformer (SMR) can be installed to generate hydrogen. Kent Harer of Air Liquide recommended this solution for the amount of hydrogen required. Air Liquide will install, operate, and maintain a hydrogen generation facility with no additional cost to the buyer. A 15 to 20 year contract is required by each company for an on-site generation facility. However, with the on-site generation facility and long-term contract, MixAlco will have to pay for all hydrogen produced whether it is used or not. The onsite generation facility eliminates transportation costs for hydrogen. Hydrogen price is dependent upon the size of the SMR and the price of natural gas. The finished ethanol fuel will have to be shipped to the Gulf Coast for blending with gasoline.

Because hydrogen price are dependent upon many factors, historical prices are not recorded. Since most hydrogen is produced from natural gas, it is assumed hydrogen price closely follows the variation in natural gas price. Air Products quoted mean delivered prices of liquid hydrogen based on \$4/thousand cubic feet (Mcf) cost of natural gas as approximately \$0.85/hundred cubic feet (hcf) or \$0.96/gallon of hydrogen delivered by truck or approximately \$0.60/hcf delivered via pipeline. Air Liquide quoted a price of \$0.80/hcf delivered via pipeline at \$6.0/Mcf of natural gas. These are estimated prices from each company can change based on a number of factors. There is no distinguishable price for hydrogen difference for hydrogen between the Panhandle, Central, and Coastal Bend Regions (Air Products, 2004).

Natural gas is currently above \$6/Mcf and is expected to increase over the next twenty years (Annual Energy Outlook, 2004). When natural gas is above \$4/Mcf, Air Products uses formula pricing to derive hydrogen prices. The formula is:

$$(12)\quad HydrogenPrice = 0.3 * BasePrice * \frac{CurrentNGPrice}{BaseNGPrice} + 0.7$$

where the *BasePrice* is the delivered hydrogen price delivered by truck at \$4/Mcf natural gas, *CurrentNGPrice* is the current natural gas price above \$4/Mcf, and *BaseNGPrice* is the \$4/McF of natural gas. This price is consistent with the industry rule of hydrogen cost from natural gas being three times the feedstock cost based on the same unit measure energy (Braun, 2003). A mean hydrogen price of \$0.85/hcf is used as the *BasePrice* and \$4/McF is used for *BaseNGPrice*. These prices are then multiplied by 70 percent to calculate hydrogen price delivered via pipeline. Stochastic natural gas prices from 2005 to 2019 are used as the *CurrentNGPrice* in the equation (12) to simulate stochastic hydrogen prices.

<u>Electricity Price</u>

In 2002, deregulation of electricity in Texas allowed businesses to “shop” and switch electric providers. Electric cooperatives, such as the Electric Reliability Council of Texas (ERCOT) still exist to distribute and sell wholesale electricity to retail electric providers. The results of the deregulation have been modest with little switching occurring. The most visible switch was Texas Instruments moving from TXU Energy to Reliant Energy, with a two-year contract worth approximately $50 million annually (Richarme, 2004).

Businesses can negotiate freely with electricity providers to obtain the lowest price. Price is dependent on business size, location, and demand level. Many providers will design electricity pricing based on the unique usage. Because of this, all commercial and industrial electricity prices are custom bid by providers and contracts are negotiated individually. Pricing structures will vary from company to company. Companies such as TXU Energy offer various pricing levels like budget certainty products (constant price), downward market movement products (low market price), and index based products (floating market price).

Because there is little price variation between electric suppliers and specific contract prices are not available, Texas industrial electric prices are used in all three regions. Industrial electricity prices from 1990 to 2003 are calculated by dividing total volume of industrial electricity sales in Texas by total industrial revenue in Texas. Texas industrial electricity revenue and sale volume data is available from Energy Information Administration (EIA) of United States Department of Energy (DOE).

Electricity consumption is projected to increase in all sectors with 1.6 percent growth expected for the industrial sector. The projected growth in commercial and industrial electricity demand from 2002 to 2025 will require significant additions of generating capacity. The increased demand and forecasted increase in natural gas price is expected to raise electricity prices in the long run (EIA, 2004). Forecasted nominal industrial electric prices for the U.S. are available in EIA's *Annual Energy Outlook 2004*. It is assumed Texas industrial prices are equal to U.S. industrial prices. The forecasted nominal price in 2005 is $0.046/kWh and $0.048/kWh in 2019.

Natural Gas Price

Natural gas price has reached record highs over the past year due to high demand, low gas storage, and slow growth in well development and supply. Texas and the Gulf of Mexico are the two largest supply regions accounting for 50 percent of the nation's total gas production (EIA, 2004). Over half of all new well completions in 2003 were located in Texas. Utilization of production is above 90 percent with continued growth in demand. The natural gas supply is expected to continue decreasing due to slow growth in the delivery infrastructure.

Natural gas price is currently above $6/Mcf and is highly volatile, ranging from highs of $8/Mcf in 2001 and 2003 to a low of $2/Mcf in 2002. Price is expected to remain high and increase over the next twenty years (Annual Energy Outlook, 2004). The increase in demand comes from new electricity generation capacity fueled by natural gas, because natural-gas-fired generators are projected to have advantages over coal-fired generators (Annual Energy Outlook, 2004).

Texas commercial natural gas prices are reported by EIA of DOE. Historical industrial prices are not available before 1997. Natural gas prices are expected to be similar in each region of Texas because of the extensive production throughout the state and the large pipeline system making transportation accessible. The industrial and electricity generation sectors have the lowest end-use prices as they receive natural gas directly from interstate pipelines

Since Texas is one of the largest natural gas producers, prices are relatively equal to national prices. EIA's long-term forecast for nominal natural gas prices are used as the deterministic forecast. The forecasted price of natural gas in 2005 is $4.28/Mcf and increases annually to $4.91/Mcf in 2019. However, technology advances in extraction of natural gas could moderate prices in the long-run (EIA, 2004).

Incentive Packages

Incentives are a common practice used by cities, counties, regions, and states to attract businesses to invest in the local economy. It is believed that attracting businesses will raise employment and income to the community and have an overall positive economic impact. Both industry and community must recognize economic and social goals as well as private profit targets when evaluating incentives as they may directly influence the location decision of a firm. Most incentive packages are negotiated and offered on a case by case basis. It should be noted this study does not consider environmental incentive programs that may be available.

The most common city, county, and regional incentives are tax abatements, interest-free loans, and zoning refunds or exemptions. The state of Texas offers various incentives through the Texas Economic Development (TDED). However, MixAlco would not qualify for Foreign Trade Zone or Freeport tax exemptions in Texas because all of the ethanol produced will likely be consumed in Texas and none will be exported.

The following section summarizes the general economic incentives offered by county and city economic development councils in each region.

State of Texas

The state of Texas offers many incentives for new businesses including specific zoning abatements, job and skills training, and loans/grants. The programs are distributed by the TDED (http://www.tded.state.tx.us). Businesses are eligible to apply for all incentives and each is reviewed on a case by case basis for the applicable incentive. These incentives are cooperative or on top of local community incentives.

MixAlco does meet Enterprise Zone requirements and Amarillo, Hillsboro, and Bay City are all designated as Enterprise Zones. An Enterprise Zone is an economic development tool which allows a community to partner with the state to offer local and state tax and regulatory benefits. The incentives offered are specific to each location. To qualify as an enterprise project, MixAlco must hire at least 25 percent of its new jobs with individuals within the enterprise zone. Incentives could include refund of state sales and use taxes paid on machinery and equipment of up to $2,500 per a permanent job created and reductions in franchise tax annual report filings of up to 50 percent. The 44 ton/hour MixAlco facility would receive a refund of $75,000 and the 176 ton/hour would receive $190,000. Also, the taxable capital reported for the franchise tax can be reduced by 50 percent. The TDED also offers three additional franchise tax credits for economic development but MixAlco is not eligible for any of the credits.

The TDED offers a large number and wide variety of loans and grants to new or expanding businesses. Many are not applicable to MixAlco, such as the Self-Sufficiency

Fund, Capital Access Fund, Capital Infrastructure Development Program, and the Texas Link Deposit Program. MixAlco also does not qualify for U.S. 7(a) small business loans which offer guaranteed loans through commercial lenders (banks) because only half of the initial required investment is borrowed and the other half is contributed by investors. In the 7(a) program the government guarantees loans for businesses who do not meet the commercial lenders requirements.

Panhandle Region

Amarillo and Potter County offer aggressive incentives programs to attract new businesses and encourage expansion of existing ones. The incentive program is funded by a half-cent sales tax for economic development. The economic development council offers many incentives including cash grants, interest free loans, and tax abatement.

After discussing the possibility of locating a MixAlco production facility in Potter County and Amarillo, Texas with the Amarillo Economic Development Corporation, MixAlco is eligible for a number of incentives. To receive these incentives, the business must meet the following requirements; its product sells outside the Panhandle Region, does not compete with existing businesses, and must show a successful history of profitability. MixAlco does not meet the third requirement as no facility is in production. However, it is assumed MixAlco is qualified to receive incentives for analysis purpose.

Cash grants of $10,000 are offered for every job created over $35,000 in annual salary. The 44 ton/hour MixAlco facility would receive $300,000 in cash grants and a

176 ton/hour will receive $760,000 in cash grants. The maximum tax abatement is 100 percent for 10 years and is negotiated for each individual tax entity.

Central Region

Hillsboro and Hill County offer incentives for businesses which enhance and expand the local economy. To receive tax abatements in Hillsboro and Hill County, three criteria must be met. First, the proposed business must employ a minimum of 10 permanent full time jobs with an annual payroll of $150,000. Second, the company must make minimum improvements of at least $500,000 to the property. Last, the project must meet all relevant zoning requirements and ordinances. A MixAlco production facility meets these requirements and would be eligible for tax abatement.

Based on the initial capital requirements, both MixAlco facility sizes are eligible for a 10 year tax abatement schedule. The tax abatement amount is 90 percent in year one and decreases 10 percent annually to no abatement in year 10 for a 44 ton/hour facility based on its initial investment level. The 176 ton/hour MixAlco facility is also eligible for a larger 10 year tax abatement schedule. In year's one through three, the abatement amount is 100 percent. Starting in year four, the abatement level is 80 percent and decreases 10 percent annually to 20 percent in year 10.

Coastal Bend Region

Matagorda County, Bay City, and the City of Palacios offer tax abatements for new and expanding businesses. Projects with a initial investment of over $1 million with a minimum of 10 jobs created is eligible for a 7 year tax abatement schedule. The tax abatement schedule is as follows, in years one through three, the tax abatement amount is 100 percent, in years four and five, the abatement amount is 75 percent, and in years six and seven, the abatement amount is 50 percent. Properties not subject for abatement are land, inventories, moveable property, and domiciled vehicles.

Financial Statements

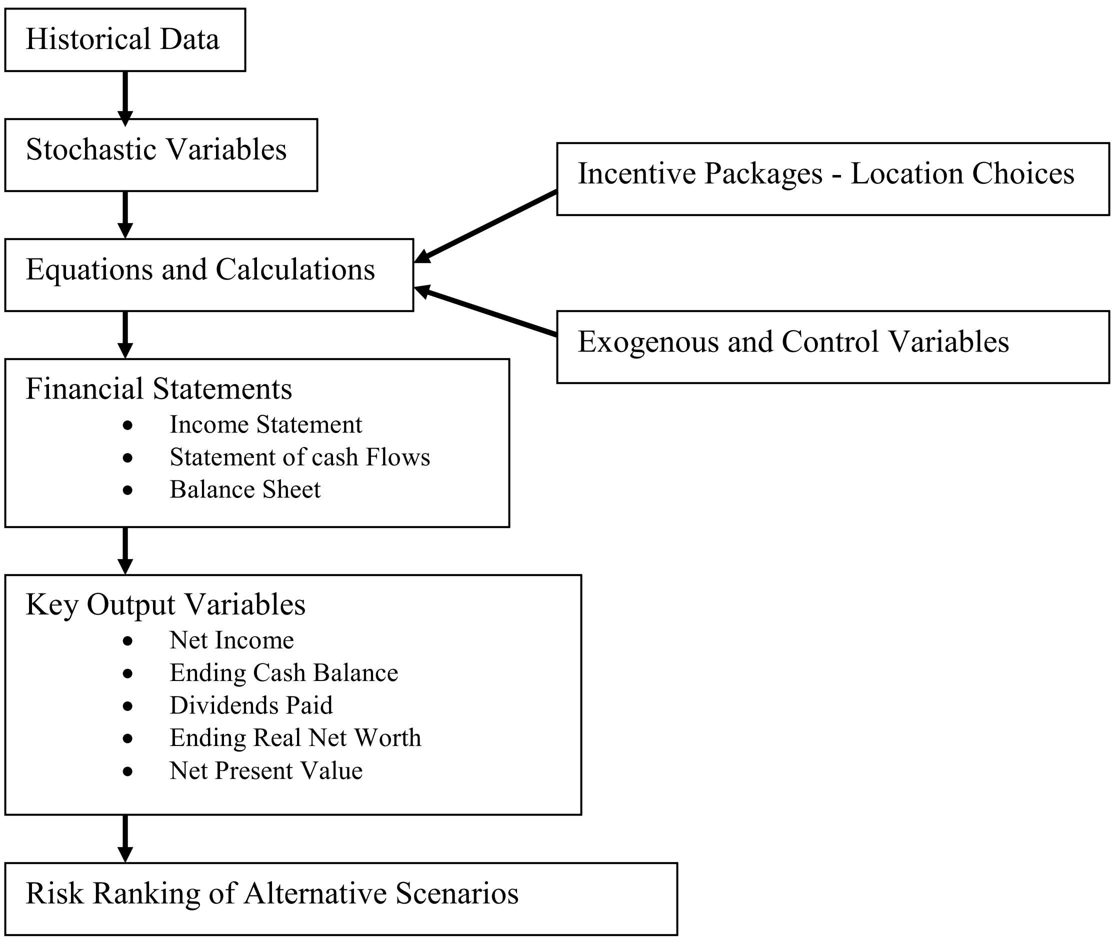

Figure 20. Diagram of simulation model

Figure 20 presents an outline diagram of how the financial statements and other variables are incorporated in the simulation model. The figure shows the relationship between the variable costs, control variables, production process, and key output variables.

Common financial statements for the two plant sizes and each of the three locations are developed. Incorporated into the financial statements are the stochastic variables and the different assumptions related to costs and incentives for each alternative scenario. Specific KOVs are calculated and compared for each alternative scenario from the financial statements.

Income Statement

Total receipts for each alternative scenario are calculated by summing alcohol fuel receipts (total gallons produced times ethanol selling price), earned interest receipts, and residual biomatter receipts. Ethanol receipts are calculated by multiplying annual stochastic ethanol price by the volume of ethanol produced for each year of the study. Residual biomatter receipts are calculated by multiplying the amount of residual biomatter (20 percent of stochastic feedstock pile) by half of the stochastic bituminous coal price for the corresponding year from 2005 to 2019. The price for residual biomatter is freight on board (FOB) price. Residual is sold at 50 percent of the full bituminous coal price because of uncertainty in demand for the residual. Earned interest is calculated by multiplying positive ending cash balances from the previous year by the interest rate for cash balances reported by WEFA from 2005 to 2013. The 2013 rate is held constant from 2014 to 2019.

Total expenses used in the income statements to derive net income before taxes are calculated by summing variable costs and interest costs. Feedstock cost is determined by multiplying the contracted acre amount by the stochastic sorghum silage price per acre. Stochastic variable costs for electricity, steam, and natural gas are calculated by multiplying the stochastic prices by the required utility amounts. Variable operating cost per each plant size is different, where the amounts required are scaled accordingly.

Interest costs for the MixAlco facility are calculated for the capital loan, cash flow deficits, and the operating loan. The initial investment, capital loan interest costs are calculated using a fixed payment amortization. Interest on cash flow deficits are paid only when cash flow is negative for the previous year. This interest payment amount is calculated by multiplying the cash flow deficit by the interest rate for operating loans projected by WEFA. An operating loan is available to the facility to cover all variable costs expense. The operating loan is calculated by multiplying the summation of all variable costs by the operating loan interest rate reported by WEFA.

The net cash income before taxes equals total receipts minus total expenses. Taxable income is defined as net cash income before taxes minus depreciation expenses.

Depreciation

Book value depreciation for tax purposes follows the current corporate tax guide defined by the Internal Revenue Service (IRS) in *Publication 946*. The General Depreciation System (GDS) under the Modified Accelerated Cost Recovery System (MACRS) is used to depreciate most property. A 200 percent declining balance method is used for all property is built after 1988. This method provides greater deductions during the earlier recovery years and changes to the straight-line method when it provides an equal or greater deduction. Depreciation percentages are available from the *MACRS Percentage Table Guide* in *Publication 946* from IRS.

Depreciation of all assets starts in 2005 when the facility is ready and available for use. The basis for depreciation is the total costs of plant, equipment, and buildings including the amount paid in cash and debt obligations. Annual capital improvements and replacement for equipment are treated as separate depreciable properties. All machinery and equipment are classified as 7- year class property. Buildings are classified as 39-year class property and are depreciated using straight line depreciation.

Statement of Cash Flow

The beginning cash balance equals the ending cash balance from the previous year. The beginning cash number in 2005 is 5 percent of the initial investment for equipment and buildings. This is consistent with ethanol industry standards and varies by plant size and initial investment amounts. For 2006 to 2019, the beginning cash balance is equal to the ending cash balance from the previous year. Total cash inflows are calculated by adding net cash income to the beginning cash balance for that year.

Total cash outflows are calculated by summing capital loan principal payments, repayment of cash flow deficits, capital replacement costs, income taxes paid, and dividends paid. Profits are taxed at corporate level consistent with 2003 federal income tax codes. Dividends paid to owners are calculated at 30 percent of positive net income after market depreciation and corporate taxes. Total cash inflows minus total cash outflows equals ending cash balance before borrowing. If ending cash balance is negative, the firm must borrow cash to bring the ending cash balance to zero. The borrowed cash plus additional interest is paid back the following year. Interest is calculated by multiplying the cash amount borrowed by the non-real estate interest rate reported by WEFA for 2005 to 2013. The 2013 rate is held constant from 2014 to 2019.

Balance Sheet

The balance sheet consists of three parts, assets, liabilities, and equity. Total assets are calculated by summing positive ending cash balance, land value, and plant and equipment market values. The annual plant and equipment values are calculated by subtracting the market value depreciation expense for equipment and buildings. Equipment is depreciated 10 percent the first year and 6.5 percent annually the following years. Buildings are depreciated 20 percent the first year and 2 percent annually afterwards. The depreciation for actual market values differ for equipment and buildings because of the fixity of the investment. The depreciation schedules are assumed based on the same rate used in the Farm Level Income and Policy Simulator (FLIPSIM) for similar assets. Annual improvements are depreciated following the same market value depreciation schedule as equipment. Land values are appreciated using U.S. land inflation rates from FAPRI for 2005 to 2013. The 2013 rate is held constant from 2014 to 2019.

Total liabilities are calculated by summing long-term liabilities and short-term liabilities. Short-term liabilities are loans for yearly cash flow deficits. Long-term liabilities consist of the annual ending balance of the initial capital loan. The initial capital requirement varies for each location because of land costs and the two alternative scenarios for equipment and building costs. Equity is calculated by subtracting total liabilities from total assets. Ending equity is presented in both real (discount rate of 8 percent) and nominal terms.

Key Output Variables

The analysis and comparison of the two different plant sizes and three alternative location choices are based on five key output variables for the MixAlco facility. The five variables are common financial indicators when evaluating capital investments. The five variables are as follows:

1. Annual Net Income - Net income is defined as revenues minus operating expenses minus depreciation expense.
2. Annual Ending Cash Before Borrowing - Ending cash before borrowing is the ending cash balance before borrowing carryover debt to make the ending cash balance zero, if necessary.
3. Annual Dividends Paid - Dividends are paid at a rate of 30 percent of positive net income after tax.
4. Ending Real Net Worth - Real net worth is nominal net worth in 2019 discounted to 2004 using the assumed discount rate.
5. Net Present Value - Net present value is calculated over the 15 years of this study. The discount rate used for calculating net present value is 8 percent.

Net present value for this study is defined as:

$$(13)\ \ \text{NPV} = -\ \text{Initial Equity} + \sum_{t=2}^{16}\left(\frac{\text{Dividends}}{(1+i)^{t}}\right) + \left(\frac{\text{Ending Net Worth}}{(1+i)^{16}}\right)$$

The discount rate, *i*, represents the rate at which returns to business are discounted to present value dollars. The discounting of future returns and ending net worth allows for the comparison of initial capital investment to returns that occur in different time periods based on the purchasing power of dollars in 2004. The stated NPV represents the value of the MixAlco production facility to the investors in current dollar terms.

Included in the discount rate of 8 percent are the combined assumptions of future inflation and the investors' required real rate of return. A NPV of zero indicates the investment exactly meets the required 8 percent rate of return. A positive NPV indicates returns over and above 8 percent. This is a risk free discount rate so the distribution for NPVs can be directly compared using a risk free rate avoids the double counting of risk (Hardaker, 2004).

It should be noted NPV is only one of many available rules for decision making in risky investments. Other decisions rules, such as internal rate of return (IRR), are widely used for comparing alternative investments. Also, NPV is a strict rule for investing or not investing if the NPV is positive or negative. In real world terms, future choices are available after an investment or no investment decision is made. This is called "value of flexibility" and is important for risky investments where some uncertainty can be resolved before a decision is made (Hardaker, 2004).

Monte Carlo stochastic simulation returns a distribution for each of the five KOVs for the two different plant sizes at each location. This will give the decision maker a complete probability representation of the KOVs for direct comparison.

SERF analysis is applied to the NPV distribution allowing comparison between the 44 ton/hour and 176 ton/hour facilities at each alternative location and returns an ordinal ranking based on a range of risk preferences. This is a useful tool as the decision makers' risk preference does not have to be specifically defined with a utility function. SERF returns a visual representation of each location choice for many groups of decision makers across a spectrum of risk aversion levels. The decision maker can than choose which location and plant size is most feasible in relation to their risk preference.

Community Impacts

The economic impacts of locating a MixAlco production facility in the Panhandle, Central, and Coastal Bend Region are analyzed using two different methods. First, Regional Industry Multiplier System (RIMS) is used to calculate the additional capital spending and household income to the community. Second, the discounted wages, hauling costs, property tax, and additional farmer income is summed from 2005 to 2019 and simulated for each region. These amounts are direct impacts from the MixAlco production facility. The two methods offer a comparison and estimate of the direct and indirect impacts of locating a MixAlco production facility in the region. Only positive economic impacts were considered in this analysis. Negative impacts, such as possible hazards from ethanol production, were not considered.

The economic impact from RIMS can be divided between construction and operation of a MixAlco production facility. RIMS were originally developed in the 1970s by the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce, based on the Department of Commerce's input-output table of the national economy. The economy is broken into 500 separate U.S. industries and measures the economic impact of an industry by accounting for three elements of potential economic impacts, direct impacts (payroll, goods sold), indirect impacts (spending off facility), and induced impacts (value of goods and services purchased by money generated) (BEA, 2004).

Location of a MixAlco facility in a particular region has direct impacts on the local community in local jobs and agriculture production for energy. Feasibility studies for ethanol facilities show a highly positive economic impact on the community (Otto and Gallagher (2001), Urbanchuck and Kapell (2002), Hudson (2002), and Urbanchuk (2004)). The primary impacts are additional labor wages and increased feed grain income (i.e. higher sorghum price). The secondary impacts include transportation, handling, energy purchases, and other inputs and services needed for operation (Otto and Gallagher, 2001).

MixAlco production is less labor intensive than ethanol production. Labor requirements for the production facility are defined by Holtzapple (2004). Wages attributed to MixAlco are deterministic per ton of feedstock for the facility and are inflated annually using the labor inflation rate from WEFA. Total additional wages to the community are calculated by summing management salaries and labor wages for each year. The additional annual wages are discounted using an 8 percent discount rate and summed over the 15 year planning horizon. The total represents the present value of additional wages to the community.

MixAlco will provide additional revenue to the local economy through hauling of feedstocks and pile building costs. However, not all hauling or pile building revenues will go directly to the local economy as some haulers may be from other regions. This measure is an approximation of revenue for hauling and piling building to the local economy. Pile building costs and feedstock and nutrient hauling costs are summed and discounted using an 8 percent discounted rate over the 15 year planning horizon. Also, the economic impacts of the addition of a hydrogen production facility are not available as the information is private for both Air Liquide and Air Products.

Additional local tax revenues are calculated for each region when tax abatements are not present. The property tax rates for the Panhandle, Central, and Coastal Bend Regions are $2.15491, $3.040776, and $2.54858 per $100 of property valuation. This amount changes annually with land inflation and depreciation of equipment and buildings. The annual tax revenues are discounted using an 8 percent discount rate and summed over the 15 year planning horizon. The total represents the presented value of taxes to the community.

Farmers are contracted on a per acre basis to grow sorghum silage instead of sorghum for grain. Farmers are offered a guaranteed price per ton of silage calculated from historical gross income, silage yield, and an additional risk premium of 20 percent.

Contracting acres and offering a set price per ton of silage rather than selling grain sorghum on the free market reduces the variability of income to farmers because price is not subject to risk. Because of using contracts, moral hazard and adverse selection must be considered. Farmers must be screened before a contract is offered and monitoring of production procedures must occur.

The economic benefit to farmers can be measured by the additional income received per acre at the contracted price over the average historical gross income per acre from 1990 to 2003 for growing sorghum for grain in each respective region. The difference between gross income at the set contracted price and the mean historical gross income is the amount of additional revenue. This amount is discounted using an 8 percent discount rate and summed over the 15 planning horizon.

The RIMS method and simulated discounted values will give a direct and indirect measure of the economic impacts to a local economy from a MixAlco production facility. This will provide a broad measure of the potential economic impacts to interested parties for evaluation.

CHAPTER V

RESULTS AND DISCUSSION

This chapter presents the results of the simulation model and is divided in four sections. The first section describes the simulation results of the stochastic variables. The second section describes the simulation results for each of the two plant sizes (44 ton/hour and 176 ton/hour), the initial investment amount (Base, Plus 30), with and without incentives, and three alternative regions (Panhandle, Central, and Coastal Bend). The third section describes the community and farmer impacts from locating a MixAlco facility in the respective region. The fourth section describes the sensitivity analysis for key variables in the model for a 44 ton/hour and 176 ton/hour production facility. The model was simulated 500 iterations for completeness.

Stochastic Variables Results

The simulated stochastic variables are compared to the historical values to validate the simulation procedure. Statistical F-test show almost all stochastic variables are equal in variance to the respective historical values at the 0.05 significance level. This validates that the stochastic variables simulate the historical variability for the analysis.

Figure 21 presents the simulated means from 2005 to 2019 for sorghum silage yield in each region, natural gas price, electricity price, ethanol price, coal price, lime price, hydrogen price, and steam price. The simulated prices increases annually due to inflation and yield increases because of new technology.

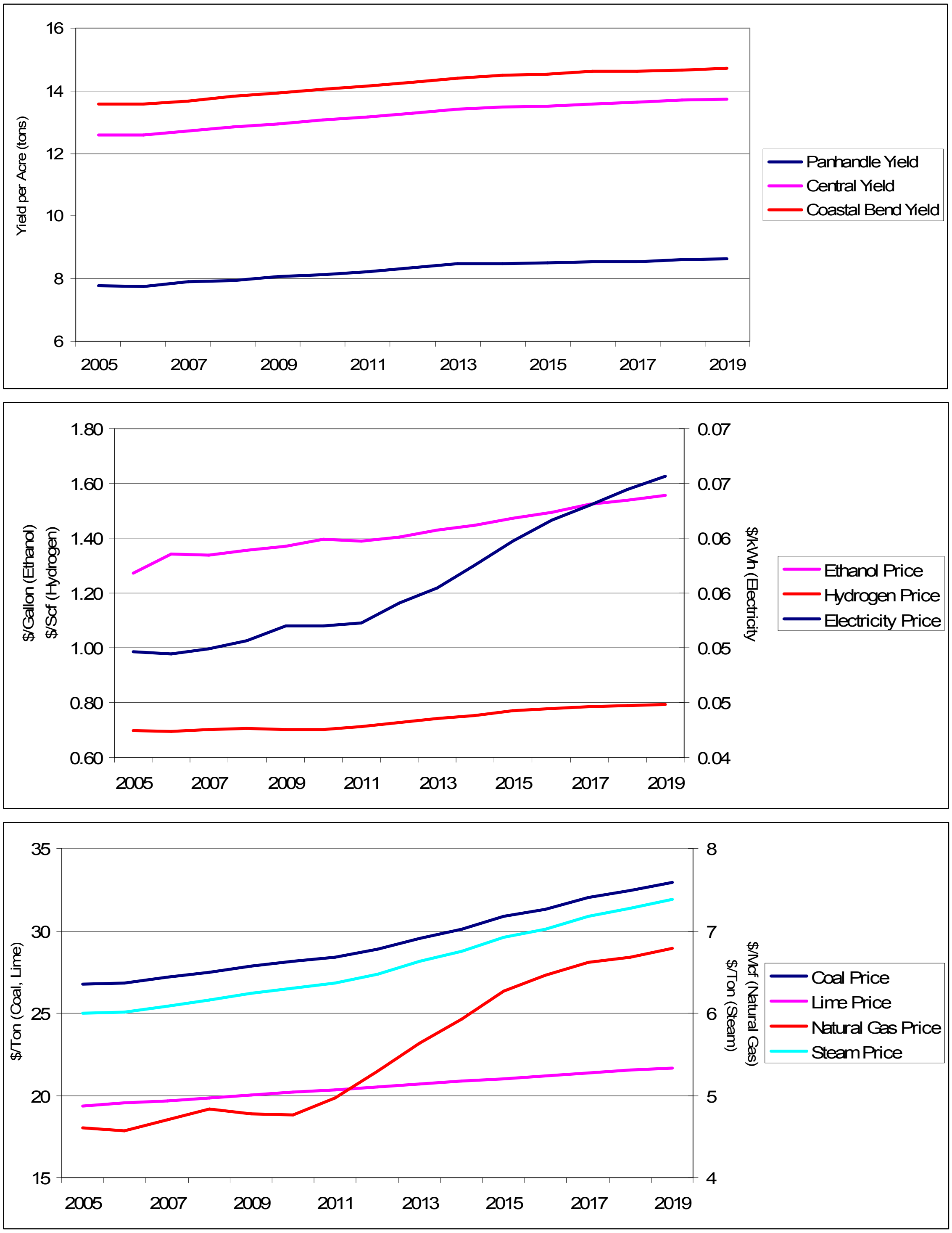

Figure 21. Simulated annual mean values for sorghum silage yield in each region, natural gas price, electricity price, ethanol price, coal price, lime price, hydrogen price, and steam price from 2005 to 2019

A detailed table presenting the simulated mean, standard deviation, coefficient of variation (CV), minimum, and maximum for sorghum silage yield in each region, natural gas price, electricity price, ethanol price, coal price, lime price, hydrogen price, and steam price is available in the Appendix A. The simulated means are not statistically equal to the historical means because the forecasted deterministic means increase for all stochastic variables from 2005 to 2019. Ethanol price increases approximately $0.02/gallon annually. This may seem optimistic but EIA's long-term forecasts for oil and gas prices show these values could increase at a higher rate than stated in the *Annual Energy Outlook 2004* (EIA, 2004). Hydrogen and steam prices increase due to the increases in natural gas price and coal price.

The standard deviations and coefficient of variations are stable for all variables from 2005 to 2019. These values are lower than the historical standard deviations and coefficient of variation because the residuals used to calculate the MVE distribution are from a trend regression. The simulated values have the same coefficient of variation as the residuals from trend and are constant over time.

Table 16 presents the historical correlation matrix for sorghum silage yield in each region, natural gas price, electricity price, ethanol price, coal price, and lime price. Steam and hydrogen prices are calculated from the stochastic coal and natural gas prices. The correlation matrix of simulated annual values for all stochastic variables in each year were tested against the historical correlation matrix using a Student t-test. Tests show the difference between the simulated correlation matrix and historical correlation matrix is not statistically significant at the 0.01 significance level. Therefore, we can say the simulation model reproduced the historical correlation among all stochastic variables.

The energy variables, natural gas, electricity, ethanol, and coal, are positively correlated. Natural gas and electricity have the highest correlation with a 0.89 correlation coefficient. This is expected as most new electric generating facilities are natural gas fired (Annual Energy Outlook 2004, 2004). Electricity and coal prices are highly correlated with a 0.66 correlation coefficient.

Silage yield in the Panhandle, Central, and Coastal Bend Regions are positively correlated. This is expected as each region is dry-land farmed. The two regions in closest proximity, the Central Region and Coastal Bend Region, are highly correlated with a 0.86 correlation coefficient. Yield in the Panhandle region is not highly correlated to yield in the Central or Coastal Bend Regions because of the lower annual rainfall associated with the difference in distance.

Table 16. Historical Correlation Matrix for Sorghum Silage Yield in Each Region, Natural Gas Price, Electricity Price, Ethanol Price, Coal Price, and Lime Price

	Panhandle Yield	Central Yield	Coastal Bend Yield	Natural Gas Price	Electricity Price	Ethanol Price	Coal Price	Lime Price
Panhandle Yield	1.00	0.03	0.02	-0.21	-0.17	-0.07	-0.15	0.08
Central Yield		1.00	0.86	0.10	0.04	-0.03	-0.02	0.67
Coastal Bend Yield			1.00	-0.25	-0.13	-0.14	-0.20	0.53
Natural Gas Price				1.00	0.89	0.53	0.60	0.47
Electricity Price					1.00	0.55	0.66	0.56
Ethanol Price						1.00	0.17	0.34
Coal Price							1.00	0.25
Lime Price								1.00

Simulation Results for Alternative Scenarios

Table 17 presents definitions for the abbreviations used to represent each scenario. The results are broken into four groups for ease of analysis and comparison between size, initial investment, and incentives in each region. The scenarios are grouped based on plant size and if incentives were received.

Table 17. Definitions of Alternative Scenario Labels and Groups for Analysis

Group	Abbreviation	Region	Size	Investment Level	Incentive
Group One	PH 44 BASE NO	Panhandle	44 Ton/Hour	Base	No
	CEN 44 BASE NO	Central	44 Ton/Hour	Base	No
	CB 44 BASE NO	Coastal Bend	44 Ton/Hour	Base	No
	PH 44 +30 NO	Panhandle	44 Ton/Hour	Plus 30	No
	CEN 44 +30 NO	Central	44 Ton/Hour	Plus 30	No
	CB 44 +30 NO	Coastal Bend	44 Ton/Hour	Plus 30	No
Group Two	PH 44 BASE YES	Panhandle	44 Ton/Hour	Base	Yes
	CEN 44 BASE YES	Central	44 Ton/Hour	Base	Yes
	CB 44 BASE YES	Coastal Bend	44 Ton/Hour	Base	Yes
	PH 44 +30 YES	Panhandle	44 Ton/Hour	Plus 30	Yes
	CEN 44 +30 YES	Central	44 Ton/Hour	Plus 30	Yes
	CB 44 +30 YES	Coastal Bend	44 Ton/Hour	Plus 30	Yes
Group Three	PH 176 BASE NO	Panhandle	176 Ton/Hour	Base	No
	CEN 176 BASE NO	Central	176 Ton/Hour	Base	No
	CB 176 BASE NO	Coastal Bend	176 Ton/Hour	Base	No
	PH 176 +30 NO	Panhandle	176 Ton/Hour	Plus 30	No
	CEN 176 +30 NO	Central	176 Ton/Hour	Plus 30	No
	CB 176 +30 NO	Coastal Bend	176 Ton/Hour	Plus 30	No
Group Four	PH 176 BASE YES	Panhandle	176 Ton/Hour	Base	Yes
	CEN 176 BASE YES	Central	176 Ton/Hour	Base	Yes
	CB 176 BASE YES	Coastal Bend	176 Ton/Hour	Base	Yes
	PH 176 +30 YES	Panhandle	176 Ton/Hour	Plus 30	Yes
	CEN 176 +30 YES	Central	176 Ton/Hour	Plus 30	Yes
	CB 176 +30 YES	Coastal Bend	176 Ton/Hour	Plus 30	Yes

Group One Simulation Results

Group one consists of scenarios for a 44 ton/hour production facility which do not receive incentives in the Panhandle, Central, or Coastal Bend Regions under the Base and Plus 30 initial investment levels. Direct comparison between plants can be made because there are no incentives to affect the KOVs.

Net Income

Figure 22 presents the projected average annual net income in millions of dollars for each scenario in group one. The graph indicates each scenario follows the same pattern at different levels. This is primarily due to few differences in the costs of production for each scenario. Natural gas price, electricity price, ethanol price, coal price, lime price, hydrogen price, and steam price are the same in each region. The differences in net income are attributed to different silage prices and yields, hauling costs, water costs, depreciation costs, and tax costs in each region. The initial investment level directly affects the long-term loan interest cost and depreciation cost.

However, net income is positive each year because of decreasing interest cost for long-term capital loan and increasing ethanol prices. EIA's long-term forecasts for oil and gas prices are expected to increase at a higher rate than other energy fuels. The VEC model used to forecast ethanol prices maintains the historical relation between ethanol price, MTBE price, and wholesale gas price.

The Panhandle and Central Regions returned the highest net income at the Base and Plus 30 initial investment level from 2005 to 1019. The Coastal Bend Region had the lowest average annual net income for both initial investment scenarios. This is because of higher silage costs per ton and higher hauling cost due to greater travel distances to supply the necessary feedstock.

In 2005, net income is below $4 million for each scenario. This is due to half production in the first year and the large initial market value depreciation expense for both equipment and buildings. In 2006, net income increases with a range of $15.35 million for CEN 44 BASE NO to $14.36 for the PH 44 +30 NO scenarios. For 2019, net income ranges from $18.69 million for CEN 44 BASE NO to $16.74 for CB 44 +30 NO.

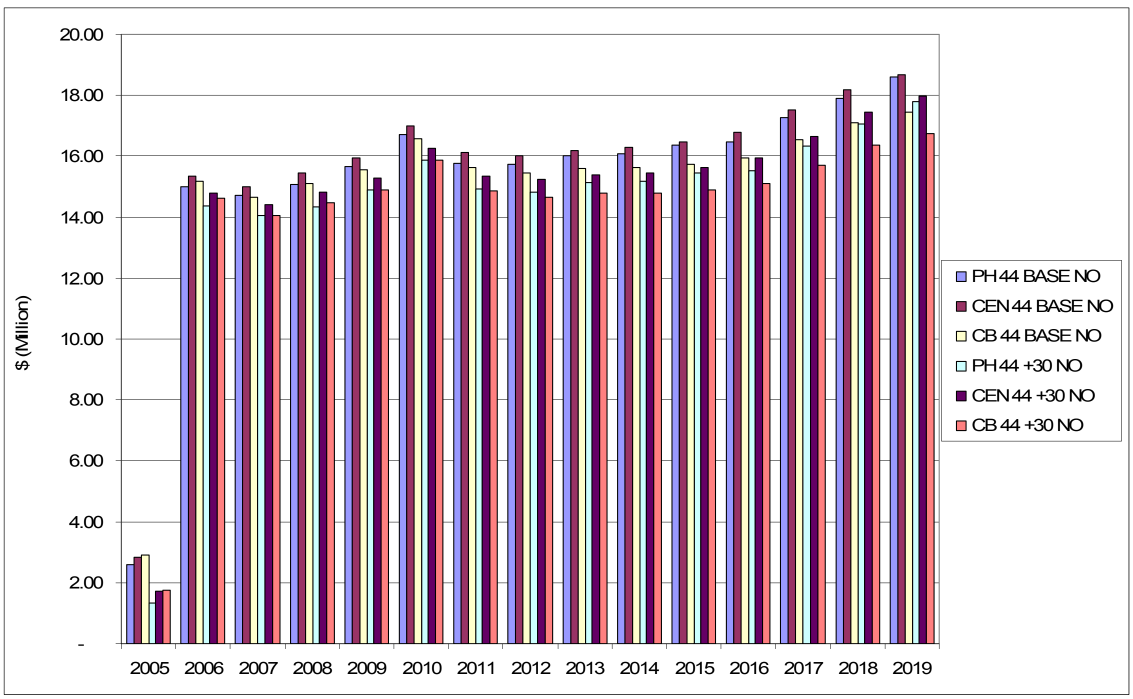

Figure 22. Projected average annual net income for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 Investment levels with no incentives

Note: See Table 17 on page 119 for definition of abbreviations

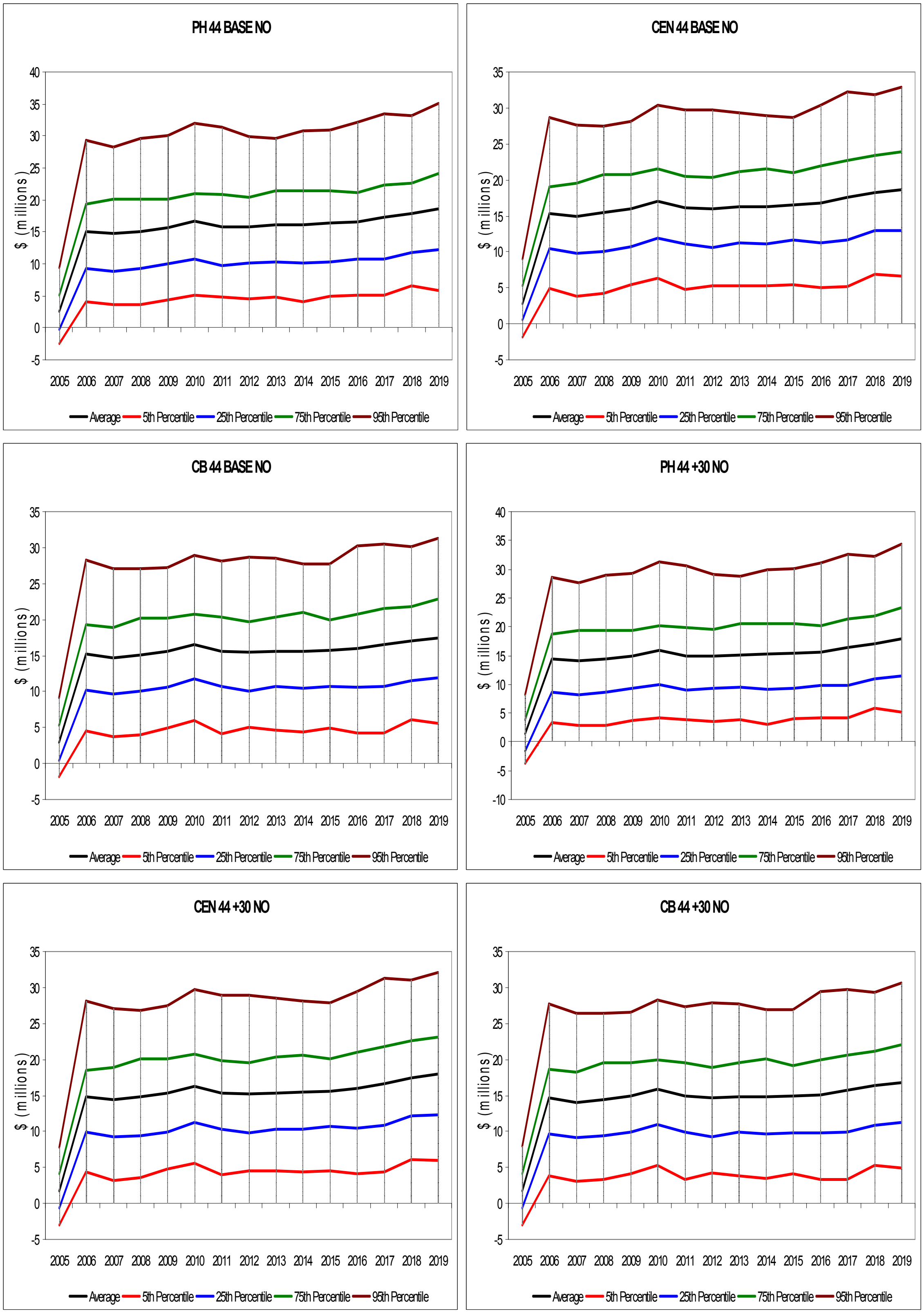

Figure 23. Projected annual net income risk for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives

Note: See Table 17 on page 119 for definition of abbreviations

Figure 23 presents the range and risk of the simulated projected annual net incomes for scenarios in group one. The upper line (purple) and lower line (red) contain 90 percent of the simulated values. The two inner lines (green, blue) contain 50 percent of the simulated values. The middle black line is the projected annual mean. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum is available in the Appendix B.

In each scenario, the probability of negative net income only occurs in the first year of the analysis. The probability of negative net income is greater under all Plus 30 initial investment levels because of the larger debt servicing costs (interest). For the Base initial investment scenarios, the probability of negative net income in 2005 is 29 percent, 22 percent, and 21 percent for Panhandle, Central, and Coastal Bend Regions. The probability of negative net income For the Plus 30 initial investment scenarios is 42 percent for Panhandle Region and 34 percent for the Central and Coastal Bend Regions. In all six scenarios, net income after 2005 is positive with a very low probability of being negative.

In 2006, the PH 44 +30 NO scenario had the largest range with 90 percent of the simulated projected values between $3.36 million to $28.65 million. CEN 44 BASE NO scenario had the narrowest range with 90 percent of the simulated projected values between $4.95 million and $28.66 million in 2006. In 2019, the PH 44 +30 NO scenario had the largest range with 90 percent of the simulated projected values between $5.11 million and $34.4 million. The CEN 44 BASE NO had the lowest range with 90 percent of the simulated projected values between $6.67 million and $32.83 million.

<u>Ending Cash Balance</u>

Figure 24 presents the projected average annual ending cash balances in millions of dollars for each scenario in group one. The graph indicates ending cash balance increases each year and all scenarios follow the same pattern at different levels. This result is expected when net income is positive. As net income remains positive, ending cash balance increases at a proportionate rate. Also, as ending cash balance increases, interest earned on cash reserves increases proportionally. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum is available in the Appendix B.

Ending cash balance is higher in the Base initial investment scenarios than the Plus 30 initial investment level scenarios. At the Base level, long-term loan principal payments, corporate taxes, property taxes, franchise tax, capital improvement expenditure, and dividends are all lower as a results of the lower initial investment level. The lower cash outflows increase ending cash balance in the Base scenario compared to the Plus 30 initial investment scenario. It should be noted that the property tax rate is different in each region though only the property tax basis is affected by the initial investment level.

Ending cash balance is highest in the Central Region for the Base and Plus 30 initial investment scenarios. Projected average annual ending cash balance is lowest in the Panhandle Region at the Base initial investment level. At the Plus 30 initial investment level, ending cash balance is lowest in the Panhandle Region. The larger initial investment increases the principle payment of the capital loan. Ending cash balance increases from $2.82 million in 2005 to $87.62 million in 2019 for the CEN 44 BASE NO scenario. In the CEN 44 +30 NO scenario, ending cash balance increases from $2.76 million in 2005 to $80.87 million in 2019. For the PH 44 +30 NO scenario, ending cash balance is $2.66 million in 2005 and $76.91 million in 2019.

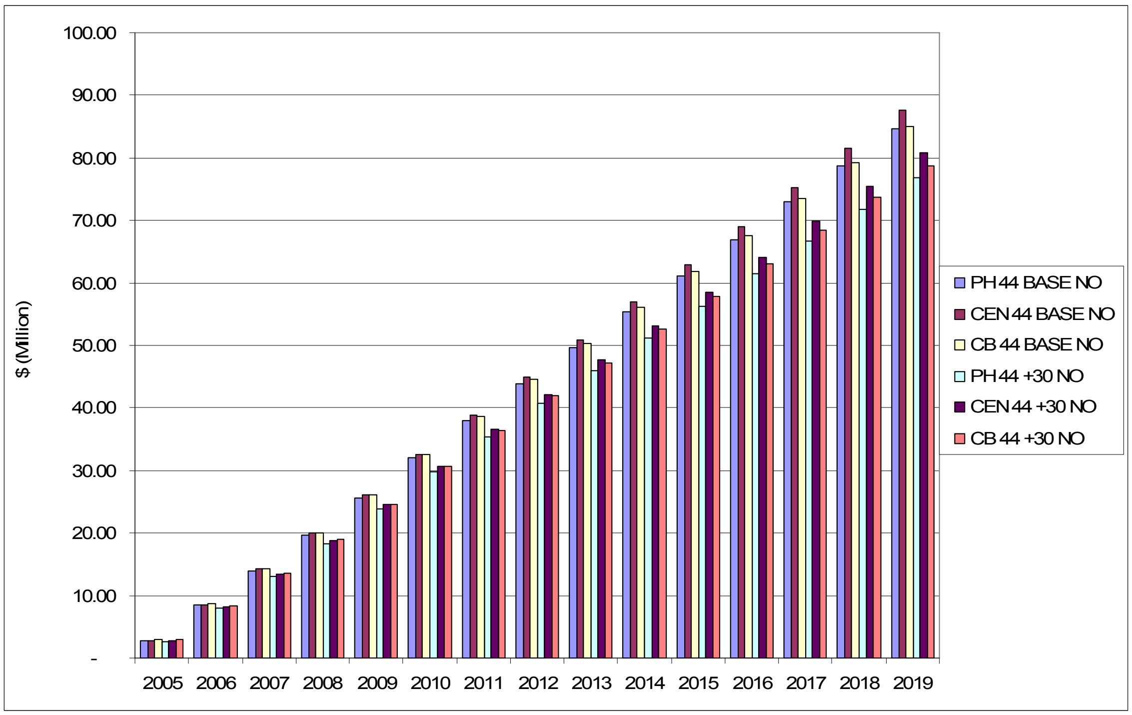

Figure 24. Projected average annual ending cash balance for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives
Note: See Table 17 on page 119 for definition of abbreviations

Figure 25 presents the range and risk of the projected average annual ending cash balances for scenarios in group one. Ending cash balance range is similar for each region when comparing the Base and Plus 30 initial investment scenarios. The risk level increases because of the compounding of risk from net income each year. For each scenario, the probability of negative ending cash balance is less than 10 percent in 2005.

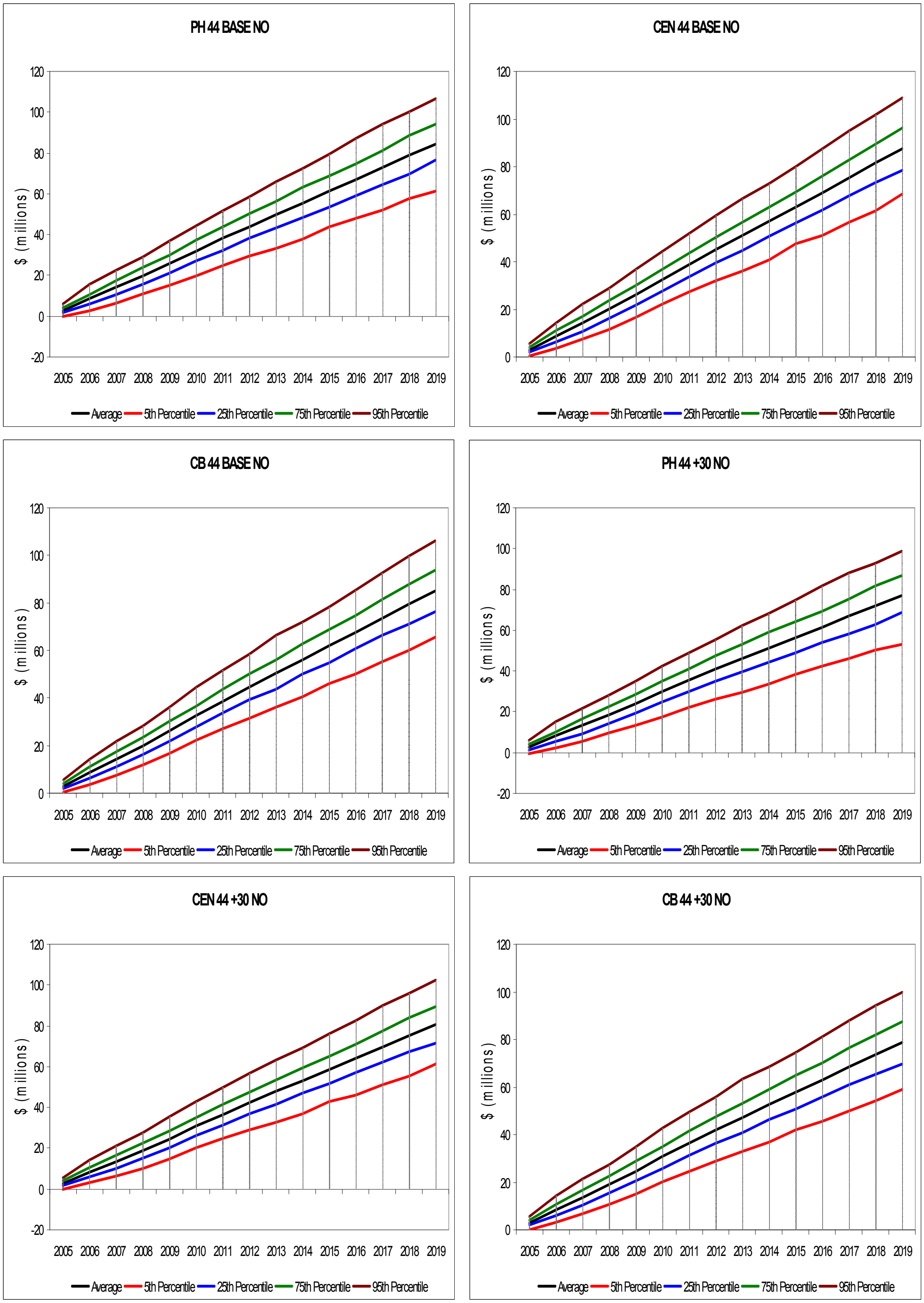

Figure 25. Projected average annual ending cash balance risk for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives
Note: See Table 17 on page 119 for definition of abbreviations

The Panhandle Region had the largest 90 percent range in 2019 for the Base and Plus 30 initial investment scenarios. Ninety percent of the simulated ending cash balances are between $61.23 million to $106.74 million for the PH 44 BASE NO scenario and $53.14 million to $98.89 million for the PH 44 +30 NO scenario. The ranges for the Central and Coastal Bend regions are similar for both the Base and Plus 30 initial investment scenarios.

Dividends Paid

Figure 26 presents the projected average annual dividends paid for each scenario in group one. In this analysis, dividends to stakeholders were paid at 30 percent of the positive net income after corporate tax. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for dividends paid is available in the Appendix B.

Dividends paid are highest in each region for the Base initial investment scenario. This is expected as higher initial investment reduces net income due to larger depreciation expenses, interest costs, and higher capital improvement costs. The Central Region returns the highest dividends for the Base and Plus 30 initial investment scenarios. In 2006, the Central Region averaged $3.15 million in the Base initial investment scenario and increases to $3.66 million in 2019. For the Plus 30 initial investment scenario, dividends paid for the Central Region are $3.08 million in 2006 and $3.52 million in 2019.

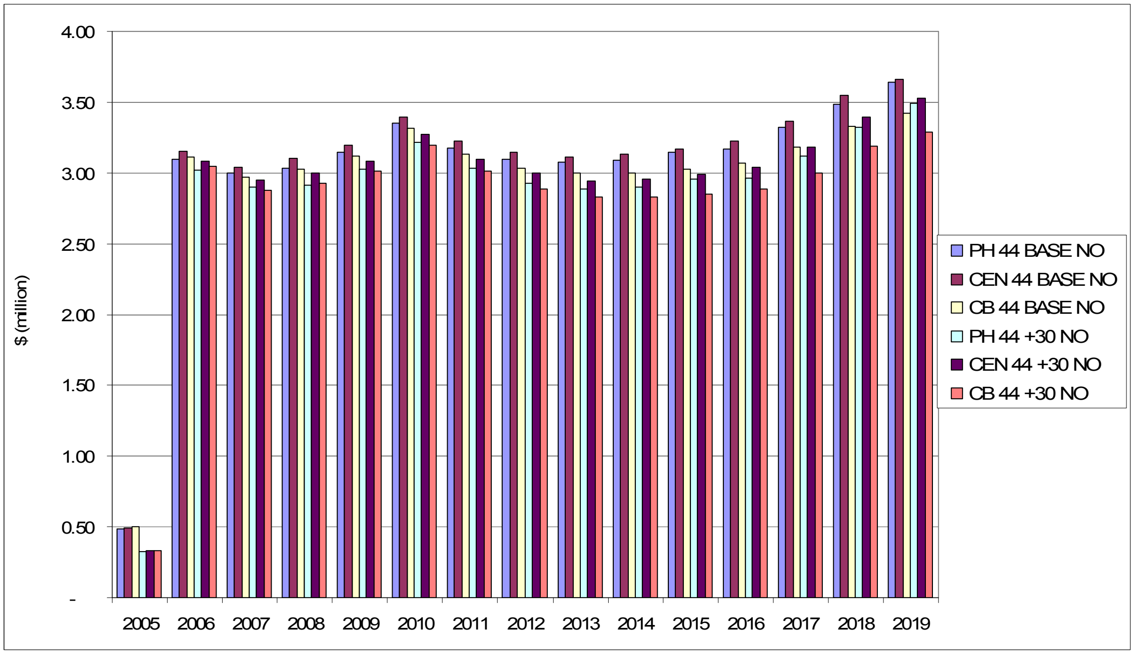

Figure 26. Projected average annual dividends paid for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives

Note: See Table 17 on page 119 for definition of abbreviations

The Coastal Bend Region returned the lowest average dividends paid in the Base and Plus 30 initial investment scenarios. However, the average dividend paid is expected to increase slightly as net income increases from 2006 to 2019. In the Base initial investment scenario, dividends paid averaged $3.11 million in 2006 and $3.42 million in 2019. For the Plus 30 scenario, dividends paid $3.05 million in 2006 and increases to $3.29 in 2019.

Figure 27 presents the range and risk of the simulated average annual dividends paid for scenarios in group one. Since dividends are only paid when net income after corporate tax is positive, the probability of dividends paid being negative is zero.

In 2005, the probability of dividends paid is 63, 70, and 71 percent in the Base initial investment scenario for the Panhandle, Central, and Coastal Bend Regions, respectively. For the Plus 30 initial investment scenario in 2005, the probability of dividends paid is 48, 50, and 53 percent for the Panhandle, Central, and Coastal Bend Regions. After 2005, the probability of dividends paid being greater than zero is 99 percent for all scenarios.

For the CEN 44 BASE NO scenario, 90 percent of simulated dividends paid are between \$1.12 million to \$5.73 million in 2006 and \$1.32 million to \$6.41 million in 2019. For the CEN 44 +30 NO scenario, 90 percent of simulated dividends paid are between \$1.05 million to \$5.66 million in 2006 and \$1.18 million to \$6.27 million 2019. For the Coastal Bend, the Base initial investment scenario returned a 90 percent range of \$1.02 million to \$5.67 million in 2006 and \$1.11 million to \$6.12 million in 2019. Ninety percent of dividends paid for the CB 44 +30 NO scenario is between \$0.95 million and \$5.60 million in 2006 and \$0.97 million and \$11.09 in 2019. The Coastal Bend Region had the largest range but returned a lower mean than the Central Region and Panhandle Regions. This indicates greater variability and risk in the Coastal Bend Region compared to the Panhandle and Central Regions.

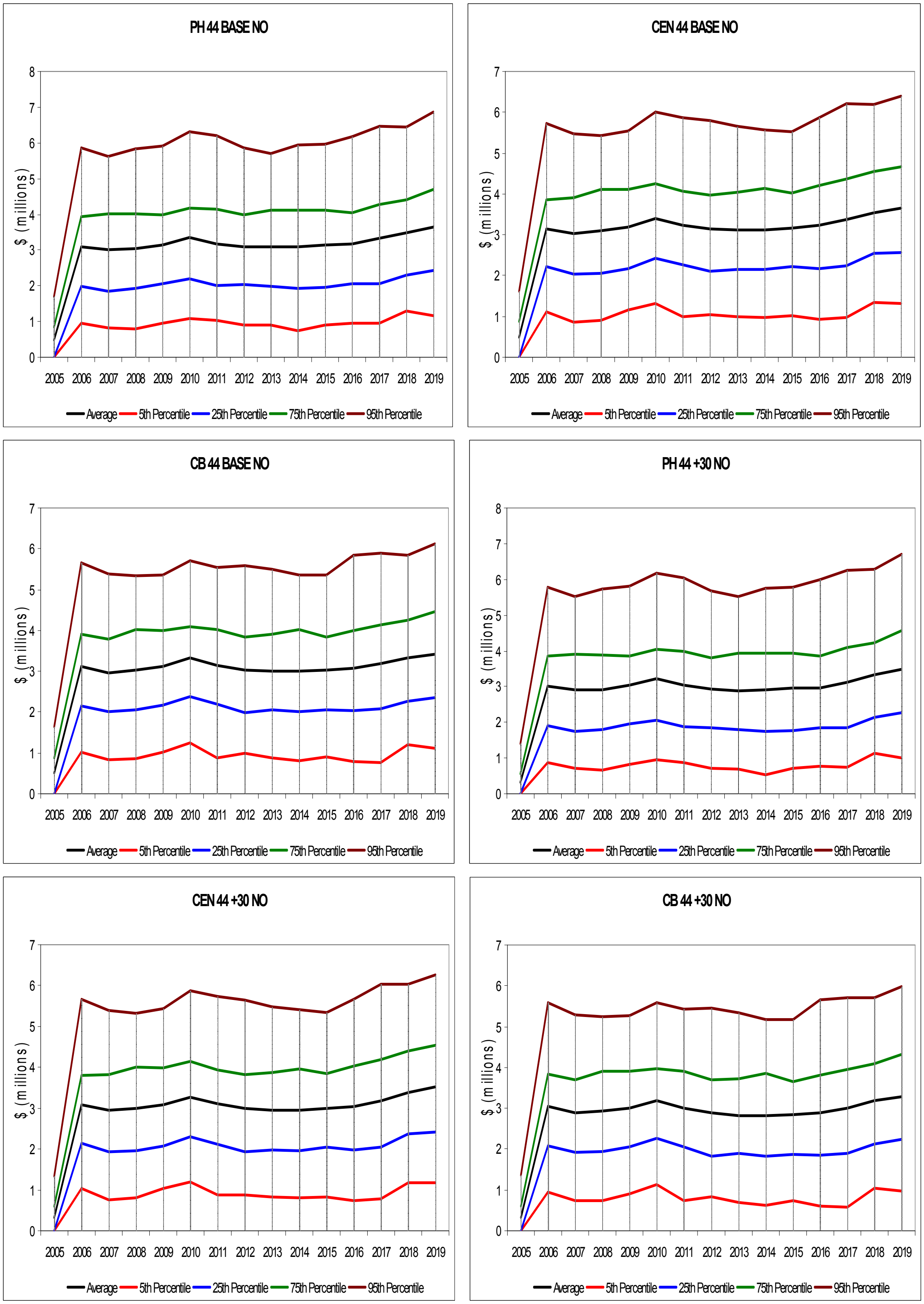

Figure 27. Projected average annual dividends paid risk for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives

Note: See Table 17 on page 119 for definition of abbreviations

Real Net Worth

When net income is positive and ending cash balance is projected to increase from 2005 to 2019, nominal net worth (unadjusted for inflation) is expected to increase. Nominal net worth is adjusted for inflation from 2005 to 2019 to give the real value of the production facility in current dollars. The deflated nominal net worth is referred to as real net worth. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for real net worth is available in the Appendix B.

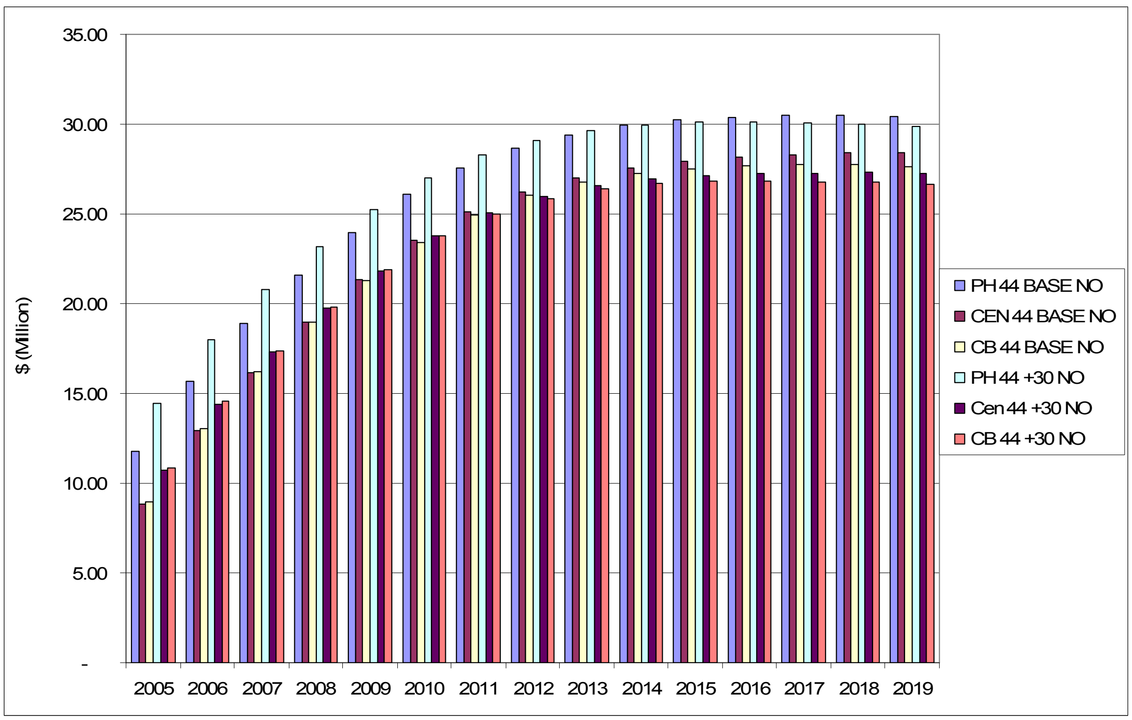

Figure 28. Projected average annual real net worth for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives

Note: See Table 17 on page 119 for definition of abbreviations

Figure 28 presents the projected average real net worth for scenarios in group one. Real net worth for each scenario increases and flattens out after 2014. This is due to the increasing deflation factor used to deflate nominal net worth. Projected average annual real net worth is highest in the Panhandle Region as the initial equity requirement is higher due to the required purchase of water rights and installation of wells in the region. Water rights are appreciated each year using the FAPRI land inflation rate which increases real net worth. In 2006, real net worth is $15.7 million for the PH 44 BASE NO scenario and $18 million for the PH 44 +30 NO scenario. In 2019, real net worth is higher for the PH 44 BASE NO scenario at $30.43 million compared to $29.89 million for the PH 44 +30 NO scenario. The difference can be attributed to the higher capital improvement costs depreciation costs, and long-term loan costs for the Plus 30 initial investment scenario.

The Central Region and Coastal Bend Region returned similar average real net worth for the Base and Plus 30 initial investment levels. In the early years, the Coastal Bend returned higher real net worth values. However, in the later years the Central Region returned higher values than the Coastal Bend Region. This is attributed to higher net income for the Central Region in later years. Real net worth for the CEN 44 BASE NO scenario is $12.92 million in 2006 and $28.39 million in 2019. For the CEN 44 +30 NO scenario, real net worth is $14.42 million in 2006 increasing to $27.26 million in 2019. Average real net worth in the Coastal Bend Region for 2006 is $13.03 million and $14.57 million for the Base and Plus 30 initial investment levels increasing to $27.64 million and $26.62 million in 2019, respectively.

Figure 29 presents the range and risk of the simulated average real net worth for scenarios in group one. Real net worth is projected to be positive from 2005 to 2019 for all scenarios. This is expected as net income is projected to be positive over the planning horizon.

For the Base initial investment scenario in 2006, ninety percent of the simulated real net worth are between $11.23 million to $21.24 million for Panhandle Region, $8.96 million to $17.53 million for the Central Region, and $9.05 million to $17.55 million for the Coastal Bend Region. For year 2019, ninety percent of the simulated values are between $23.6 million to $36.88 million for the Panhandle Region, $22.76 million to $34.61 million for the Central Region, and $21.9 million to $33.82 million for the Coastal Bend Region.

The Plus 30 initial investment level ranges are higher for each region when compared to the Base initial investment scenario. For 2006, ninety percent of the simulated values are between $13.39 million to $23.7 million for the Panhandle Region and $10.29 million to $19.13 million for the Central Region. For 2019, ninety percent of the simulated values are between $22.95 million to $36.3 million for the Panhandle Region, $21.6 million to $33.54 million for the Central Region, and $20.86 million to $32.84 million for the Coastal Bend Region.

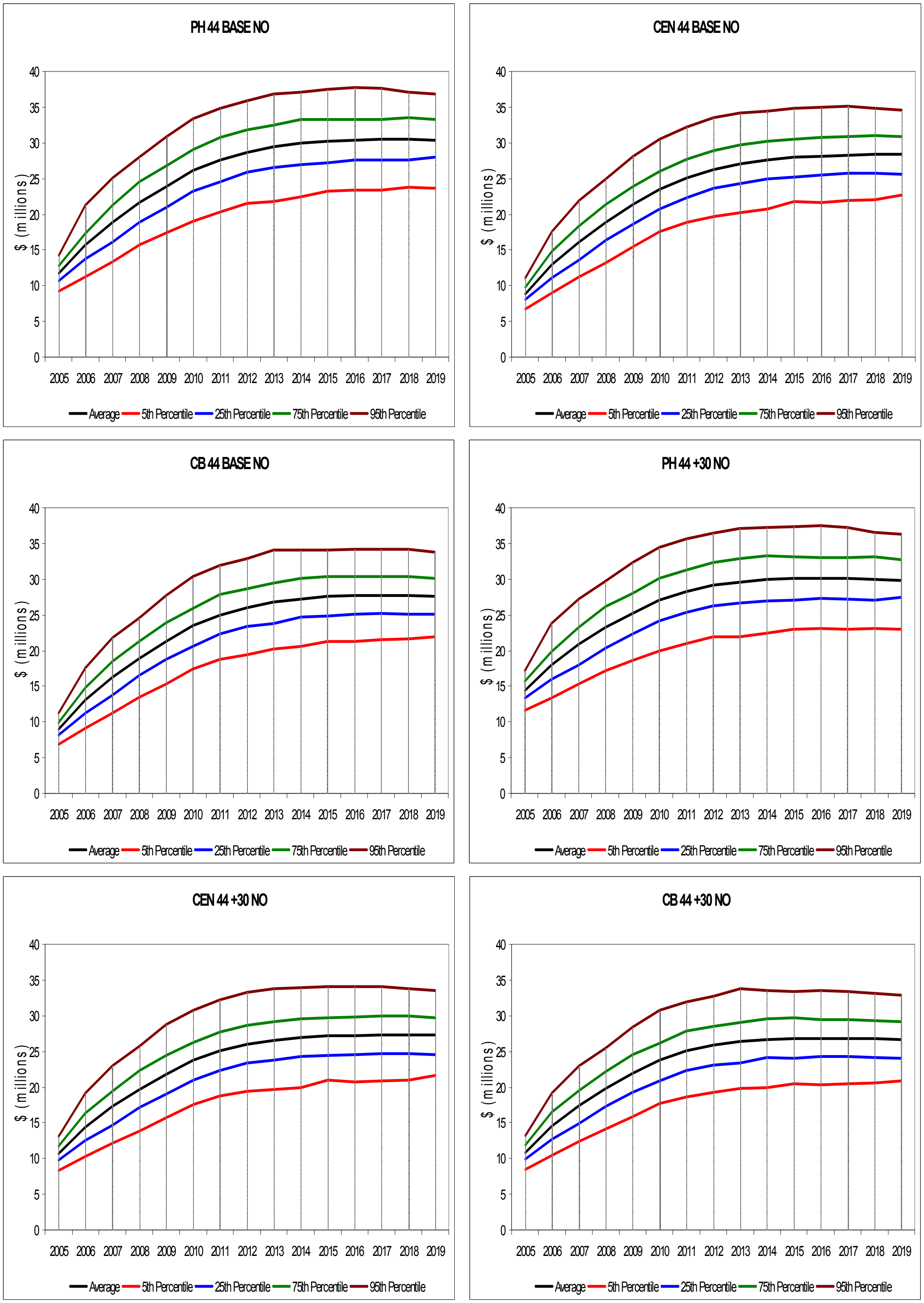

Figure 29. Projected annual real net worth risk for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives

Note: See Table 17 on page 119 for definition of abbreviations

Net Present Value

Net present value (NPV) summarizes net income, ending cash balance, dividends paid, and real net worth into a single value for comparison between scenarios. More specifically, NPV of a capital budgeting project indicates the expected impact of a project on the value of the firm and its income earning potential. Thus, the NPV decision rule specifies that all independent projects with a positive NPV should be accepted. When choosing among mutually exclusive projects, the project with the largest (positive) NPV should be selected. A positive net present value indicates the discounted stream on net returns is sufficient to achieve the desired rate of return defined by the discount rate. A discount rate of 8 percent is used for this analysis.

Figure 30 presents a cumulative density function (CDF) graph of NPV for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions with no incentives. A CDF graph represents the risk of simulated NPV outcomes for visual comparison between alternative scenarios. Probability of a NPV outcome is measured on the vertical axis and NPV values are measured on the horizontal axis. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for NPV is available in the Appendix B.

The CDF graph shows all scenarios in group one return a positive net present value with a low probability of being negative. A clear distinction can be made between the Base and Plus 30 initial investment levels. For the Base initial investment scenario, the average NPVs are $39.67 million, $41.2 million, and $39.71 million for the Panhandle, Central, and Coastal Bend Regions. For the Plus 30 initial investment level scenario, the average NPVs are $33.9 million, $35.91 million, and $34.53 million for the Panhandle, Central, and Coastal Bend Regions, respectively. The differences are explained by higher depreciation cost, capital improvement cost, property tax costs, and additional water rights cost in the Panhandle Region.

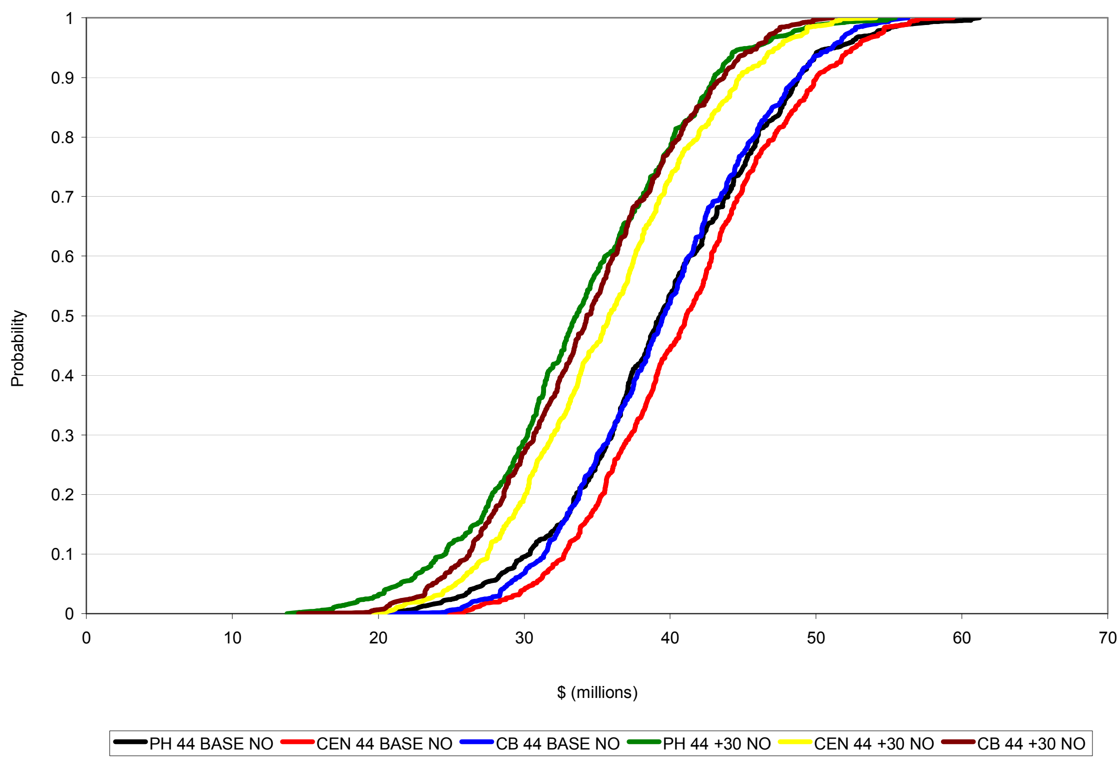

Figure 30. Cumulative density functions of net present value for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives
Note: See Table 17 on page 119 for definition of abbreviations

In the Base initial investment scenario, the Central Region (red line) returned the higher (farther to the right in the above graph) NPV values when compared to the Panhandle (black line) and Coastal Bend Regions (blue line). However, because the CDF lines cross for different scenarios, one cannot say a certain scenario is strictly preferred to other scenarios when analyzing the CDF graph. The Panhandle and Coastal Bend Regions CDF lines cross several times and the Panhandle and Central Region cross at the probability levels.

The results are similar for the Plus 30 initial investment scenario. The Central Region (yellow line) returned the higher NPV values except for at the higher probability levels where it crosses the Panhandle Region line (green line). The Coastal Bend Region (maroon line) crosses the Panhandle line several times.

Because no region is strictly preferred, stochastic efficiency with respect to a function (SERF) is used to analyze and rank the simulated NPVs for each scenario. SERF varies risk aversion over a defined range and ranks the alternatives in terms of certainty equivalence (CE). The upper and lower limit risk aversion coefficients (RACs) were defined using equation 14 (McCarl and Bessler, 1989):

$$(14)\quad RAC = \pm\frac{5}{Std.Dev.}$$

For the 44 ton/hour scenarios, a RAC range of -0.5 to +0.5 is used and a range of -0.2 to +0.2 is used for the 176 ton/hour facilities. A negative RAC value indicates a risk loving decision maker and a positive RAC indicates a risk averse decision maker with zero being risk neutral. The negative exponential utility function is used for all SERF analyses.

Figure 31 presents a SERF graph of NPV for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions with no incentives. The graph clearly shows different regions are preferred under alternative risk preferences. For all Base initial investment scenarios, the CE lines are above the Plus 30 CE lines as expected. When the CE lines cross, a risk root is defined where the decision maker is indifferent between the alternative scenarios.

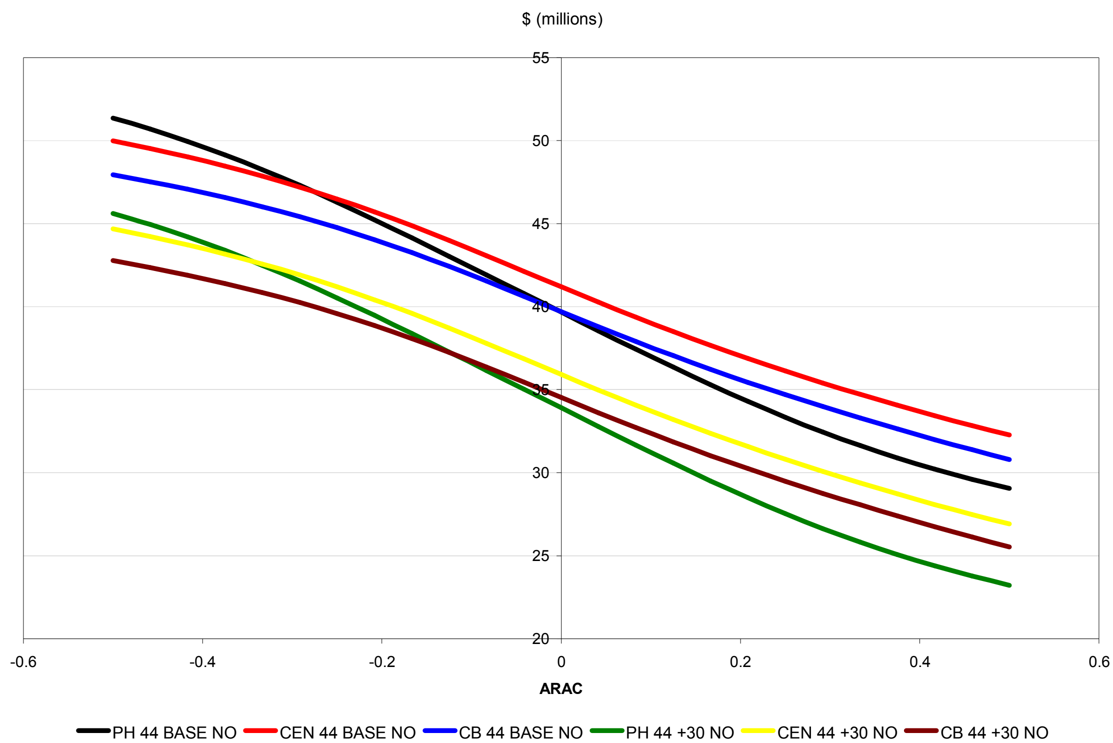

Figure 31. Stochastic efficiency with respect to a function graph of net present value for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives

Note: See Table 17 on page 119 for definition of abbreviations

For risk loving decision makers with RACs smaller than -0.33, the Panhandle Region is preferred for the Base and Plus 30 initial investment levels. At the -0.33 RAC level, the CE lines cross and decision makers are indifferent between the Panhandle and Central Regions for the Plus 30 initial investment level. For the Base initial investment scenario, the CE lines cross at a larger value, -0.25 RAC. Decision makers with RACs between -0.25 and zero prefer the Central Region over the Panhandle and Coastal Bend

Regions for the Base and Plus 30 initial investment levels. The Central Region is preferred over the Panhandle and Coastal Bend Regions for risk neutral and risk averse decision makers with the Coastal Bend Region being preferred over the Panhandle Region.

Table 18 presents the calculated risk premiums between the alternative scenarios for risk neutral (RAC of zero), moderately risk averse (RAC of 0.2), and risk neutral decision makers (RAC of 0.4). The differences between the CE lines in Figure 31 represent the risk premium decision makers place on the preferred alternative over another alternative. Risk premiums represent the amount of money decision makers would have to be paid to be indifferent between two risky alternatives. The risk premiums are dependent upon a decision maker's risk preference and the uncertainty of the alternative choice captured by the CE. The Central Region at the Base initial investment level scenario is used as the base scenario for comparison to calculate the risk premiums.

Table 18. Risk Premiums for a 44 Ton/Hour MixAlco Production Facility in the Panhandle, Central, and Coastal Bend Regions at the Base and Plus 30 Investment Levels with No Incentives

	Risk Neutral	**Moderately Risk Averse**	**Risk Averse**
		$ (millions)	
PH 44 BASE NO	(1.53)	(2.59)	(3.21)
CEN 44 BASE NO	-	-	-
CB 44 BASE NO	(1.49)	(1.43)	(1.43)
PH 44 +30 NO	(7.29)	(8.39)	(9.04)
CEN 44 +30 NO	(5.29)	(5.31)	(5.35)
CB 44 +30 NO	(6.67)	(6.64)	(6.68)

Note: See Table 17 on page 119 for definition of abbreviations

Risk neutral and risk averse decision makers prefer the CEN 44 BASE NO scenario over all other scenarios. To entice risk neutral decision makers to move from the Central Region at the Base initial investment level to the Panhandle Region, decision makers would have to be paid $1.53 million. The risk premium between the CEN 44 BASE NO and CB 44 BASE NO scenarios is $1.49 million, meaning decision makers are almost indifferent between locating in the Central or Coastal Bend Regions at the Base initial investment scenario with no incentives. The results for the Plus 30 initial investment scenario show the Central Region is preferred over the Panhandle and Coastal Bend Regions as it has the smallest risk premium in comparison to the Base initial investment scenario. For risk averse decision makers, the risk premiums are larger, indicating the Central Region at the Base initial investment is even more preferred.

Group Two Simulation Results

Group two consist of scenarios for a 44 ton/hour production facility which receives incentives in the Panhandle, Central, or Coastal Bend Regions under the Base and Plus 30 initial investment levels. Most incentives are tax abatements, which do not affect net income or dividends paid but do directly affect ending cash balance, real net worth, and net present value.

Net Income

Figure 32 presents the projected average annual net income in millions of dollars for each scenario in group two. The graph indicates each scenario follows the same pattern at different levels and is similar to the corresponding scenarios with no incentives in group one. The Panhandle and Central Regions returned the highest net income at the Base and Plus 30 initial investment level from 2005 to 2019. The Coastal Bend Region had the lowest average annual net income for the Base and Plus 30 initial investment scenarios. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for net income is available in the Appendix C.

Net income increases gradually each year for all scenarios because of decreasing interest cost for long-term capital loan and increasing ethanol prices. In 2005, the net income is below $4 million for each scenario. In 2006, net income is $15.02 million, $15.36 million, and $15.18 million for the PH 44 BASE YES, CEN 44 BASE YES, and CB 44 BASE YES scenarios and $14.36 million, $14.82 million, and $14.62 million for the PH 44 +30 YES, CEN 44 +30 YES, and CB 44 +30 YES scenarios. Net income increases for all scenarios through 2019.

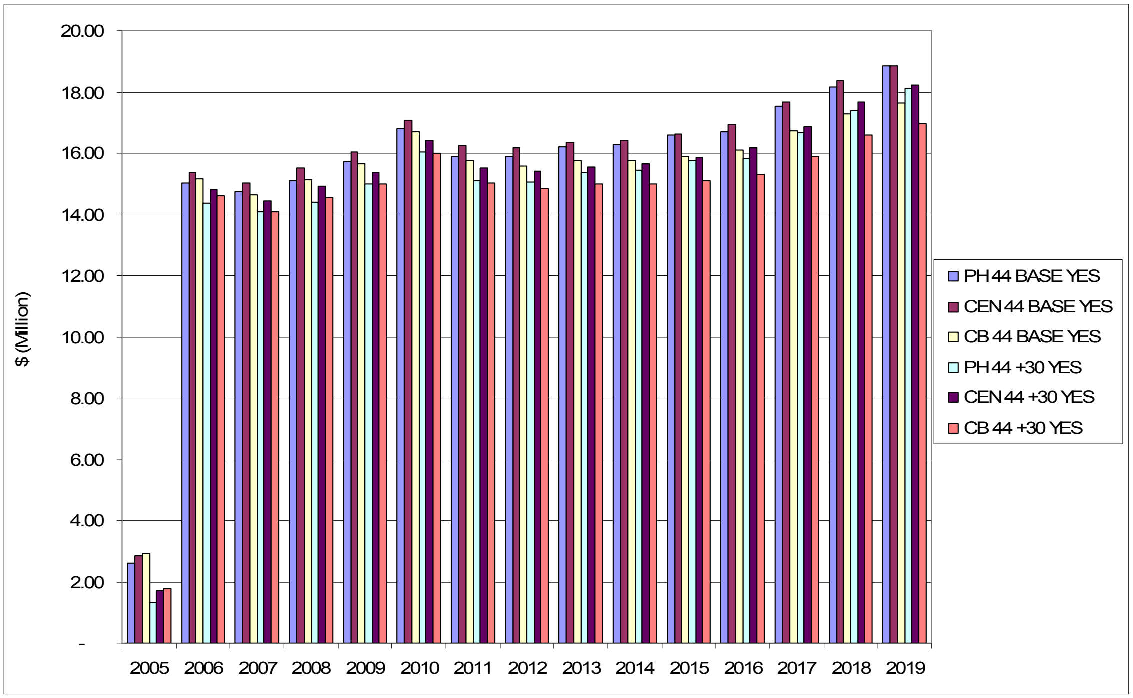

Figure 32. Projected average annual net income for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives
Note: See Table 17 on page 119 for definition of abbreviations

Figure 33 presents the range and risk of the simulated projected annual net incomes for scenarios in group two. The range and risk are similar to the corresponding scenarios in group one with no incentives with a very low probability of being negative after 2005. The probability of negative net income only occurs in the first year of the analysis. Also, the probability of negative net income is greater for all Plus 30 initial investment levels as expected. In the Base initial investment scenarios, the probability of negative net income in 2005 is 29 percent, 22 percent, and 21 percent for Panhandle, Central, and Coastal Bend Regions. In the Plus 30 initial investment scenarios, the probability of negative net income is 42 percent for Panhandle Region and 34 percent for the Central and Coastal Bend Regions.

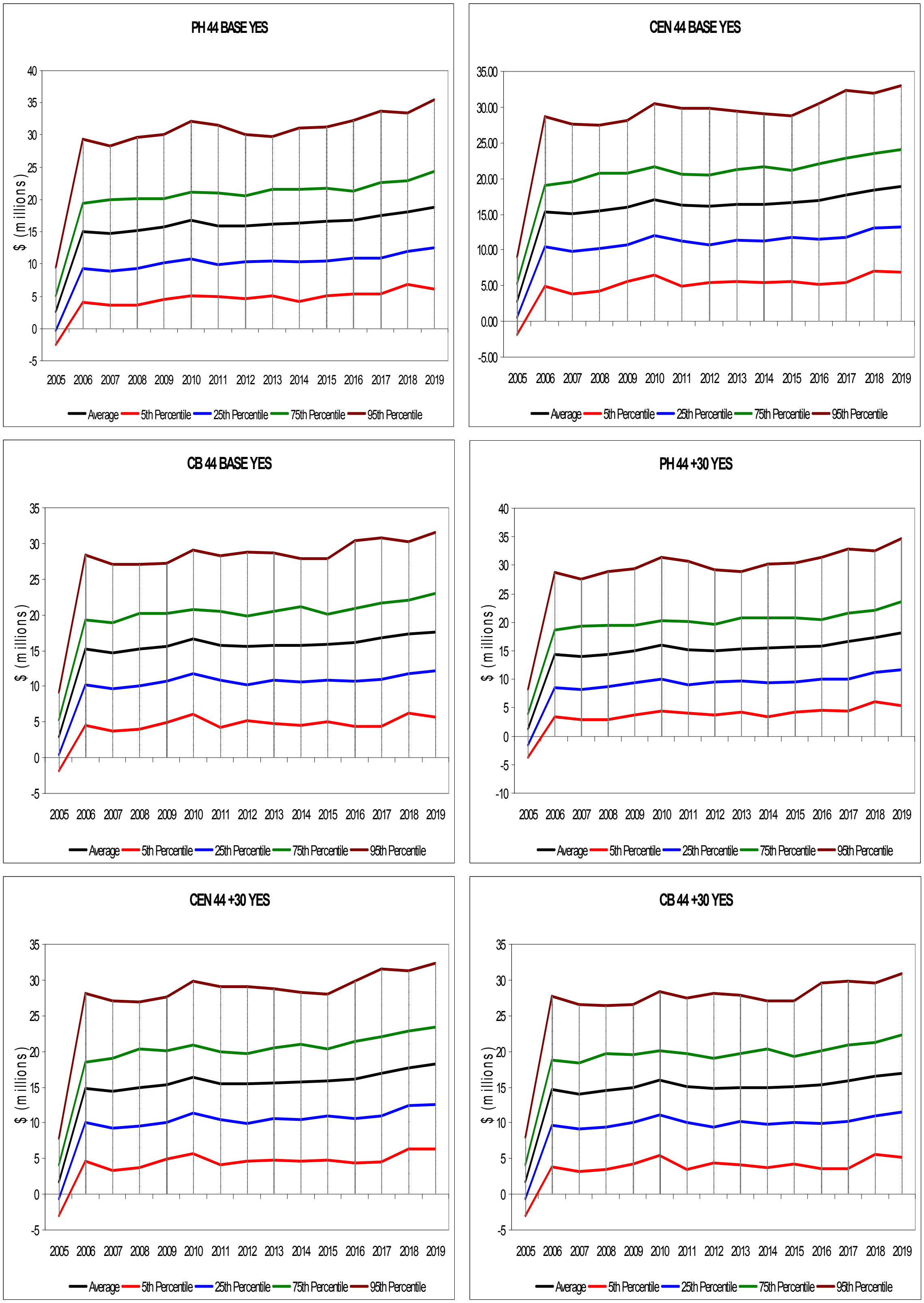

Figure 33. Projected average annual net income risk for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives

Note: See Table 17 on page 119 for definition of abbreviations

In 2006, the 90 percent of the simulated net income values are between $4.02 million to $29.3 million, $4.95 million to $28.67 million, and $4.45 million to $28.34 million for the PH 44 BASE YES, CEN 44 BASE YES, and CB 44 BASE YES scenarios. The range increases to $6.15 million to $35.42 million, $6.85 million to $33.02 million, and $5.76 million to $31.52 million in 2019 for the Panhandle, Central, and Coastal Bend Regions. The Plus 30 initial investment scenario lowers the 90 percent range for all three regions.

Ending Cash Balance

Figure 34 presents the projected average annual ending cash balances in millions of dollars for scenarios in group two. The graph indicates ending cash balance increases each year and follow the same pattern at different levels. This result is expected with positive net income. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for ending cash balance is available in the Appendix C.

The projected average annual ending cash balances are higher for all Base initial investment scenarios than the Plus 30 initial investment level scenarios. Long-term loan principle payments, corporate taxes, property taxes, franchise tax, capital improvement expenditure, and dividends are lower as a result of the lower initial investment level. The incentive packages and property tax rates are different in each region.

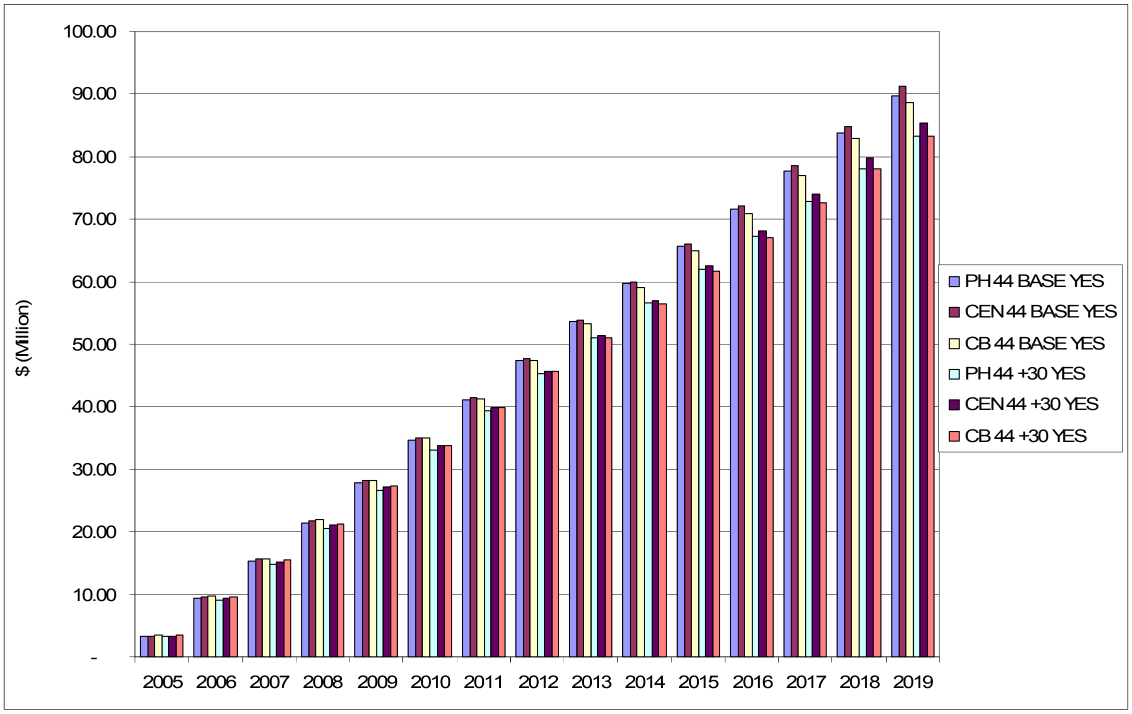

Figure 34. Projected average annual ending cash balance for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives

Note: See Table 17 on page 119 for definition of abbreviations

The projected average ending end cash balance results for scenarios in group two follow a similar pattern to ending cash balance results for scenarios in group one. Projected ending cash balance is highest for the Central Region in the Base and Plus 30 initial investment scenarios. Ending cash balance is similar in the Coastal Bend and Panhandle Regions at the Plus 30 initial investment level. In 2019, projected average annual ending cash balance for the CB 44 BASE YES and CB 44 +30 NO scenarios are \$88.74 million and \$83.2 million. For the Central Region, annual ending cash balance is \$9.58 million and \$9.44 million for the Base and Plus 30 initial investment levels in 2006 and \$91.21 million and \$85.37 million in 2019.

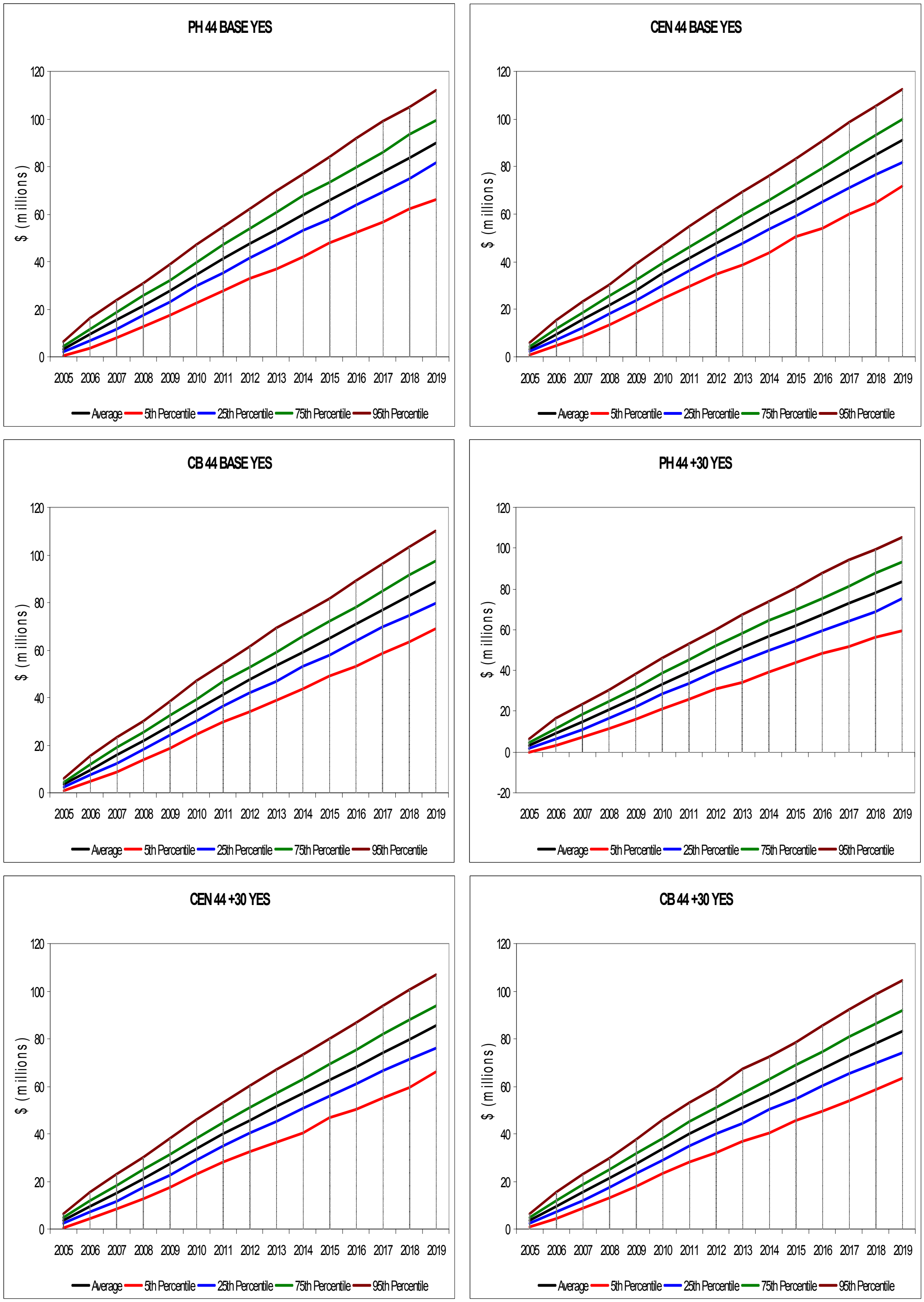

Figure 35. Projected average annual ending cash balance risk for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives
Note: See Table 17 on page 119 for definition of abbreviations

Figure 35 presents the range and risk of the projected average annual ending cash balances for scenarios in group two. Ending cash balance is similar for each region when comparing the Base and Plus 30 initial investment scenarios with risk increasing over time. The probability of negative average annual ending cash balance ranges from 5 percent for the PH 44 +30 YES scenario to 2 percent for the CEN 44 BASE YES scenario in year 2005. from 2006 to 2019, the probability of ending cash balance being negative is less than one percent.

For the Base initial investment scenario, ninety percent of the simulated average annual ending cash balances in 2019 are between $66.15 million to $112 million, $71.85 million to $112.68 million, and $68.97 million to $110.06 million for the Panhandle, Central, and Coastal Bend Regions. For the Plus 30 initial investment level, 90 percent of the simulated average annual ending cash balances are between $59.32 million to $105.4 million, $66 million to $106.96 million, and $63.27 million to $104.67 million for the Panhandle, Central, and Coastal Bend Regions, respectively.

Dividends Paid

Figure 36 presents the projected average annual dividends paid for each scenario in group two. The projected average annual dividends paid are highest in each region for the Base initial investment scenario when compared to the Plus 30 initial investment level. The Central Region returns the highest dividends for the Base and Plus 30 initial investment scenarios. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for dividends paid is available in the Appendix C.

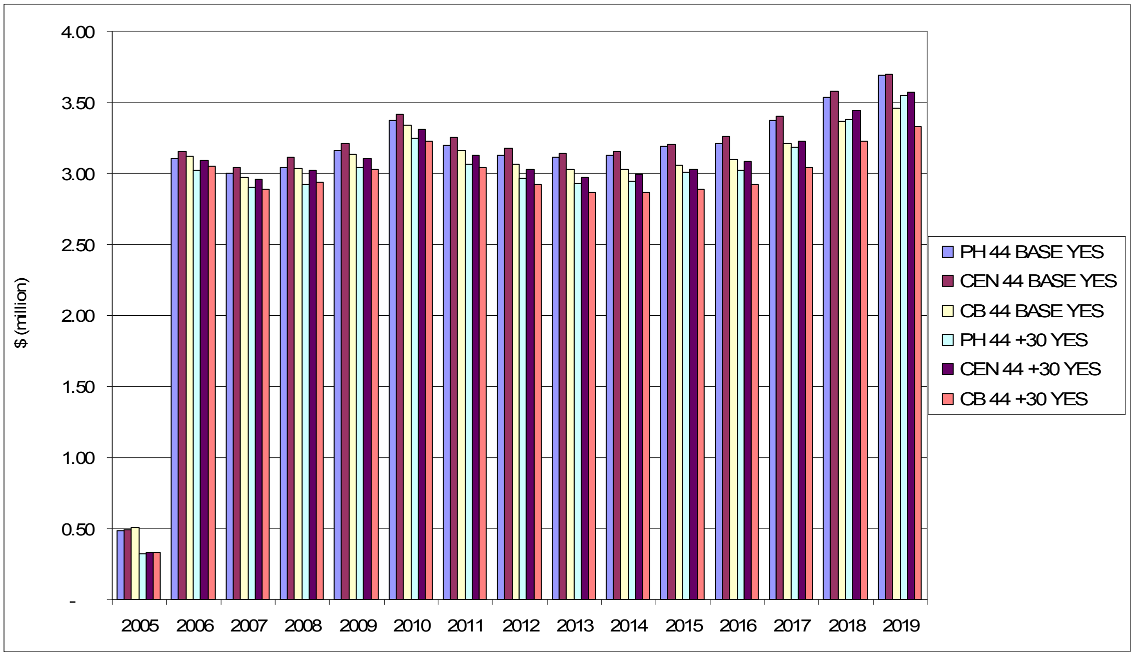

Figure 36. Projected average annual dividends paid for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives

Note: See Table 17 on page 119 for definition of abbreviations

In 2006, the Central Region averaged $3.15 million for the Base initial investment scenario increasing to $3.7 million in 2019. For the Plus 30 initial investment scenario, the Central Region averaged $3.09 million dividends paid in 2006 and $3.57 million in 2019. Dividends paid in the Coastal Bend Region averaged $3.12 million in 2006 and $3.46 million in 2019 for the Base initial investment scenario. In the Plus 30 scenario, dividends paid decreased for the Coastal Bend ranging from $3.05 million in 2006 and increases to $3.33 in 2019.

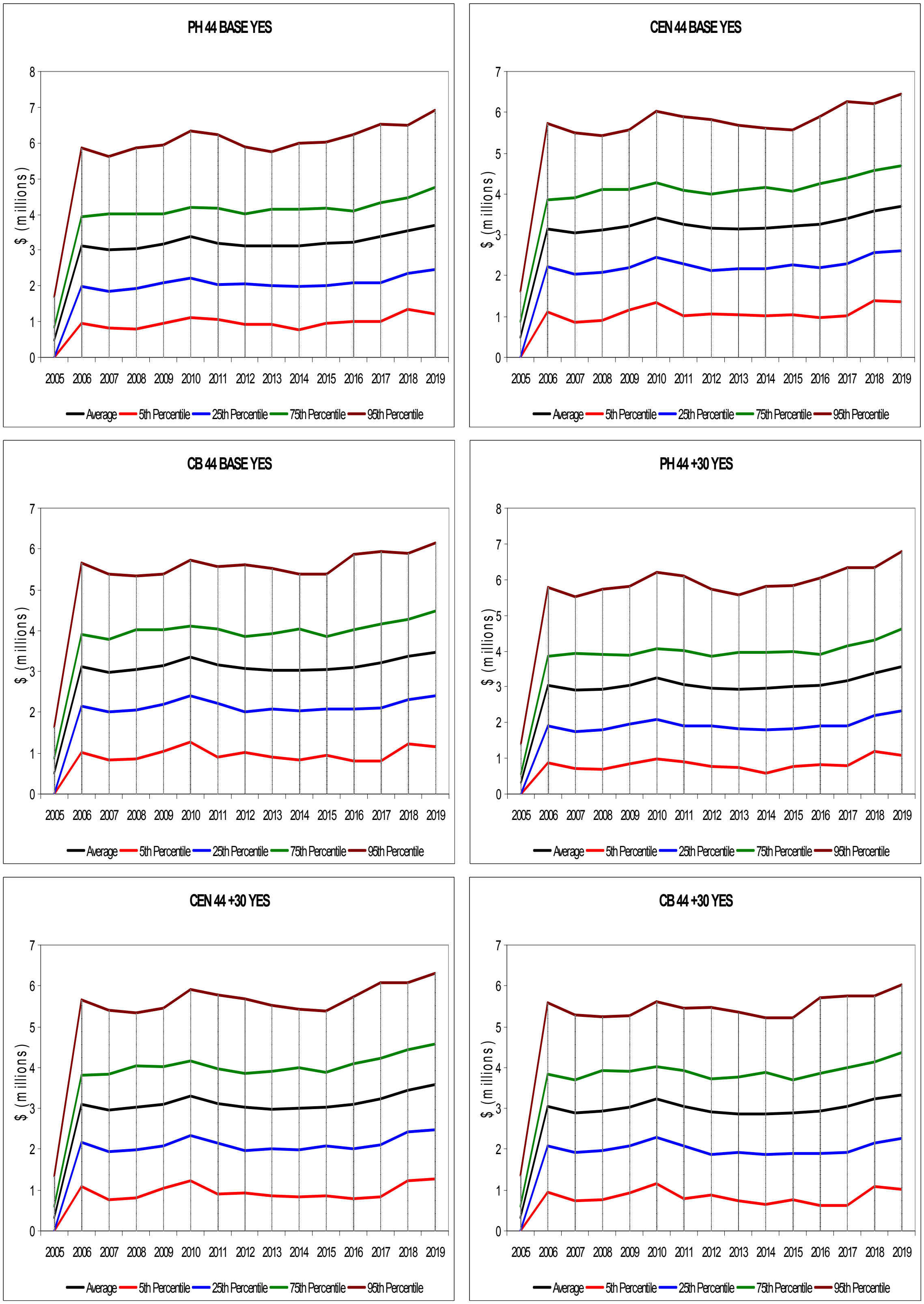

Figure 37. Projected average annual dividends paid risk for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives

Note: See Table 17 on page 119 for definition of abbreviations

Figure 37 presents the range and risk of the simulated average annual dividends paid for scenarios in group two. In 2005, the probabilitiy of dividends paid is 63, 70, and 71 percent in the Base initial investment scenario for the Panhandle, Central, and Coastal Bend Regions, respectively. For the Plus 30 initial investment scenario in 2005, the probability of dividends paid is 48, 50, and 53 percent for the Panhandle, Central, and Coastal Bend Regions. After 2005, the probability of dividends paid is 99 percent.

For 2019, ninety percent of the simulated average annual dividends paid are between $1.22 million to $6.91 million, $1.36 million to $6.44 million, and $1.14 to $6.15 million for the Panhandle, Central and Coastal Bend Regions for the Base initial investment scenario. In the Plus 30 initial investment scenario for 2019, ninety percent of the simulated average annual dividends paid range from $1.08 million to $6.77 million, $1.26 million to $6.31 million, and $1.02 million to $6.03 million for the Panhandle, Central, and Coastal Bend Regions, respectively.

Real Net Worth

Figure 38 presents the projected average real net worth for scenarios in group two. Projected average annual real net worth for each scenario increases and flattens out after 2014 due to the increasing deflation factor used to deflate nominal net worth. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for real net worth is available in the Appendix C.

Projected average annual real net worth is highest in the Panhandle Region as the initial equity requirement is higher due to the required purchase of water rights in the region. In 2006 for the Base initial investment level, projected average annual real net worth is $16.43 million, $13.68 million, and $13.78 million for the Panhandle, Central, and Coastal Bend Regions. In 2019, the projected average annual real net worth increases to $31.92 million, $29.44 million, and $28.72 million for the Panhandle, Central, and Coastal Bend Regions.

The Central Region and Coastal Bend Region returned similar average real net worth values in the Base and Plus 30 initial investment levels. However, in the later years the Coastal Bend Region returned lower real net worth values than the Central Region. Average annual real net worth in 2019 for the Coastal Bend Region is $28.72 million and $27.94 million for the and Plus 30 initial investment levels.

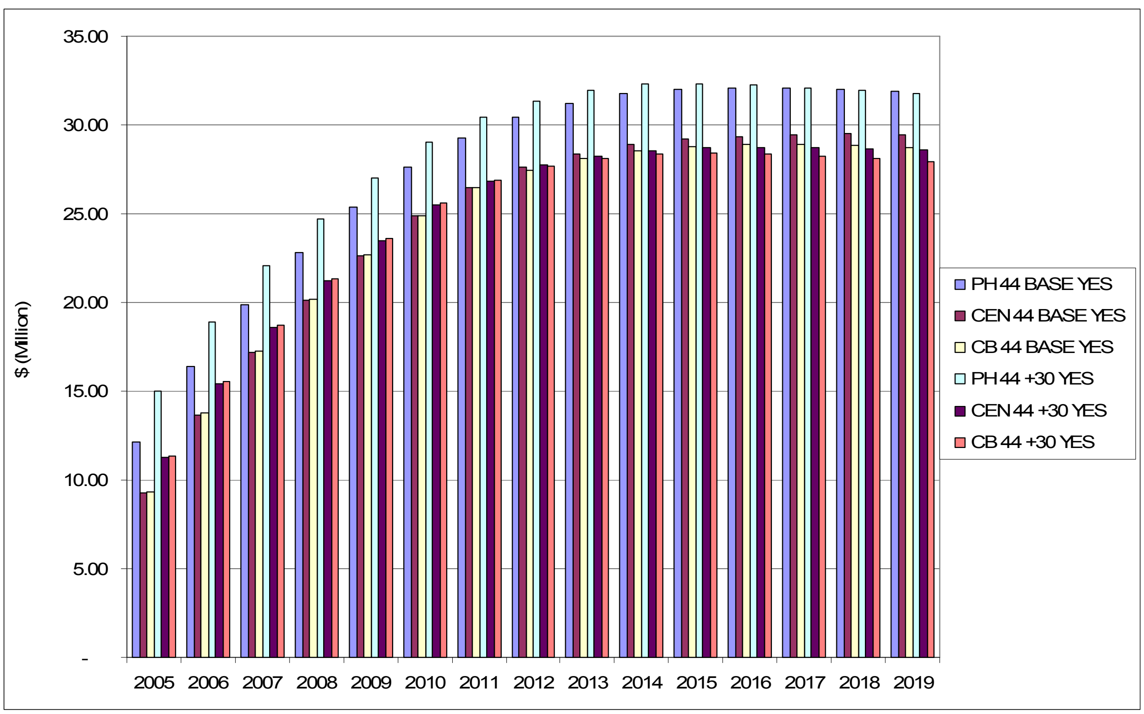

Figure 38. Projected average annual real net worth for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives

Note: See Table 17 on page 119 for definition of abbreviations

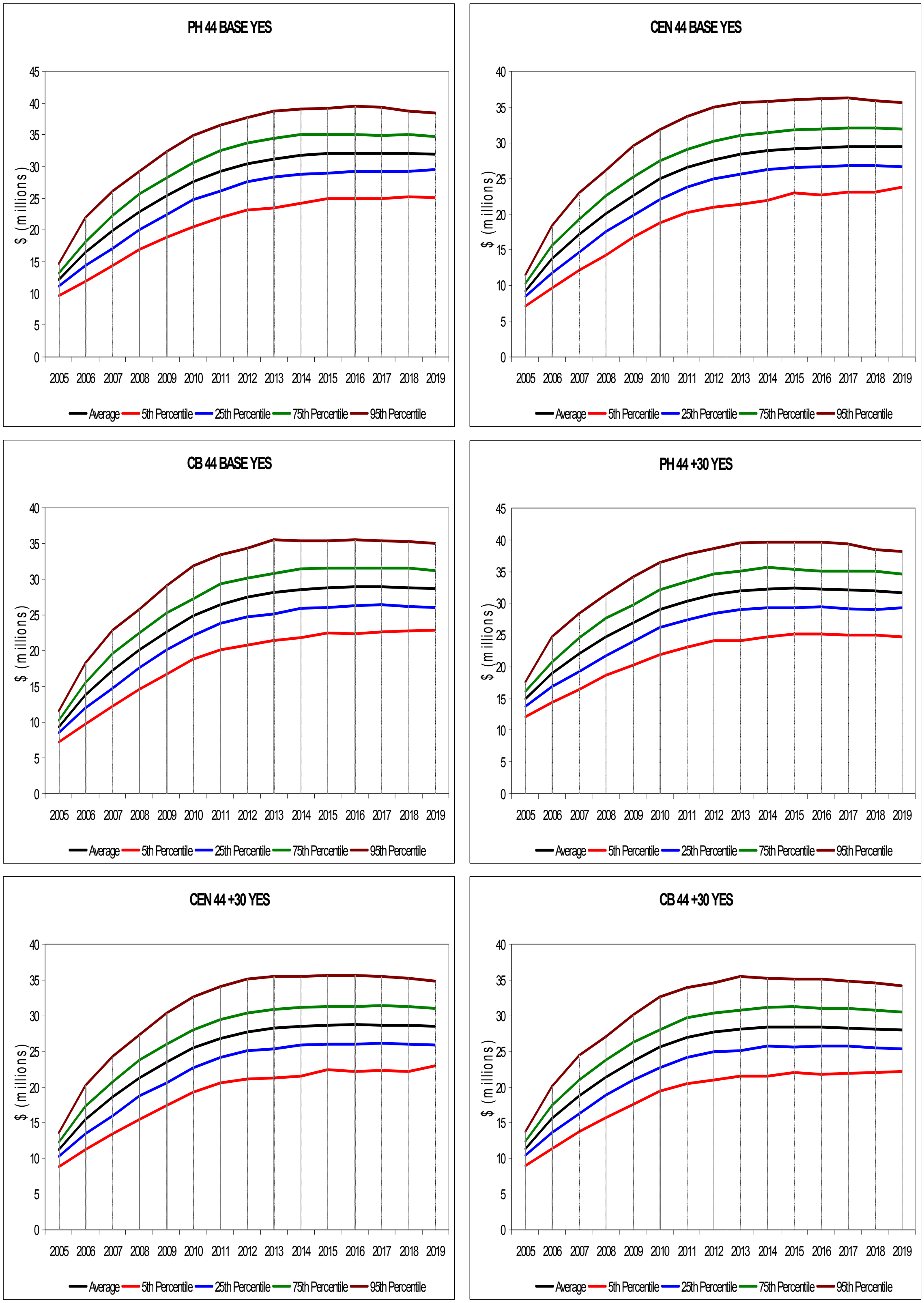

Figure 39. Projected annual real net worth risk for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives

Note: See Table 17 on page 119 for definition of abbreviations

Figure 39 presents the range and risk of the simulated average annual real net worth for scenarios in group two. Real net worth is projected to be positive and increase from 2005 to 2019 for all scenarios. In 2019 for the Base initial investment scenario, 90 percent of the simulated average real net worth are between $25.03 to $38.41 million, $23.79 million to $35.7 million, and $22.94 million to $34.94 million for the Panhandle, Central, and Coastal Bend Regions. For the Plus 30 initial investment scenario in 2019, ninety percent of the simulated average annual real net worth are between $24.75 million to $38.20 million for Panhandle Region, $22.92 million to $34.88 million for the Central Region, and $22.12 million to $34.21 million for the Coastal Bend Region.

Net Present Value

Figure 40 presents a CDF graph of NPV for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions with incentives. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for NPV is available in the Appendix C.

The CDF graph shows each scenario returns a positive net present value. A clear separation can be made between the Base and Plus 30 initial investment levels. For the Base initial investment scenario, the average NPVs are $41.26 million, $42.38 million, and $40.92 million for the Panhandle, Central, and Coastal Bend Regions. For the Plus 30 initial investment level scenario, the average NPVs are $35.91 million, $37.41 million, and $36.03 million for the Panhandle, Central, and Coastal Bend Regions, respectively. When comparing these NPVs to the corresponding NPVs with no incentives for the scenarios in group one, the average NPVs are higher as expected because of the tax abatements.

In the Base initial investment scenario, the Central Region (red line) returned the higher (farther to the right in the above graph) NPV values when compared to the Panhandle (black line) and Coastal Bend Regions (blue line). The Panhandle and Coastal Bend Regions CDF lines cross several times and the Panhandle and Central Region cross at the higher probability levels. Because the CDF lines cross for each scenario, one cannot say a certain region is strictly preferred to other regions when analyzing the CDF graph.

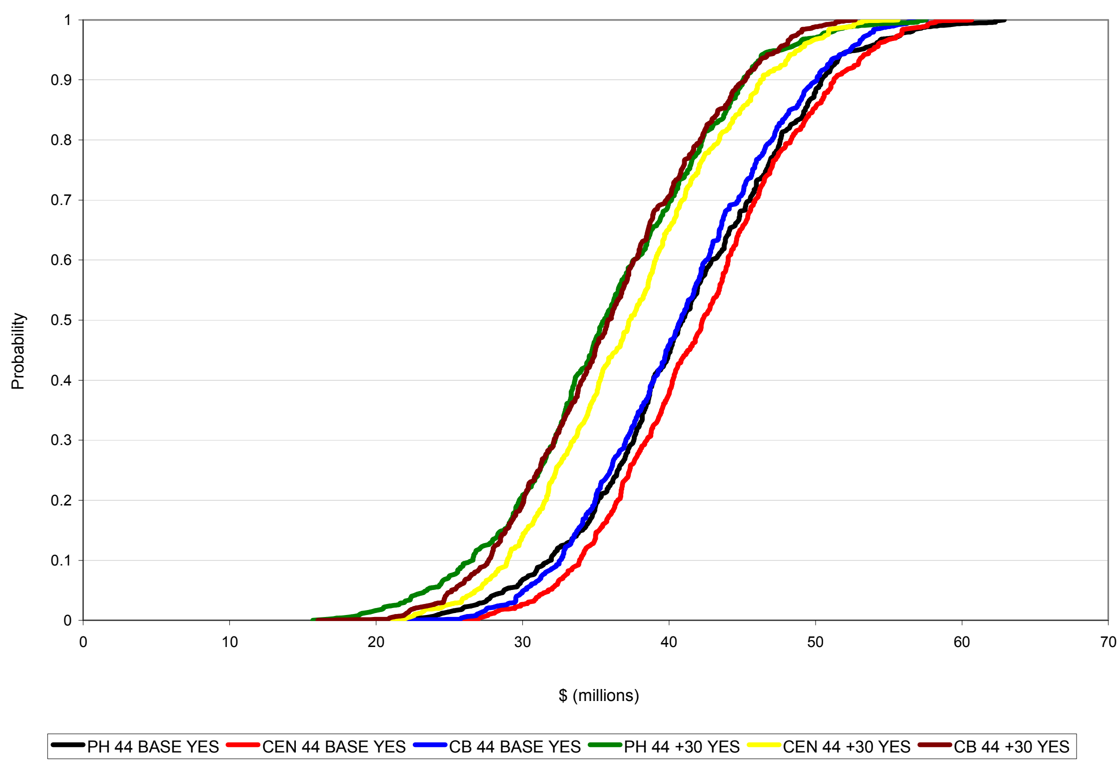

Figure 40. Cumulative density functions of net present value for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives

Note: See Table 17 on page 119 for definition of abbreviations

For the Plus 30 initial investment scenario, the Central Region (yellow line) returned the larger NPV values except for at the higher probability levels where it crosses the Panhandle Region line (green line). The Coastal Bend Region (maroon line) crosses the Panhandle line several times. All Plus 30 initial investment level scenarios are lower than the Base initial investment scenarios.

Figure 42 presents a SERF graph of NPV for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions with incentives. The graph shows different regions are preferred at alternative risk preferences. The certainty equivalent (CE) lines for the Base initial investment scenarios are above the Plus 30 CE lines as expected.

For risk loving decision makers with RACs smaller than -0.25, the Panhandle Region is preferred for the Base and Plus 30 initial investment levels. At the -0.25 and -0.21 RAC levels, the CE lines cross and decision makers are indifferent between the Panhandle and Central Regions. Decision makers with RACs between -0.21 and zero prefer the Central Region over the Panhandle and Coastal Bend Regions for the Base and Plus 30 initial investment levels. The Central Region is preferred over the Panhandle and Coastal Bend Regions for risk neutral and risk averse decision makers with the Coastal Bend Region being preferred over the Panhandle Region.

Table 19 presents the calculated risk premiums between the alternative scenarios for risk neutral (RAC of zero), moderately risk neutral (RAC of 0.2), and risk neutral decision makers (RAC of 0.4). The Central Region at the Base initial investment level is used as the base region for comparison to calculate the risk premiums.

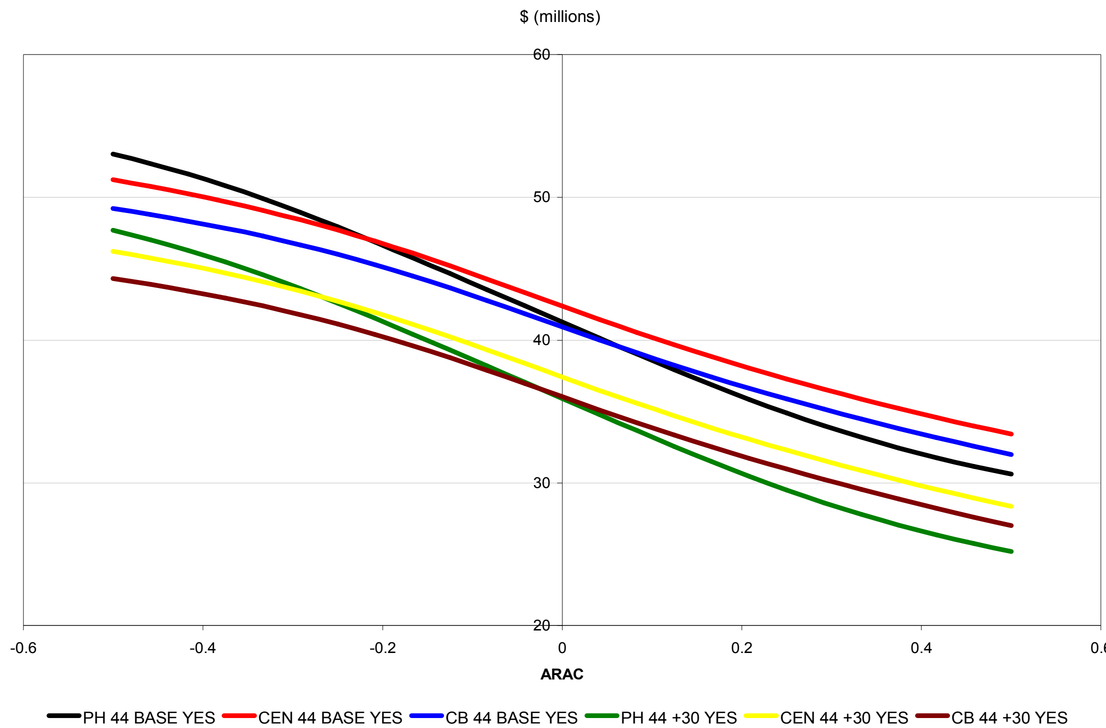

Figure 41. Stochastic efficiency with respect to a function graph of net present value for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives
Note: See Table 17 on page 119 for definition of abbreviations

Table 19. Risk Premiums for a 44 Ton/Hour MixAlco Production Facility in the Panhandle, Central, and Coastal Bend Regions at the Base and Plus 30 Investment Levels with Incentives

	Risk Neutral	Moderately Risk Averse	Risk Averse
		$ (millions)	
PH 44 BASE YES	(1.12)	(2.19)	(2.82)
CEN 44 BASE YES	-	-	-
CB 44 BASE YES	(1.46)	(1.40)	(1.40)
PH 44 +30 YES	(6.47)	(7.57)	(8.22)
CEN 44 +30 YES	(4.97)	(4.98)	(5.03)
CB 44 +30 YES	(6.35)	(6.32)	(6.36)

Note: See Table 17 on page 119 for definition of abbreviations

Risk neutral and risk averse decision makers prefer the CEN 44 BASE YES scenario over all other scenarios. Risk neutral decision makers would have to be paid $1.12 million to move from the preferred Central Region to the Panhandle Region and $1.46 million to move to the Coastal Bend Region at the Base initial investment scenario. The results for the Plus 30 initial investment scenario are similar where the Central Region is preferred.

For risk averse decision makers at the Base initial investment scenario, the Central Region is preferred and decision makers would have to be paid $2.82 million and $1.40 million to move to the Panhandle or Coastal Bend Regions. Similarly, the results for the Plus 30 initial investment scenario show the Central Region is preferred over the Panhandle and Coastal Bend Regions with larger risk premiums.

Group Three Simulation Results

Group three consist of scenarios for a 176 ton/hour production facility which does not receive incentives in the Panhandle, Central, or Coastal Bend Regions under the Base and Plus 30 initial investment levels. Comparisons between plants can be directly made because there are no incentives to affect the KOVs.

<u>Net Income</u>

Figure 42 presents the projected average annual net income in millions of dollars for each scenario in group three. The graph indicates each scenario follows the same pattern at different levels. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for net income is available in the Appendix D.

The Central Region returned the highest net income at the Base and Plus 30 initial investment level from 2005 to 2019. After 2010, the Coastal Bend Region had the lowest average annual net income for the Base and Plus 30 initial investment scenarios. This is because as plant size increases, the distance traveled to supply the required feedstock is greater because of the half ring caused by the shoreline.

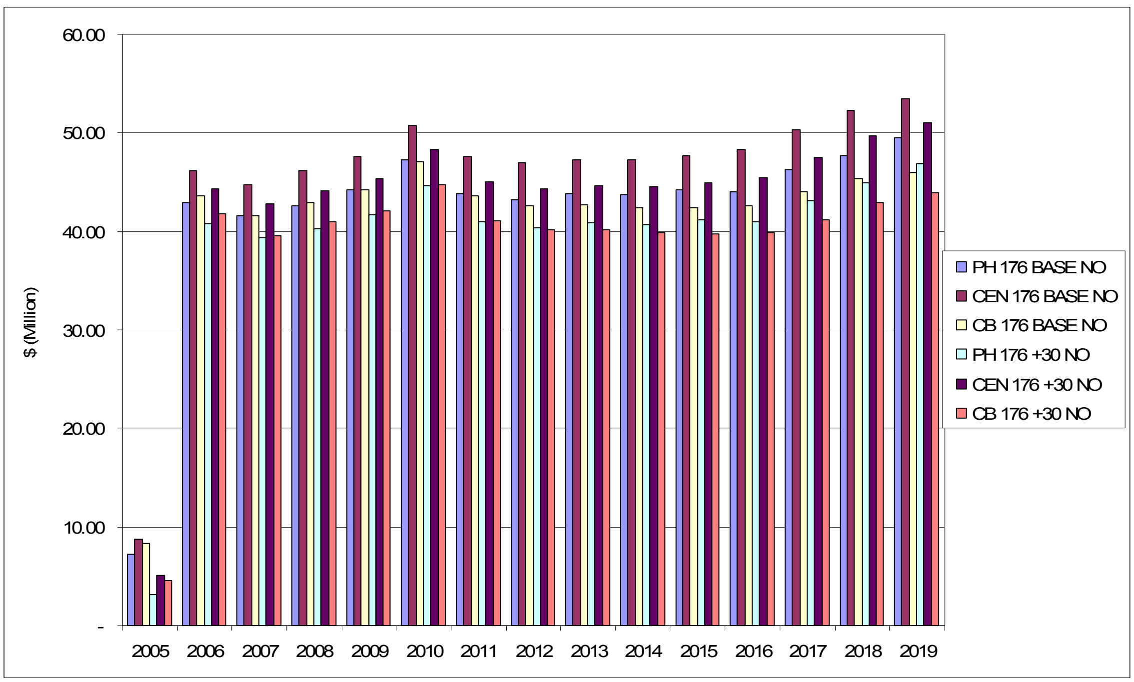

Figure 42. Projected average annual net income for a 176 Ton/Hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives
Note: See Table 17 on page 119 for definition of abbreviations

In 2005, the net income is below $10 million for each scenario. In 2006 for the Base initial investment level, the projected average annual net income is $42.93 million,

$46.16 million, and $43.61 million for the Panhandle, Central, and Coastal Bend Regions. The projected average annual net incomes for the Plus 30 initial investment level are $40.82 million, $44.33 million, and $41.84 million for the Panhandle, Central, and Coastal Bend Regions. Net income increases for all scenarios through 2019.

Figure 43 presents the range and risk of the simulated projected annual net incomes for scenarios in group two. The range and risk follow the same pattern in each region at different levels. In the Base initial investment scenarios, the probability of negative net income in 2005 is 32 percent, 23 percent, and 24 percent for Panhandle, Central, and Coastal Bend Regions. In the Plus 30 initial investment scenarios, the probability of negative net income increases to 46 percent for Panhandle Region, 37 percent for the Central Region, and 38 percent Coastal Bend Region. The probability of projected average annual net income being negative is one percent from 2006 to 2019 for all scenarios. The probability of negative net income in 2005 is greater for a 176 ton/hour production facility when compared to the 44 ton/hour production facility at the Base and Plus 30 initial investment levels.

Because of the large plant size and variability in prices, the simulated average annual net incomes returned a wide distribution. In 2019 for the Base initial investment level, 90 percent of the simulated average annual net incomes are between $9.49 million to $102.17 million for the Panhandle Region, $13.76 million to $99.31 million for the Central Region, and $6.43 million to $90.94 million for the Coastal Bend Region. The Pus 30 initial investment scenario lowers the 90 percent range for all three regions.

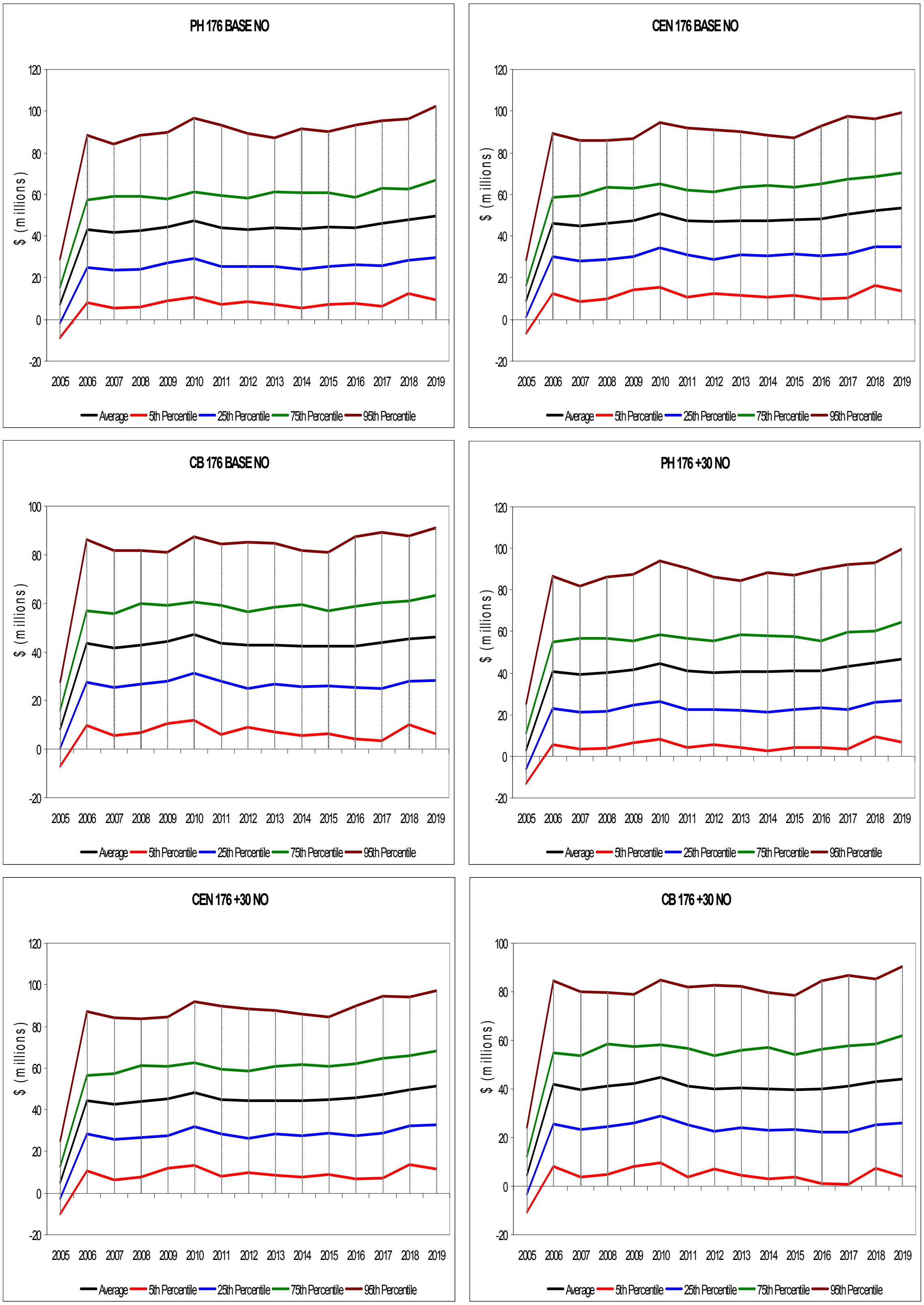

Figure 43. Projected average annual net income risk for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives

Note: See Table 17 on page 119 for definition of abbreviations

Ending Cash Balance

Figure 44 presents the projected average annual ending cash balances in millions of dollars for scenarios in group three. Ending cash increases each year with positive net income. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for net income is available in the Appendix D.

The projected average annual ending cash balance is greater in all Base initial investment scenarios than the Plus 30 initial investment level. Projected ending cash balance is highest for the Central Region in the Base and Plus 30 initial investment scenarios. The ending cash balance is lowest in the Panhandle Region at the Base and Plus 30 initial investment level. For the Base initial investment level in 2019, projected average annual ending cash balance is $225.78 million, $252.27 million, and $228.45 million for the Panhandle, Central, and Coastal Bend Regions. Ending cash balance follows the same pattern for the Plus 30 initial investment level except all values are lower from 2005 to 2019.

Figure 45 presents the range and risk of the projected average annual ending cash balances for scenarios in group three. Ending cash balance is similar for each region with the risk of ending cash balance increasing from 2005 to 2019. In 2005, the probability of negative average annual cash balance is 7 percent for the Panhandle Region and 4 percent for the Central and Coastal Bend Region for the Base initial investment scenario. The probability of negative ending cash balance increase for the Plus 30 initial investment level to 11 percent for the Panhandle Region and 7 percent for the Central and Coastal Bend Regions.

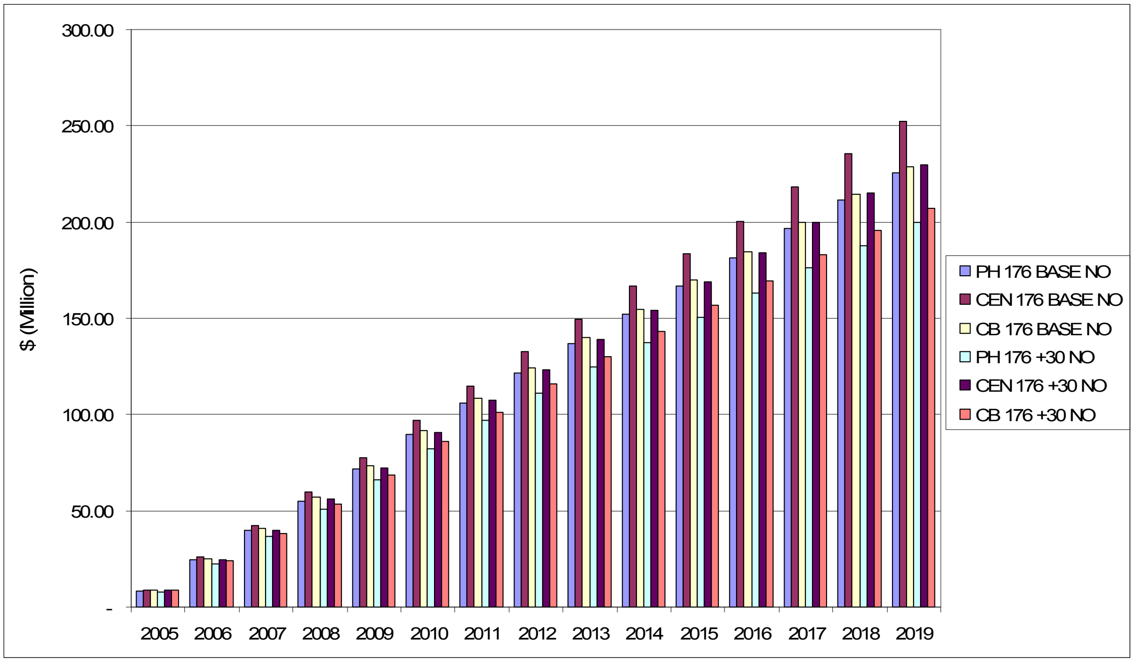

Figure 44. Projected average annual ending cash balance for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives
Note: See Table 17 on page 119 for definition of abbreviations

Ninety percent of the simulated average annual ending cash balances in 2019 for the Base initial investment scenario are between $150.34 million to $300.1 million, $186.18 million to $323.83 million, and $162.37 million to $298.79 million for the Panhandle, Central, and Coastal Bend Regions. For the Plus 30 initial investment level in 2019, ninety percent of the projected average annual ending cash balance are between $125.03 million to $274.51 million, $162.37 million to $302.18 million, and $139.34 million to $278.34 million for the Panhandle, Central, and Coastal Bend Regions, respectively. The projected average annual ending cash balances are lower for the Plus 30 initial investment level as expected.

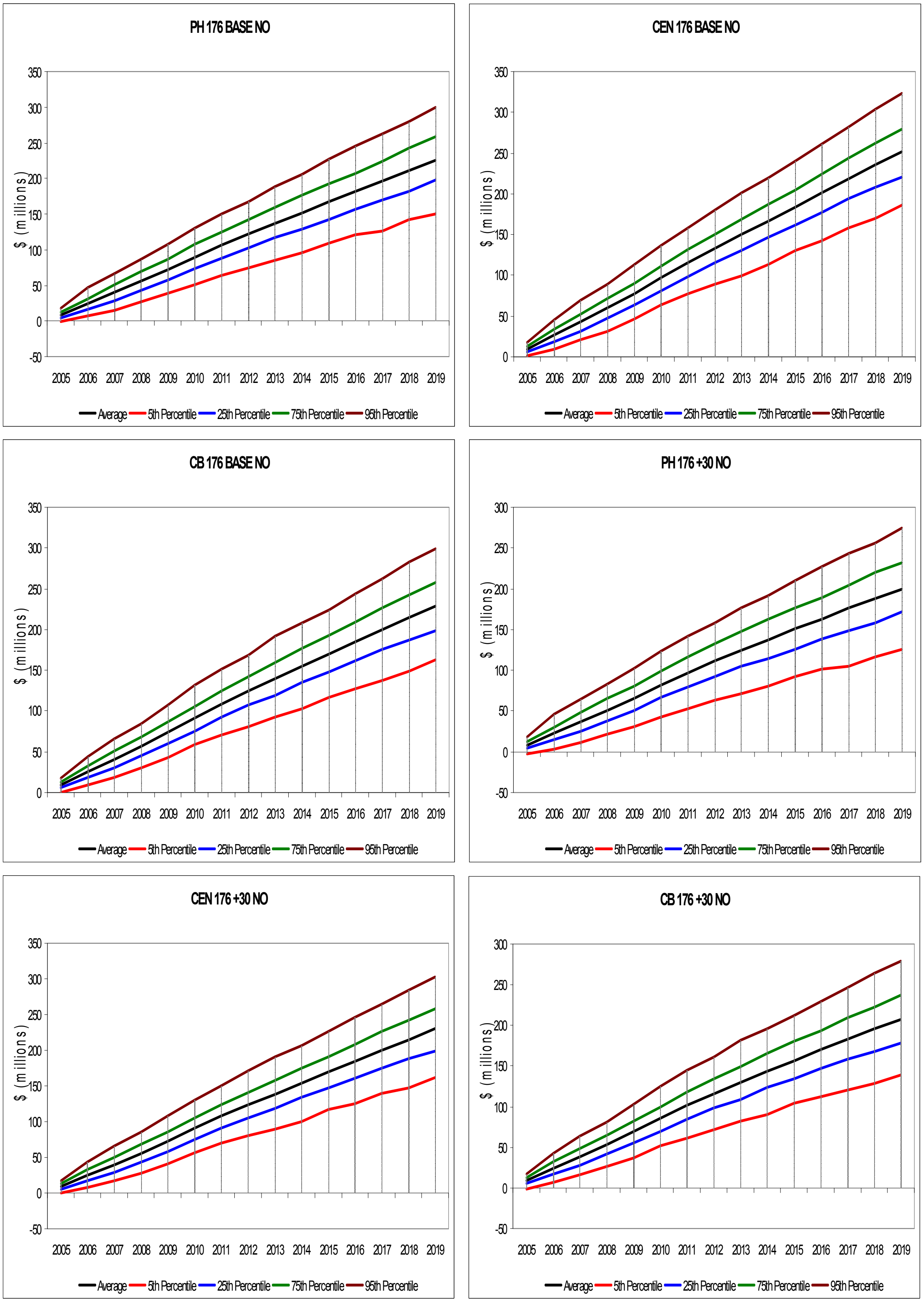

Figure 45. Projected average annual ending cash balance risk for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives

Note: See Table 17 on page 119 for definition of abbreviations

Dividends Paid

Figure 46 presents the projected average annual dividends paid for each scenario in group three. The projected average annual dividends paid are highest for the Base initial investment scenario when compared to the Plus 30 initial investment level. The Central Region returns the highest dividends paid for the Base and Plus 30 initial investment scenarios. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for dividends paid is available in the Appendix D.

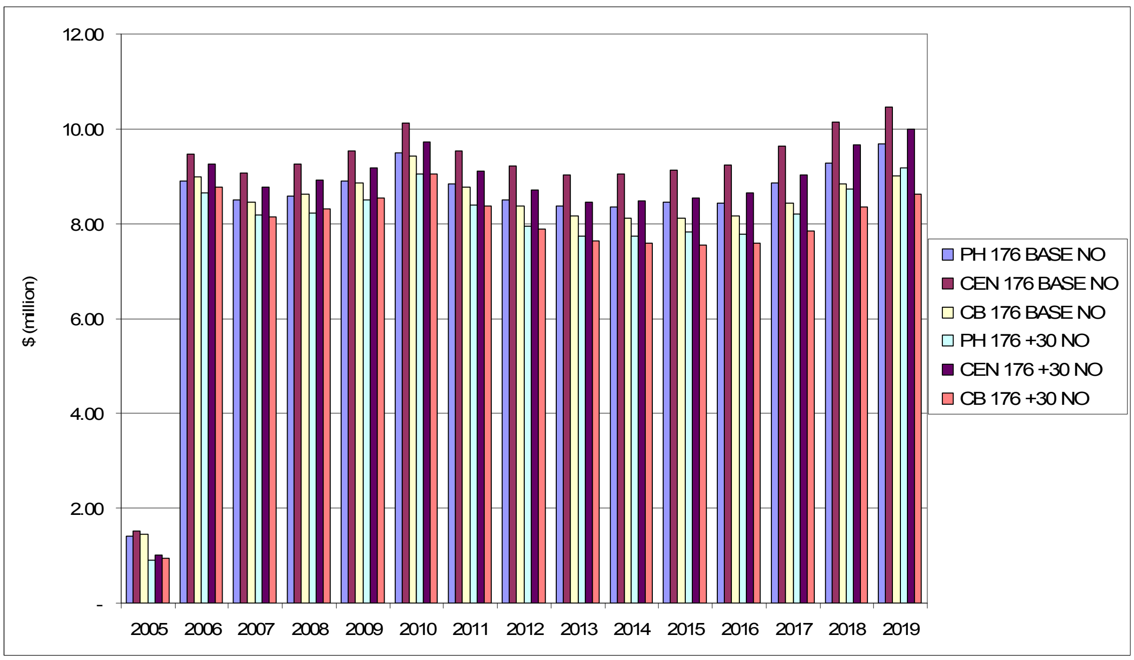

Figure 46. Projected average annual dividends paid for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives
Note: See Table 17 on page 119 for definition of abbreviations

Projected average annual dividends paid are lowest in the Panhandle Region in the early years and lowest in the Coastal Bend Region in the later years. In 2019 for the

Base initial investment scenario, the average annual dividends paid is $9.68 million, $10.45 million, and $9.01 million for the Panhandle, Central, and Coastal Bend Regions. For the Plus 30 initial investment level in 2019, projected average annual dividends paid are $9.18 million, $10 million, and $8.63 million for the Panhandle, Central, and Coastal Bend Regions.

Figure 47 presents the range and risk of the simulated average annual dividends paid for scenarios in group three. In 2005, the probability of dividends paid is 59, 68 and 66 percent for the Base initial investment scenario for the Panhandle, Central, and Coastal Bend Regions, respectively. For the Plus 30 initial investment scenario in 2005, the probability of dividends paid is 45, 44, and 48 percent for the Panhandle, Central, and Coastal Bend Regions. After 2005, the probability of dividends paid is 99 percent.

For the Base initial investment Scenario in 2019, ninety percent of the simulated average annual dividends paid are between $1.88 million to $19.92 million, $2.73 million to $19.38 million, and $1.29 to $17.75 million for the Panhandle, Central and Coastal Bend Regions for the Base initial investment scenario. In the Plus 30 initial investment scenario for 2019, ninety percent of the simulated average annual dividends paid range from $1.36 million to $19.741 million, $2.26 million to $18.93 million, and $0.84 million to $17.67 million for the Panhandle, Central, and Coastal Bend Regions, respectively.

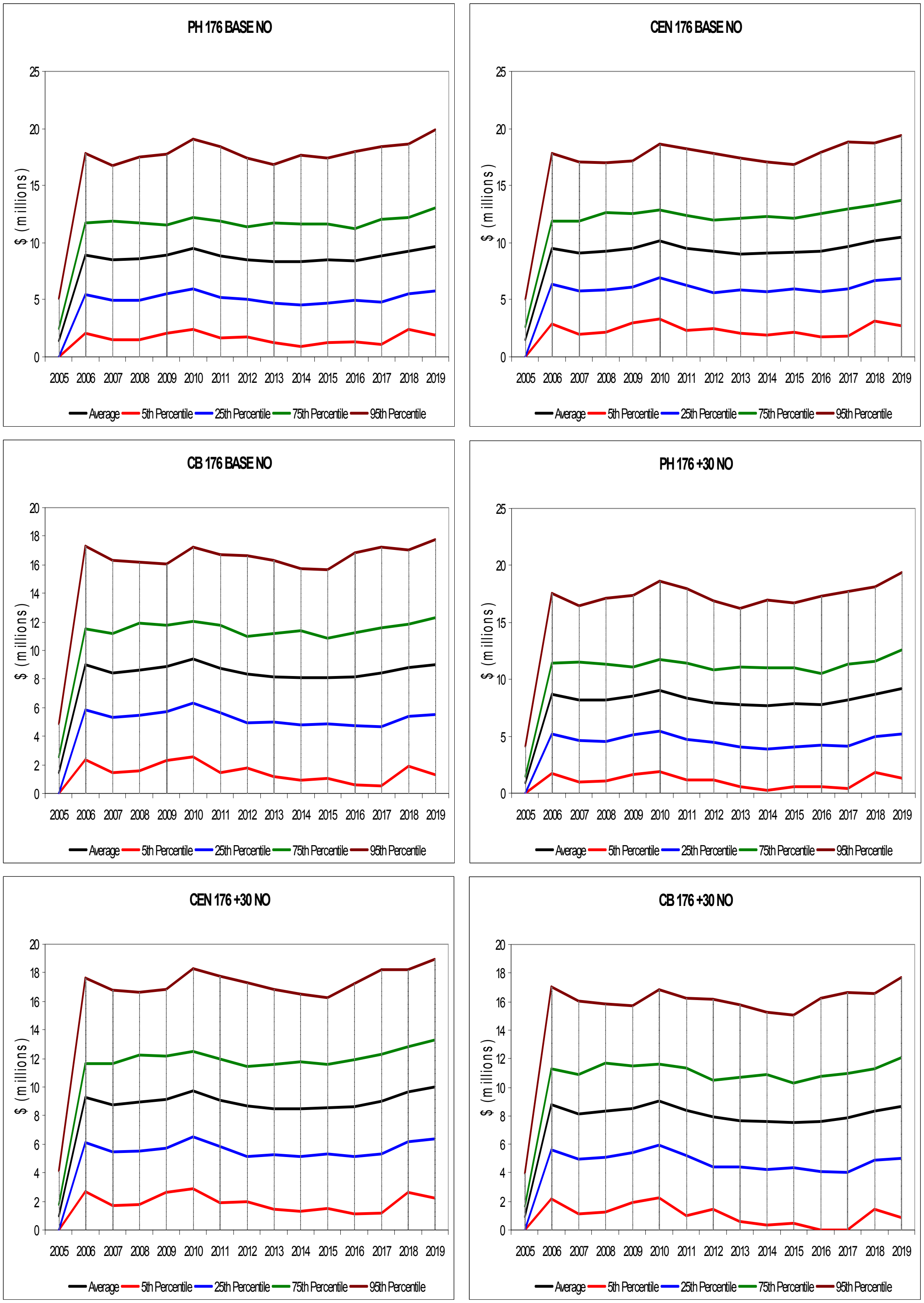

Figure 47. Projected average annual dividends paid risk for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives

Note: See Table 17 on page 119 for definition of abbreviations

Real Net Worth

Figure 48 presents the projected average real net worth for scenarios in group three. The projected average real net worth increases and flattens out after year 2014. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for real net worth is available in the Appendix D.

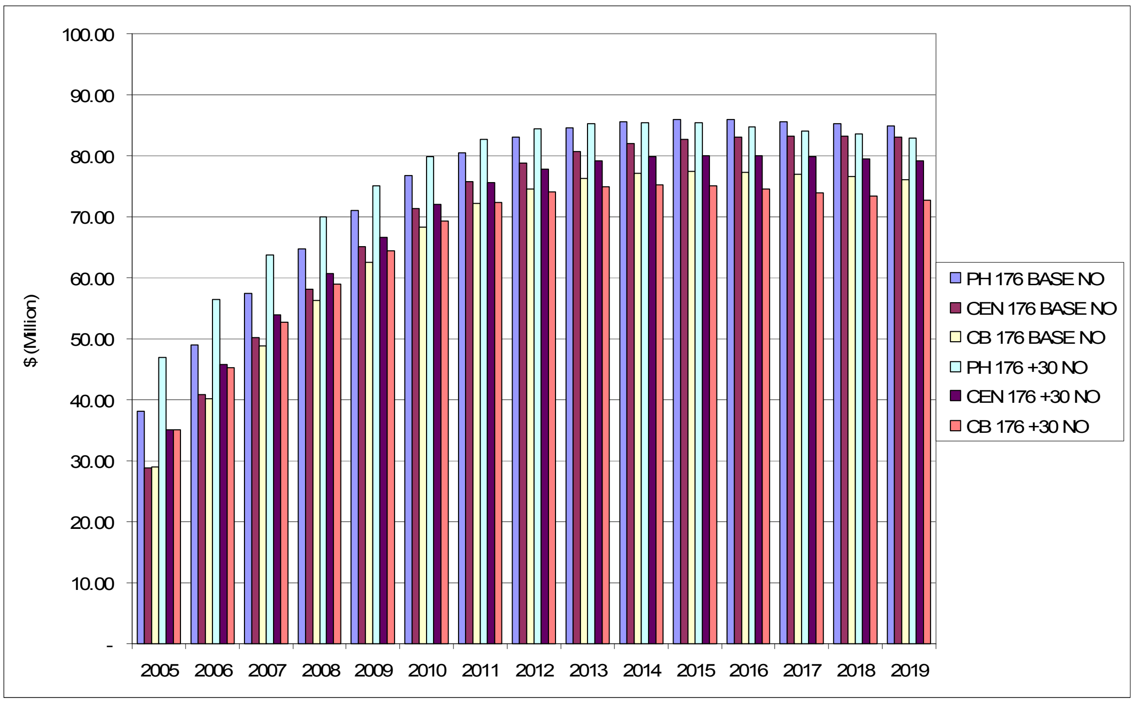

Figure 48. Projected average annual real net worth for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives
Note: See Table 17 on page 119 for definition of abbreviations

Projected average real net worth is highest in the Panhandle Region as the initial equity requirement is higher due to the required purchase of water rights in the region. For the 176 ton/hour facility, water rights cost approximately $18 million. For the Panhandle Region, the projected average real net worth increases from $38.08 million in

2005 to $84.83 million in 2019 for the Base initial investment scenario. For the Plus 30 initial investment scenario, real net worth increases from $46.96 million in 2005 to $82.92 million in 2019.

The Coastal Bend Region returned the lowest average real net worth in the Base and Plus 30 initial investment levels because average annual dividends paid are lower. Average real net worth for the Coastal Bend Region in 2019 is $76.04 million for the Base initial investment scenario and $72.67 million for the Plus 30 initial investment level.

Figure 49 presents the range and risk of the simulated average real net worth for scenarios in group three. Real net worth is projected to be positive from 2005 to 2019 for all scenarios. The probability of real net worth being negative is less than 1 percent from 2005 to 2019 for all scenarios in group three.

In 2019 for the Base initial investment scenario, 90 percent of the simulated average real net worth value are between $62.81 million to $106.53 million, $63.7 million to $103.88 million, and $56.75 million to $96.57 million for the Panhandle, Central, and Coastal Bend Regions. The range decreases for the Plus 30 initial investment scenario. In 2019, ninety percent of the simulated average real net worth values are between $61.11 million to $104.74 million for Panhandle Region, $59.56 million to $100.36 million for the Central Region, and $52.83 million to $93.52 million for the Coastal Bend Region.

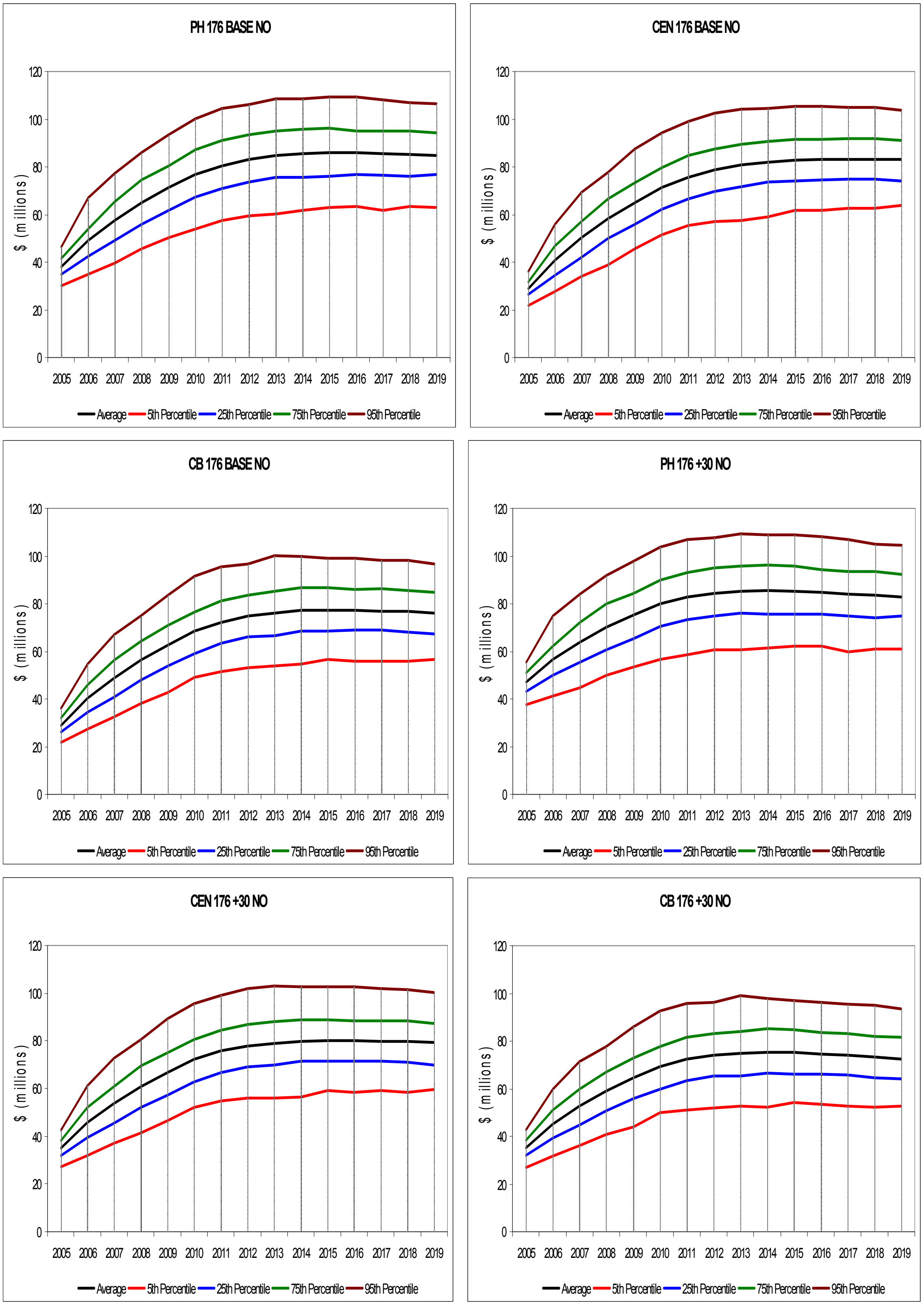

Figure 49. Projected annual real net worth risk for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives
Note: See Table 17 on page 119 for definition of abbreviations

Net Present Value

Figure 50 presents a CDF graph of NPV for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions with no incentives. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for NPV is available in the Appendix D.

The CDF graph shows each scenario returns a positive net present value. A clear distinction can be made between the Base and Plus 30 initial investment levels. For the Base initial investment scenario, the average NPVs are $103.43 million, $117.07 million, and $104.29 million for the Panhandle, Central, and Coastal Bend Regions. For the Plus 30 initial investment level scenario, the average NPVs are $84.39 million, $99.66 million, and $87.43 million for the Panhandle, Central, and Coastal Bend Regions, respectively.

In the Base initial investment scenario, the Central Region (red line) returned the larger (farther to the right in the above graph) NPV values when compared to the Panhandle (black line) and Coastal Bend Regions (blue line). The Panhandle and Coastal Bend Regions CDF lines cross several times. Because the CDF lines cross for each scenario, no is strictly preferred to the alternative regions when analyzing the CDF graph.

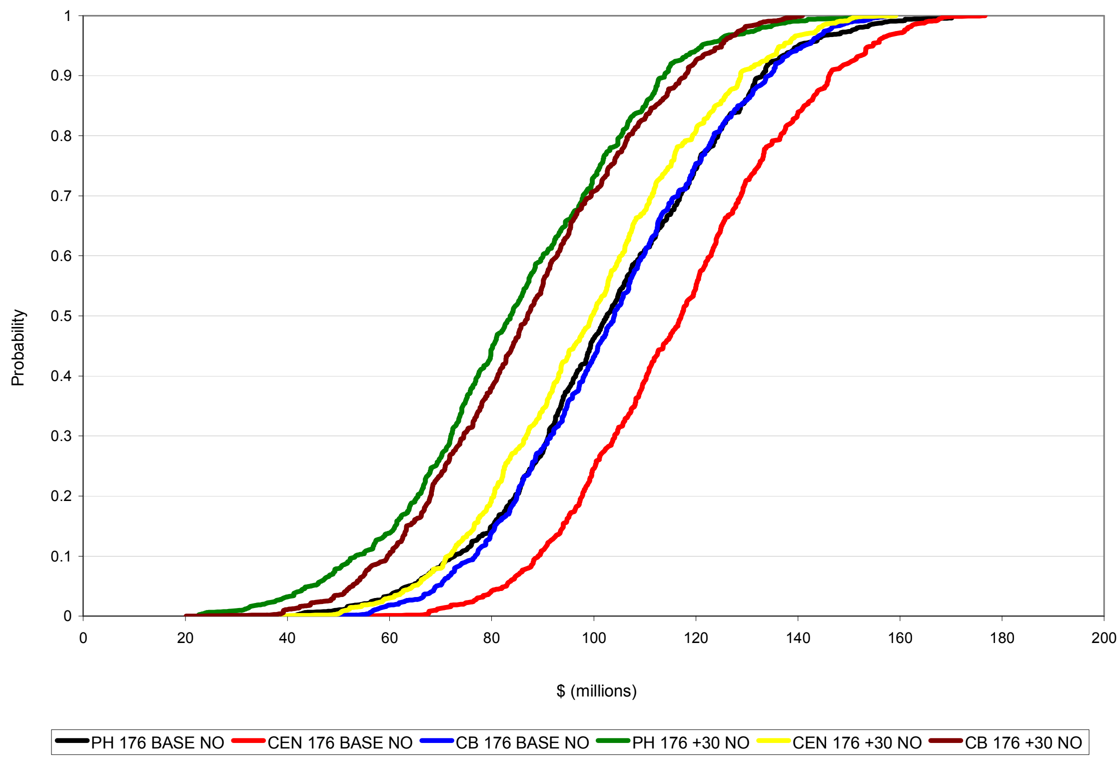

Figure 50. Cumulative density functions of net present value for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives
Note: See Table 17 on page 119 for definition of abbreviations

For the Plus 30 initial investment scenario, the Central Region (yellow line) returned the higher NPV. The Coastal Bend Region (maroon line) crosses the Panhandle line several times. At the Plus 30 initial investment scenario level, the Central Region CDF line is very close to the Panhandle and Coastal Bend Regions at the Base initial investment scenario. At a 30 percent higher initial investment cost, the Central Region could be preferred to the Panhandle and Coastal Bend Regions with lower initial investment costs.

Figure 51 presents a SERF graph of NPV for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions with no incentives. The graph shows different regions are preferred under alternative risk preferences. The certainty equivalent (CE) lines for the Base initial investment scenarios are above the Plus 30 CE lines as expected. The upper and lower limit RACs are -0.2 for risk loving decision makers and 0.2 for risk averse decision makers and were determined using equation 14 (McCarl and Bessler, 1989).

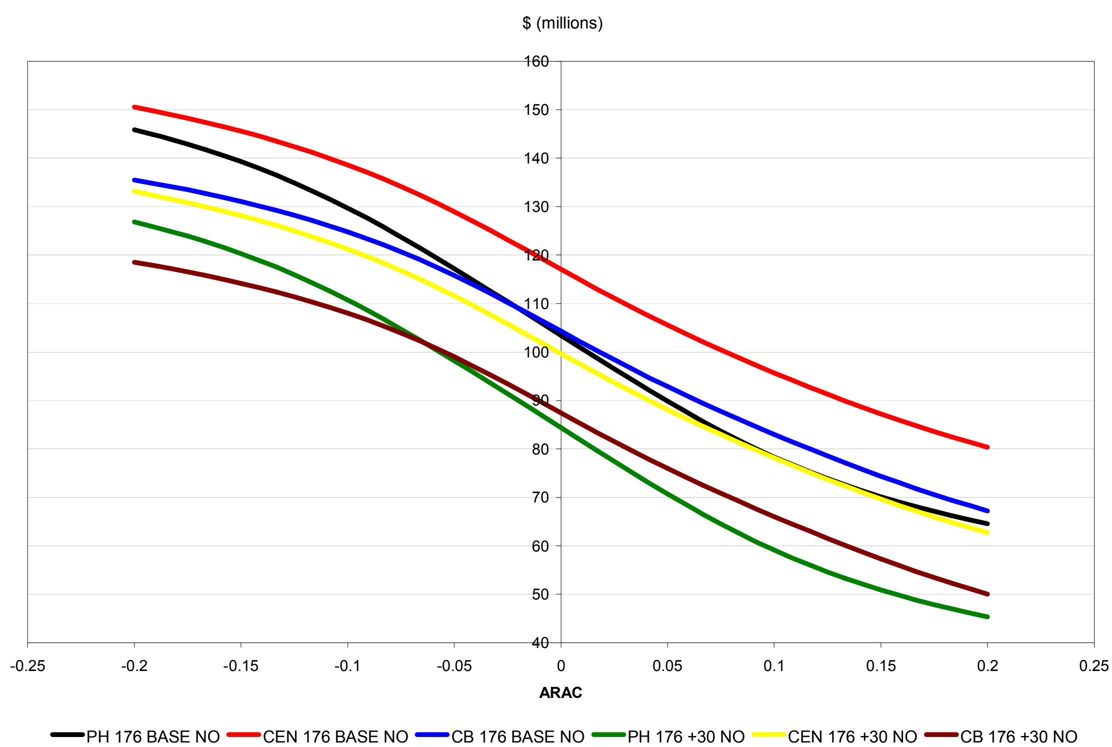

Figure 51. Stochastic efficiency with respect to a function graph of net present value for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives

Note: See Table 17 on page 119 for definition of abbreviations

For all RAC levels, risk loving decision makers prefer the Central Region to the Panhandle and Coastal Bend Regions for the Base and Plus 30 initial investment levels. At the -0.012 and -0.05 RAC levels, the CE lines cross and decision makers are indifferent between the Panhandle and Coastal Bend Regions for the Base and Plus 30 initial investment scenarios. For RACs larger than -0.012, the Coastal Bend Region is preferred over the Panhandle Region for the Base and Plus 30 initial investment levels. One interesting observation can be made, at RAC values greater than 0.1, decision makers are almost indifferent between the Central Region at the Plus 30 initial investment level and the Panhandle Region at the Base initial investment level.

Table 20 presents the calculated risk premiums between the alternative scenarios for risk neutral (RAC of zero), moderately risk neutral (RAC of 0.05), and risk neutral decision makers (RAC of 0.15). The Central Region at the Base initial investment level is used as the base region for comparison to calculate the risk premiums.

The risk premiums show the Central Region is preferred to the Panhandle and Coastal Bend Regions for all risk aversion levels for the Base and Plus 30 initial investment levels. Risk neutral decision makers would have to be paid $13.64 million to be indifferent between the preferred Central Region and the Panhandle Region for the Base initial investment scenario. For moderately risk averse decisions makers, the risk premium increases to $15.71 million. The results for the Plus 30 initial investment scenario are similar where the Central Region is preferred.

The rankings of alternative scenarios are the same for risk averse decision makers. For decision makers to be indifferent between the Central Region and the

Panhandle and Coastal Bend Regions, decision makers would have to be paid $17.08 million and $12.87 million for the Base initial investment scenario. For the Plus 30 initial investment scenario, the results are similar where the Central Region is preferred.

Table 20. Risk Premiums for a 176 Ton/Hour MixAlco Production Facility in the Panhandle, Central, and Coastal Bend Regions at the Base and Plus 30 Investment Levels with No Incentives

	Risk Neutral	Moderately Risk Averse	Risk Averse
		$ (millions)	
PH 176 BASE NO	(13.64)	(15.71)	(17.08)
CEN 176 BASE NO	-	-	-
CB 176 BASE NO	(12.78)	(12.68)	(12.87)
PH 176 +30 NO	(32.67)	(34.85)	(36.31)
CEN 176 +30 NO	(17.40)	(17.46)	(17.59)
CB 176 +30 NO	(29.64)	(29.59)	(29.94)

Note: See Table 17 on page 119 for definition of abbreviations

Group Four Simulation Results

Group four consist of scenarios for a 176 ton/hour production facility with incentives in the Panhandle, Central, or Coastal Bend Regions under the Base and Plus 30 initial investment levels. Most incentives are tax abatements, which does not affect net income or dividends paid but does directly affect ending cash balance, real net worth, and net present value.

<u>Net Income</u>

Figure 52 presents the projected average annual net income in millions of dollars for scenarios in group four. The graph indicates each scenario follows the same pattern at different levels and are similar to the results for scenarios in group three. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for net income is available in the Appendix D.

The Central Region returned the highest net income at the Base and Plus 30 initial investment level from 2005 to 1019. The Coastal Bend Region had the lowest average annual net income for the Base and Plus 30 initial investment scenarios after 2010. This is because as plant size increases, the distance traveled to supply the required feedstock is greater because of the half ring caused by the shoreline.

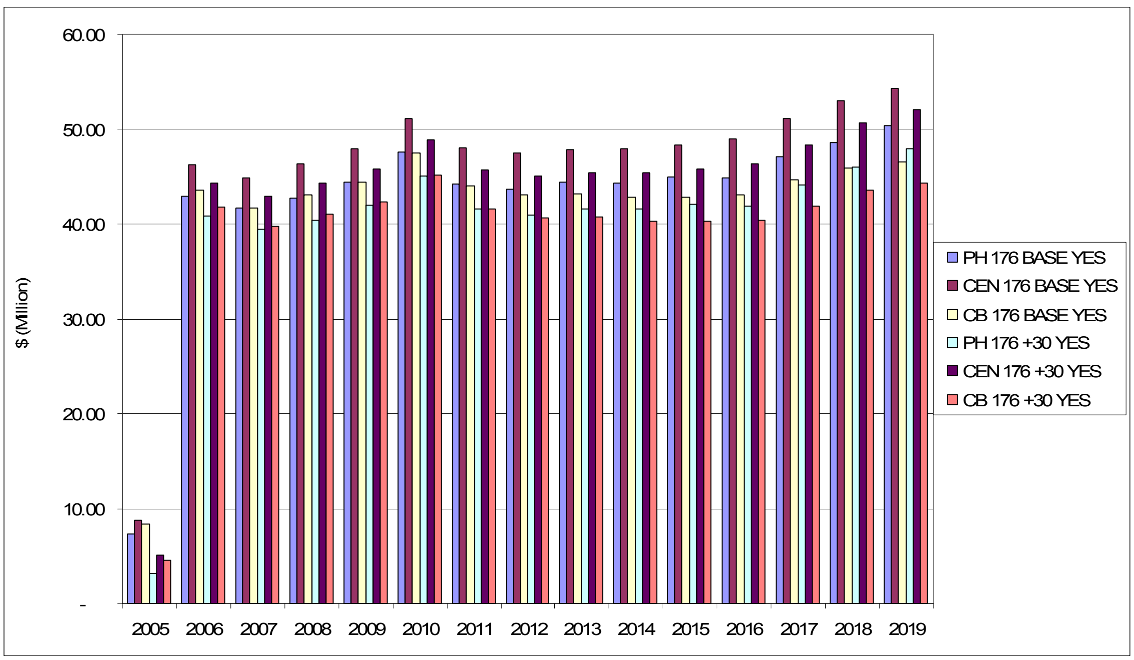

Figure 52. Projected average annual net income for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives
Note: See Table 17 on page 119 for definition of abbreviations

In 2005, the net income is below $10 million for all scenarios. In 2006 for the Base initial investment scenario, net income is $42.97 million, $46.2 million, and $43.65 million for the Panhandle, Central, and Coastal Bend Regions. For the Plus 30 initial investment level, the projected average annual net incomes are $40.86 million, $44.38 million, and $41.83 million for the Panhandle, Central, and Coastal Bend Regions. Net income remains at the same level or increases for all scenarios through 2019.

Figure 53 presents the range and risk of the simulated projected annual net incomes for scenarios in group two. The range and risk follow the same pattern in each region. The probability of negative net income occurs mainly in the first year of the analysis and the probability of negative net income is greater for all Plus 30 initial investment levels. In the Base initial investment scenarios, the probability of negative net income in 2005 is 32 percent, 23 percent, and 24 percent for Panhandle, Central, and Coastal Bend Regions. In the Plus 30 initial investment scenarios, the probability of negative net income increases to 46 percent for the Panhandle, 37 percent for the Central Region, and 38 percent for the Coastal Bend Regions. The probability of projected average annual net income being negative is approximately 1 percent from 2006 to 2019 for all scenarios.

Because of the large plant size and variability in prices, the simulated average annual net incomes returned a wide range. In 2019 for the Base initial investment level, the 90 percent of the simulated average annual net income values are between $10.33 million to $102.99 million for the Panhandle Region, $14.55 million to $100.11 million for the Central Region, and $7.03 million to $91.53 million for the Coastal Bend Region. The Plus 30 initial investment scenario lowers the 90 percent range for all three regions.

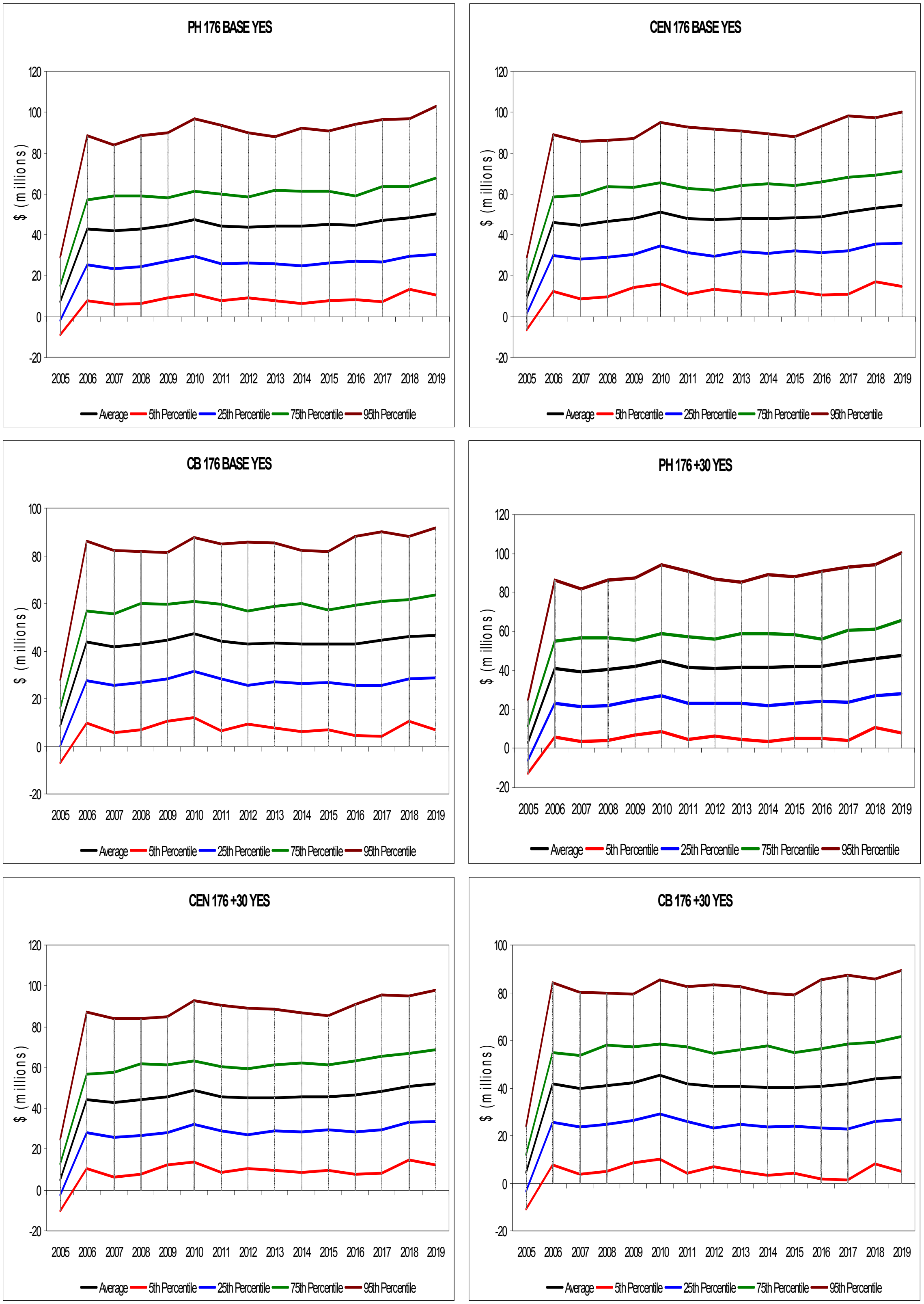

Figure 53. Projected average annual net income risk for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives

Note: See Table 17 on page 119 for definition of abbreviations

Ending Cash Balance

Figure 54 presents the projected average annual ending cash balances in millions of dollars for scenarios in group four. Ending cash increases each year as expected with positive net income. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for ending cash balance is available in the Appendix E.

The projected average annual ending cash balance is greater in all Base initial investment scenarios than Plus 30 initial investment level. Long-term loan principle payments, corporate taxes, property taxes, franchise tax, capital improvement expenditure, and dividends are higher as a result of the higher initial investment level. The incentive packages and property tax rates are different in each region.

The projected average ending end cash balance results for all scenarios follow a similar pattern at different magnitudes. Projected ending cash balance is highest for the Central Region in the Base and Plus 30 initial investment scenarios and lowest in the Panhandle Regions. For the Base initial investment level in 2019, projected average annual ending cash balance is $242.33 million, $267.63 million, and $240.28 million for the Panhandle, Central, and Coastal Bend Regions. Projected average annual ending cash balance follows the same pattern for the Plus 30 initial investment level except all values are lower from 2005 to 2019. The projected average annual ending cash balances are greater than the corresponding scenarios with no incentives in group three.

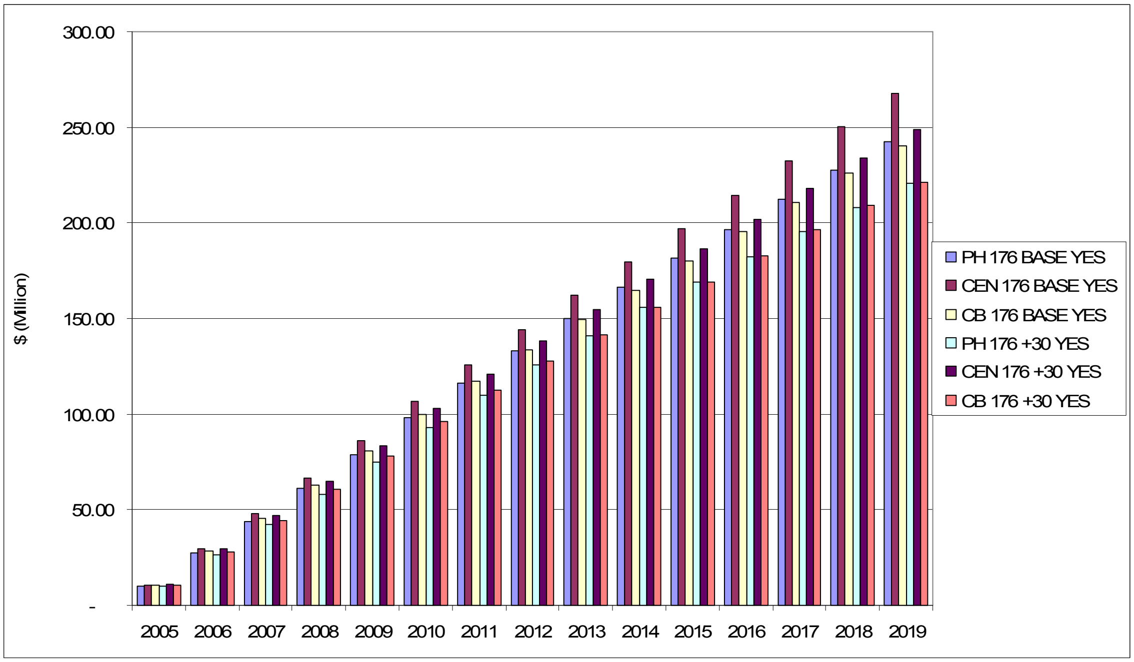

Figure 54. Projected average annual ending cash balance for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives

Note: See Table 17 on page 119 for definition of abbreviations

Figure 55 presents the range and risk of the projected average annual ending cash balances for scenarios in group four. In 2005, the probability of negative average annual cash balance being negative is 4 percent for the Panhandle Region and 3 percent for the Central and Coastal Bend Region for the Base initial investment scenario. The probability of negative ending cash balance increase for the Plus 30 initial investment level to 7 percent for the Panhandle Region and 4 percent for the Central and Coastal Bend Regions. The projected average annual ending cash balances are lower for the Plus 30 initial investment level as expected.

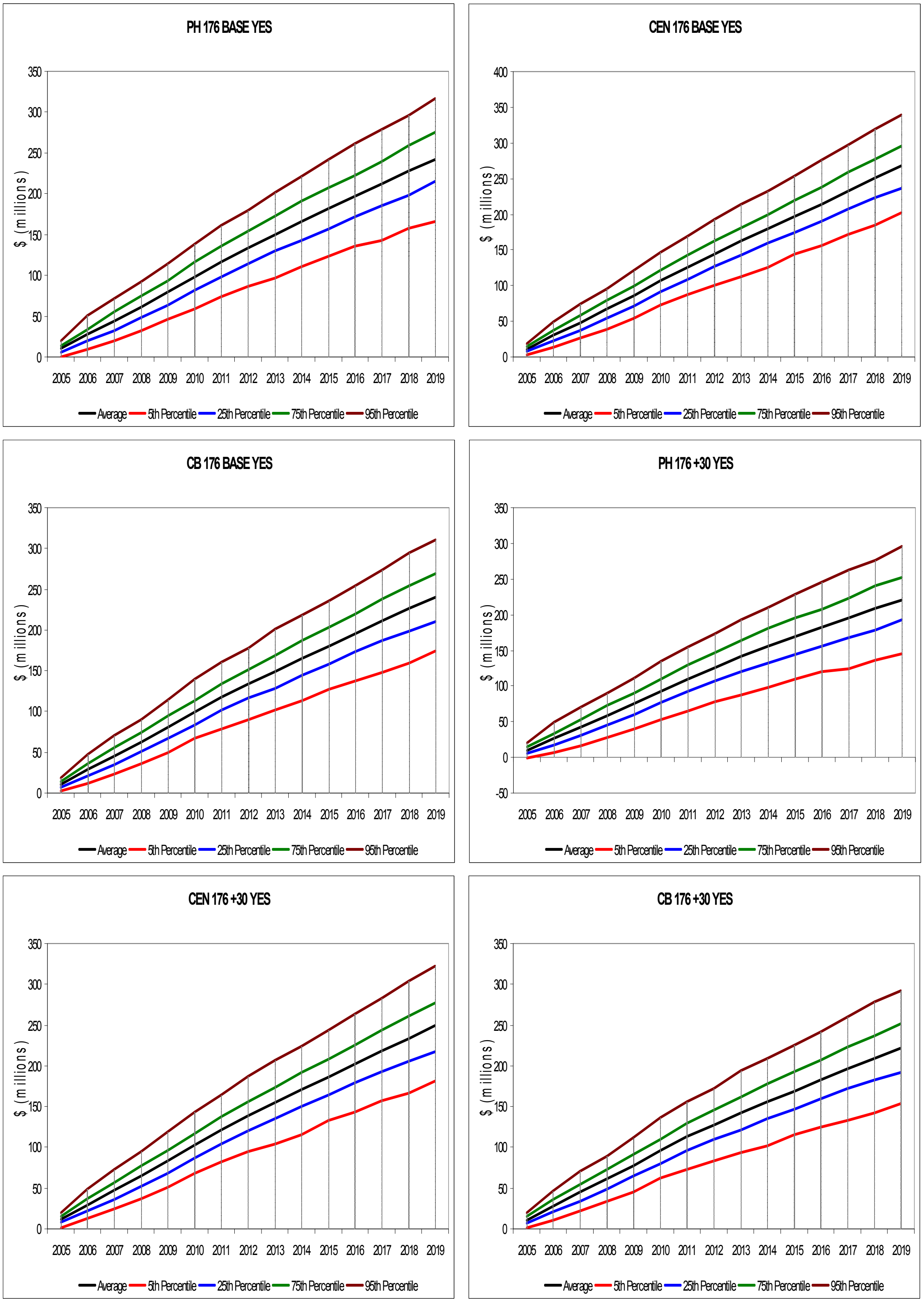

Figure 55. Projected average annual ending cash balance risk for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with no incentives
Note: See Table 17 on page 119 for definition of abbreviations

Ninety percent of the simulated average annual ending cash balances in 2019 for the Base initial investment scenario are between \$166.30 million to \$317.07 million, \$201.35 million to \$339.63 million, and \$173.85 million to \$310.99 million for the Panhandle, Central, and Coastal Bend Regions. For the Plus 30 initial investment level in 2019, ninety percent of the projected average annual ending cash balance are between \$145.61 million to \$295.73 million, \$181.51 million to \$321.84 million, and \$153.85 million to \$292.57 million for the Panhandle, Central, and Coastal Bend Regions, respectively.

Dividends Paid

Figure 56 presents the projected average annual dividends paid for each scenario in group four. The projected average annual dividends paid are highest for the Base initial investment scenario when compared to the Plus 30 initial investment level. The Central Region returns the highest dividends for the Base and Plus 30 initial investment scenarios. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for dividends paid is available in the Appendix E.

Projected average annual dividends paid are lowest in the Panhandle Region in the early years and lowest in the Coastal Bend Region in the later years. In 2019 for the Base initial investment scenario, average annual dividends paid are \$9.84 million, \$10.60 million, and \$9.13 million for the Panhandle, Central, and Coastal Bend Regions. For the Plus 30 initial investment level, projected average annual dividends paid are lower in 2019 at \$9.38 million, \$10.19 million, and \$8.72 million for the Panhandle, Central, and Coastal Bend Regions.

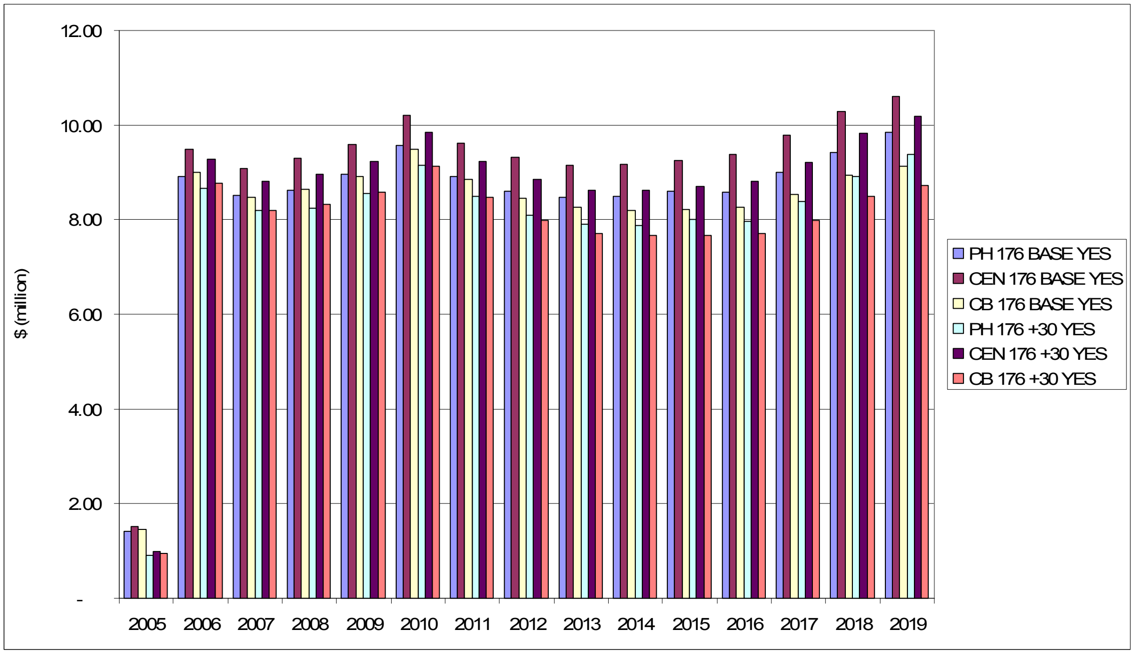

Figure 56. Projected average annual dividends paid for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives

Note: See Table 17 on page 119 for definition of abbreviations

Figure 57 presents the range and risk of the simulated average annual dividends paid for scenarios in group three. In 2005, the probability of receiving dividends is 59, 68 and 66 percent in the Base initial investment scenario for the Panhandle, Central, and Coastal Bend Regions, respectively. For the Plus 30 initial investment scenario in 2005, the probability of receiving dividends is 45 percent for the Panhandle Region and 48 percent for the Central and Coastal Bend Regions. After 2005, the probability of dividends paid being greater than zero is 99 percent.

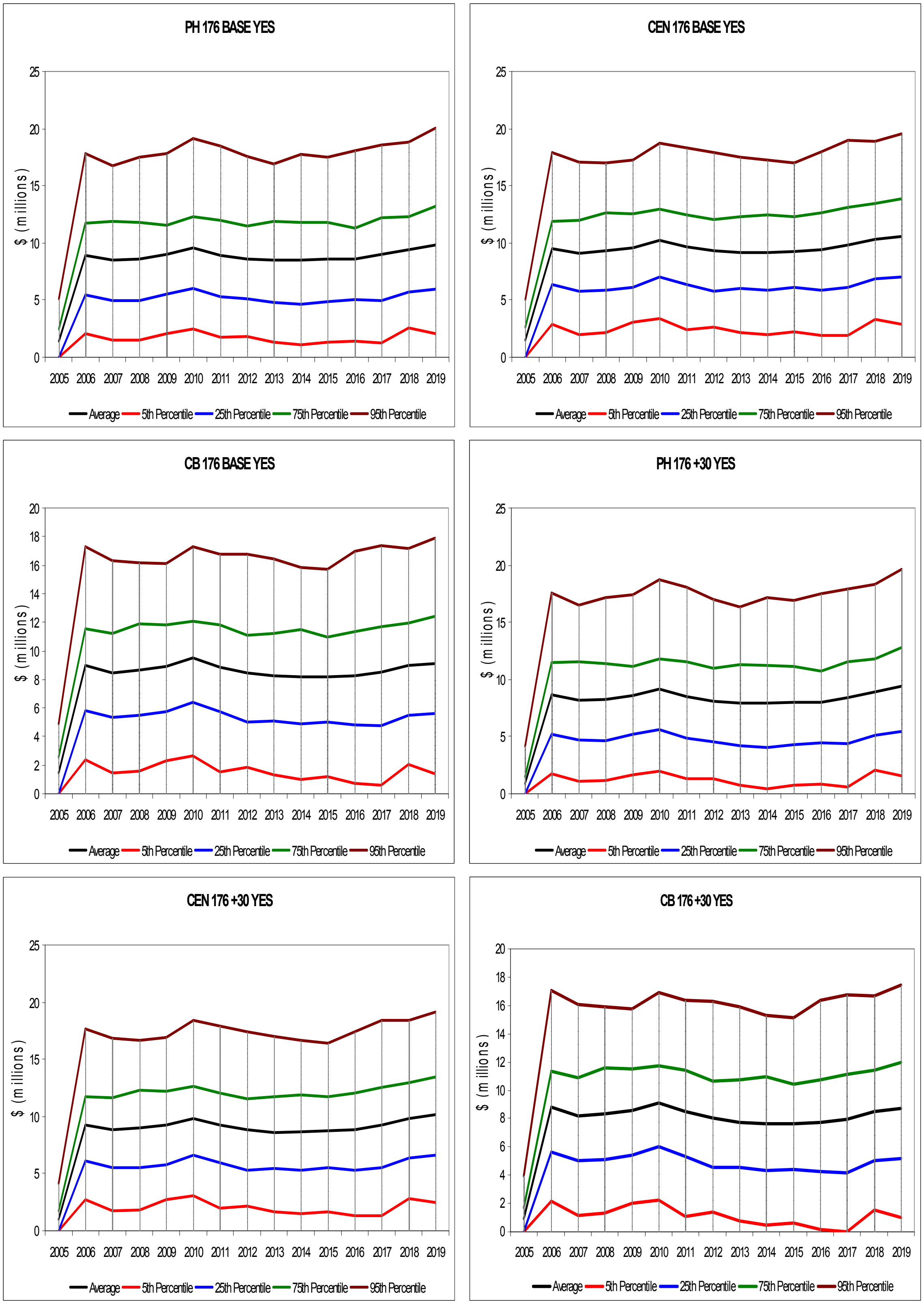

Figure 57. Projected average annual dividends paid risk for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives
Note: See Table 17 on page 119 for definition of abbreviations

For the Base initial investment Scenario in 2019, ninety percent of the simulated average annual dividends paid are between $2.05 million to $20.09 million, $2.88 million to $19.53 million, and $1.4 to $17.86 million for the Panhandle, Central and Coastal Bend Regions for the Base initial investment scenario. In 2019, ninety percent of the simulated average annual dividends paid range from $1.57 million to $19.62 million, $2.46 million to $19.12 million, and $0.98 million to $17.44 million for the Panhandle, Central, and Coastal Bend Regions at the Plus 30 initial investment scenario. These ranges are similar to the ranges for the corresponding scenarios in group three with no incentives.

Real Net Worth

Figure 58 presents the projected average real net worth for scenarios in group four. The projected average annual real net worth increases and flattens out after year 2014. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for real net worth is available in the Appendix E.

Projected average real net worth is highest in the Panhandle Region as the initial equity requirement is higher due to the required purchase of water rights in the region. The projected average real net worth is $39.4 million in 2005 increasing to $89.66 million in 2019 for the Panhandle Region and Base initial investment scenario. For the Plus 30 initial investment scenario, real net worth increases from $48.62 million in 2005 to $88.98 million in 2019.

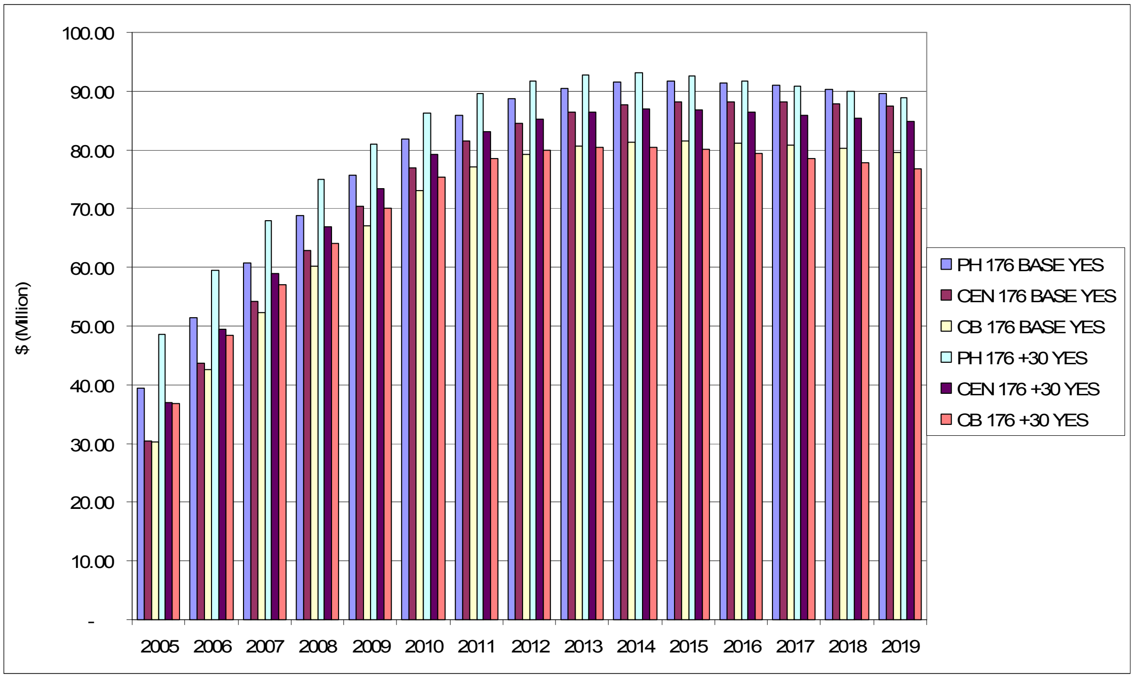

Figure 58. Projected average annual real net worth for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives
Note: See Table 17 on page 119 for definition of abbreviations

The Coastal Bend Region returned the lowest average real net worth in the Base and Plus 30 initial investment levels. Average real net worth for the Coastal Bend Region in 2019 is $79.49 million for the Base initial investment scenario and $76.82 million for the Plus 30 initial investment level. For the Central Region in 2019, average real net worth is $87.47 million for the Base initial investment scenario and $84.84 million for the Plus 30 initial investment scenario.

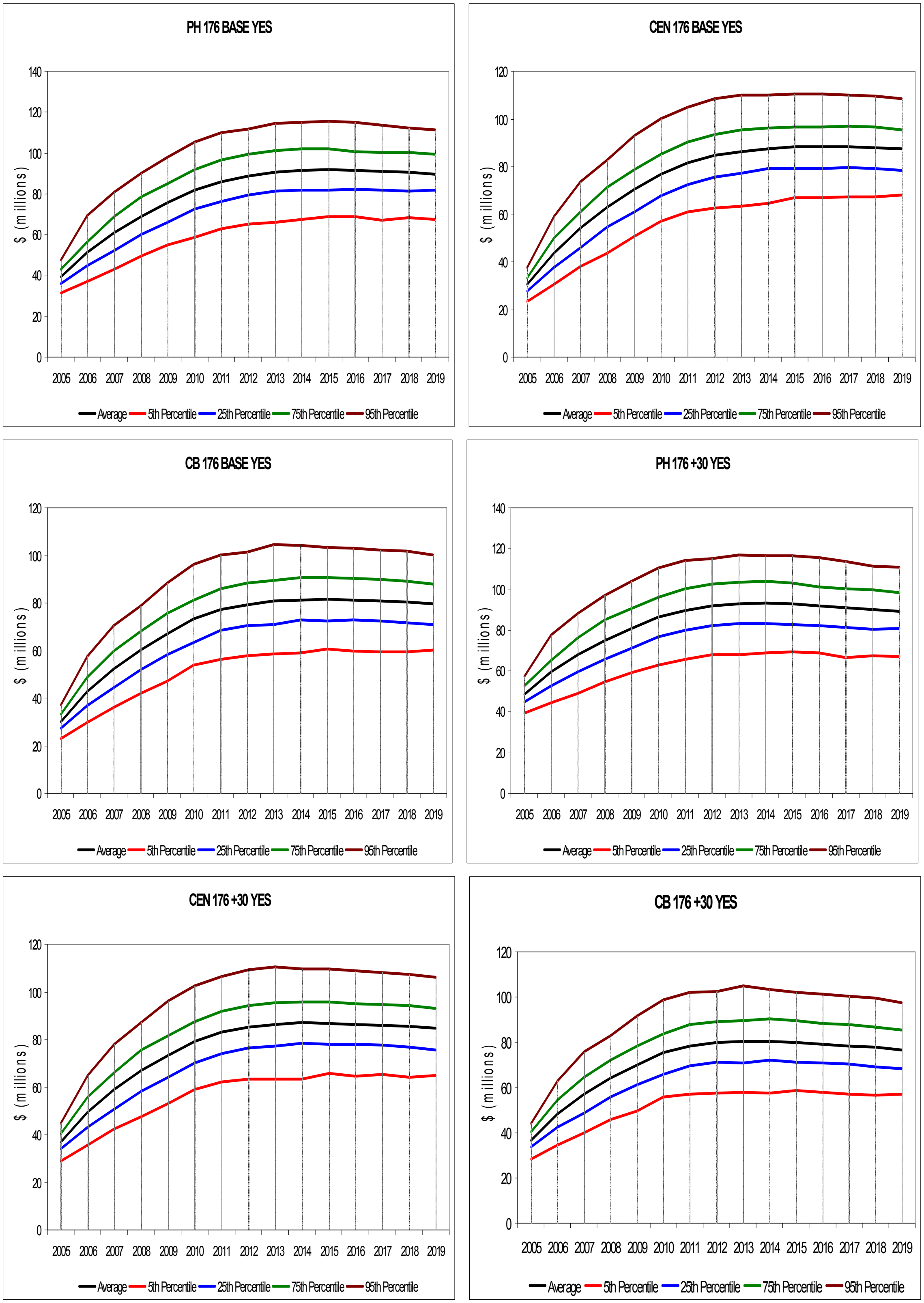

Figure 59. Projected annual real net worth risk for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives
Note: See Table 17 on page 119 for definition of abbreviations

Figure 59 presents the range and risk of the simulated average real net worth for scenarios in group four. Real net worth is projected to be positive from 2005 to 2019 for all scenarios. The range and risk increase from 2005 to 2019 for all scenarios and the probability of real net worth being negative is less than 1 percent.

In 2019 for the Base initial investment scenario, 90 percent of the simulated average real net worth are between $67.47 million to $111.48 million, $68.13 million to $108.49 million, and $60.1 million to $100.13 million for the Panhandle, Central, and Coastal Bend Regions. These ranges decrease for the Plus 30 initial investment scenario. When compared to corresponding scenarios in group three with no incentives, the ranges are higher because of the money saved from tax abatements.

Net Present Value

Figure 60 presents a CDF graph of NPV for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions with incentives. A detailed table presenting the mean, standard deviation, coefficient of variation, minimum, and maximum for NPV is available in the Appendix E.

The CDF graph shows each scenario returns a positive net present value. A distinct separation can be made between the Base and Plus 30 initial investment levels. For the Base initial investment scenario, the average NPVs are $108.64 million, $122.13 million, and $108.2 million for the Panhandle, Central, and Coastal Bend Regions. For the Plus 30 initial investment level scenario, the average NPVs are $90.98 million, $106.02 million, and $92.08 million for the Panhandle, Central, and Coastal Bend Regions, respectively.

In the Base initial investment scenario, the Central Region (red line) returned the higher (farther to the right in the graph) NPV values when compared to the Panhandle (black line) and Coastal Bend Regions (blue line). The Panhandle and Coastal Bend Regions CDF lines cross several times. Because the CDF lines cross, one cannot say a certain region is preferred to an alternative region when analyzing the CDF graph.

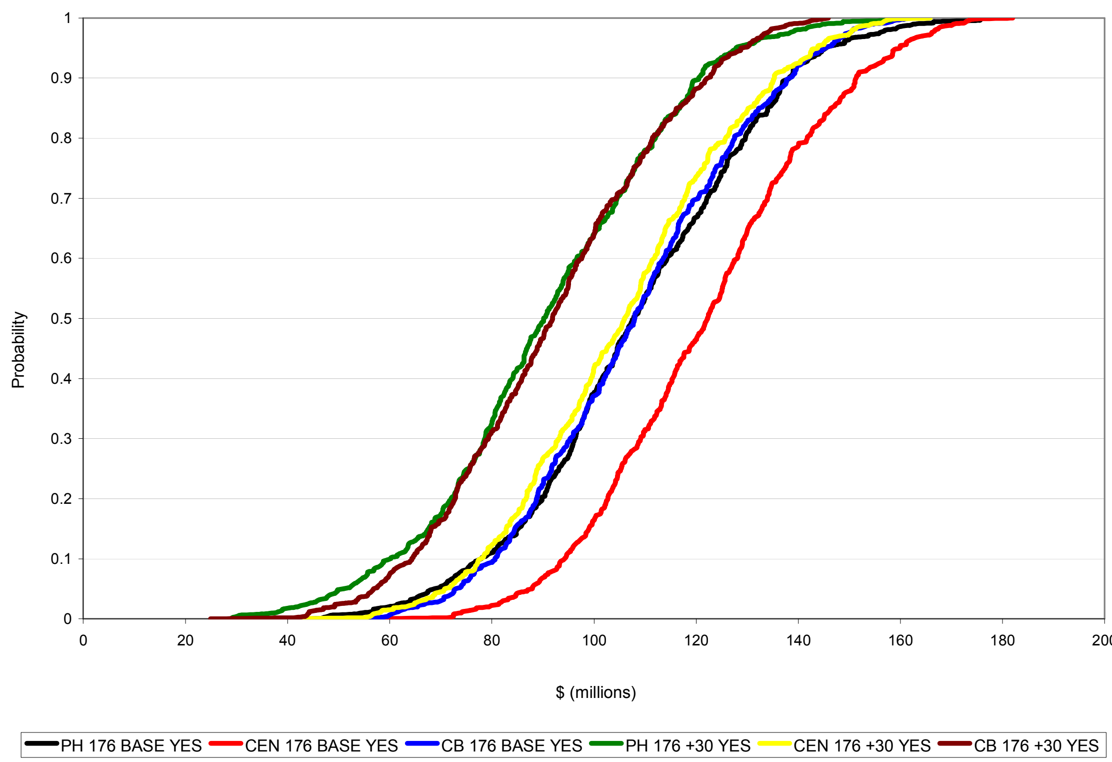

Figure 60. Cumulative density functions of net present value for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives
Note: See Table 17 on page 119 for definition of abbreviations

For the Plus 30 initial investment scenario, the Central Region (yellow line) returned the larger NPV values. The Coastal Bend Region (maroon line) crosses the Panhandle Region (green line) several times. At the Plus 30 initial investment scenario level, the CEN 176 +30 YES scenario is very close to the Panhandle and Coastal Bend Regions at the Base initial investment scenario. This indicates that even with a 30 percent higher initial investment cost, the Central Region could be preferred to the Panhandle and Coastal Bend Regions.

Figure 61 presents a SERF graph of NPV for a 44 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions with no incentives. The graph shows different regions are preferred under alternative risk preferences. The certainty equivalent (CE) lines for the Base initial investment scenarios are above the Plus 30 CE lines as expected. The upper and lower limit RACs are -0.2 for risk loving decision makers and 0.2 for risk averse decision makers.

For all RAC levels, decision makers prefer the Central Region to the Panhandle and Coastal Bend Regions for the Base and Plus 30 initial investment levels. For the Plus 30 initial investment levels, the CE lines cross and decision makers are indifferent between the Panhandle and Coastal Bend Regions at the -0.012 RAC level. For the Base initial investment level, the CE lines for the Panhandle Region and Coastal Bend Region cross at the zero RAC value meaning risk neutral decision makers are indifferent. For risk neutral to risk averse decision makers, the Coastal Bend Region is preferred to the Panhandle Region for the Base and Plus 30 initial investment levels.

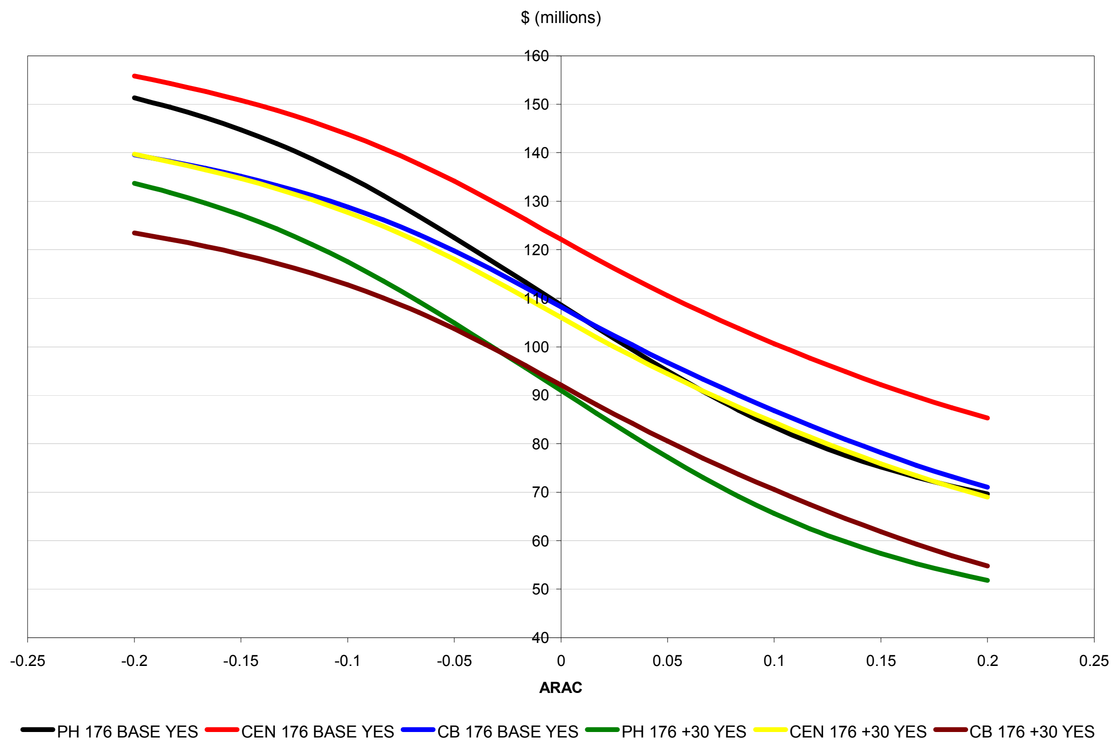

Figure 61. Stochastic efficiency with respect to a function graph of net present value for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions at Base and Plus 30 investment levels with incentives
Note: See Table 17 on page 119 for definition of abbreviations

One interesting observation can be made between the Central Region at the Plus 30 initial investment level and the Panhandle Region at the Base initial investment level. At RAC values greater than 0.07, decision makers are indifferent between the two scenarios. Decision makers could pay 30 percent more to located in the Central Region and still be indifferent between it and the Panhandle Region.

Table 21 presents the calculated risk premiums between the alternative scenarios for risk neutral (RAC of zero), moderately risk neutral (RAC of 0.05), and risk neutral decision makers (RAC of 0.15). The Central Region at the Base initial investment level is used as the base region for comparison to calculate the risk premiums.

The risk premiums show the Central Region is preferred to the Panhandle and Coastal Bend Regions for all risk aversion levels under the Base and Plus 30 initial investment levels. Risk neutral decision makers would have to be paid $13.49 million to be indifferent between the Panhandle Region and preferred Central Region for the Base initial investment scenario. Risk neutral decision makers are almost indifferent between the Panhandle and Coastal Bend Regions for the Base initial investment scenario as the risk premiums are almost identical. The results for the Plus 30 initial investment scenario are similar where the Central Region is preferred.

Table 21. Risk Premiums for a 176 Ton/Hour MixAlco Production Facility in the Panhandle, Central, and Coastal Bend Regions at the Base and Plus 30 Investment Levels with Incentives

	Risk Neutral	Moderately Risk Averse	Risk Averse
PH 176 BASE YES	(13.49)	(15.58)	(16.98)
CEN 176 BASE YES	-	-	-
CB 176 BASE YES	(13.94)	(13.83)	(14.03)
PH 176 +30 YES	(31.16)	(33.33)	(34.80)
CEN 176 +30 YES	(16.12)	(16.17)	(16.29)
CB 176 +30 YES	(30.05)	(30.03)	(30.33)

Note: See Table 17 on page 119 for definition of abbreviations

For risk averse decision makers to be indifferent between the preferred Central Region and the Panhandle or Coastal Bend Regions at the Base initial investment scenario, they would have to be paid $16.98 million and $14.03 million, respectively. For the Plus 30 initial investment scenario, decision makers prefer the Central Region over the Panhandle and Coastal Bend Regions as well. The risk premiums show risk neutral decision makers are almost indifferent between the Panhandle Region at the Base initial investment level and the Central Region at the Plus 30 initial investment. The large risk premiums show the Central Region is highly preferred to the Panhandle and Coastal Bend Regions for the Base and Plus 30 initial investment scenarios. Because the risk premiums are so large, we are more confident that the ranking is robust (Mjelde and Cochran, 1988).

Community Impacts

The economic impacts of locating a MixAlco production facility in the Panhandle, Central, and Coastal Bend Region are analyzed using two different methods. First, Regional Industry Multiplier System (RIMS) is used to calculate the additional capital spending and household income to the community. Second, the discounted wages, hauling costs, property tax, and additional farmer income are summed from 2005 to 2019 and simulated. These amounts are direct impacts from the MixAlco production facility. Negative impacts, such as possible hazards from ethanol production, were not considered in this analysis.

To entice a production facility to locate in the region, incentives are offered to attract businesses and assists in improving the probability of success for the entity. The incentives vary by region and consist of mainly alternative tax abatement levels. The amount of abatement is dependent upon the initial investment amount and number of jobs created by the entity. On average, the Panhandle, Central, and Coastal Bend Regions would forego $2.1 million in discounted total tax revenue for a 44 ton/hour production facility and $7.7 million for a 176 ton/hour production facility for the life of the production facility. These amounts are much smaller than the additional economic benefit a community would gain from a MixAlco production facility. A benefit to cost ratio can be calculate and is helpful to communities, cities, counties in determining if a new business entity would provide positive economic gains to the local economy.

Table 22 presents the economic impacts based on RIMS multipliers for a 44 ton/hour MixAlco production facility. The benefit for plant costs are one time measures and the benefits for output value are annual measures. For the analysis, plant costs are defined as capital spending for building, equipment, and land for the MixAlco production facility. For scenarios in group one, capital spending (output) associated with the construction phase range from $50.17 million for the Central and Panhandle Region at the Base initial investment level to $68.34 million for the Panhandle Region at the Plus 30 initial investment level. New household income generated from the construction phase range from $16.29 million for the Central and Coastal Bend Regions at the Base initial investment scenario to $21.17 million for the Panhandle Region at the Plus 30 initial investment scenario. This amount is the additional household income to the community annually.

For the operation phase, average annual ethanol revenue from 2006 to 2019 is used to calculate the RIMS economic effects. The total capital spending for the operation phase ranged from $124 million for the Coastal Bend Region to $133.91 million for the Panhandle Region. Economic benefits from profitable operations range from $22.05 million in the Coastal Bend Region to $23.82 million in the Panhandle Region.

Table 22. Estimated Economic Impact of the Construction (One Time) and Operation (Annual) of a 44 Ton/Hour MixAlco Production Facility Using RIMS Multipliers

	RIMS Mult.	PH 44 BASE NO	CEN 44 BASE NO	CB 44 BASE NO	PH 44 +30 NO	CEN 44 +30 NO	CB 44 +30 NO
				$ (millions)			
Plant Costs		21.66	20.67	20.67	28.16	26.88	26.88
Output	2.427	52.57	50.17	50.17	68.34	65.22	65.22
One Time Earnings	0.788	17.07	16.29	16.29	22.19	21.17	21.17
				$ (millions)			
Output Value		68.24	64.36	63.19	68.24	64.36	63.19
Output	1.963	133.91	126.29	124.00	133.91	126.29	124.00
Annual Earnings	0.349	23.82	22.46	22.05	23.82	22.46	22.05

Note: See Table 17 on page 119 for definition of abbreviations

The simulated average economic impacts for wages, hauling, property tax, and additional farmer income for a 44 ton/hour facility with and without incentives are presented in Figure 62. These amounts are the summed annual additional economic benefit from 2005 to 2019 discounted to 2004 dollars. The average additional discounted total wages to the community are $12.2 million for each scenario. This is based on 30 employees for the 44 ton/hour production facility.

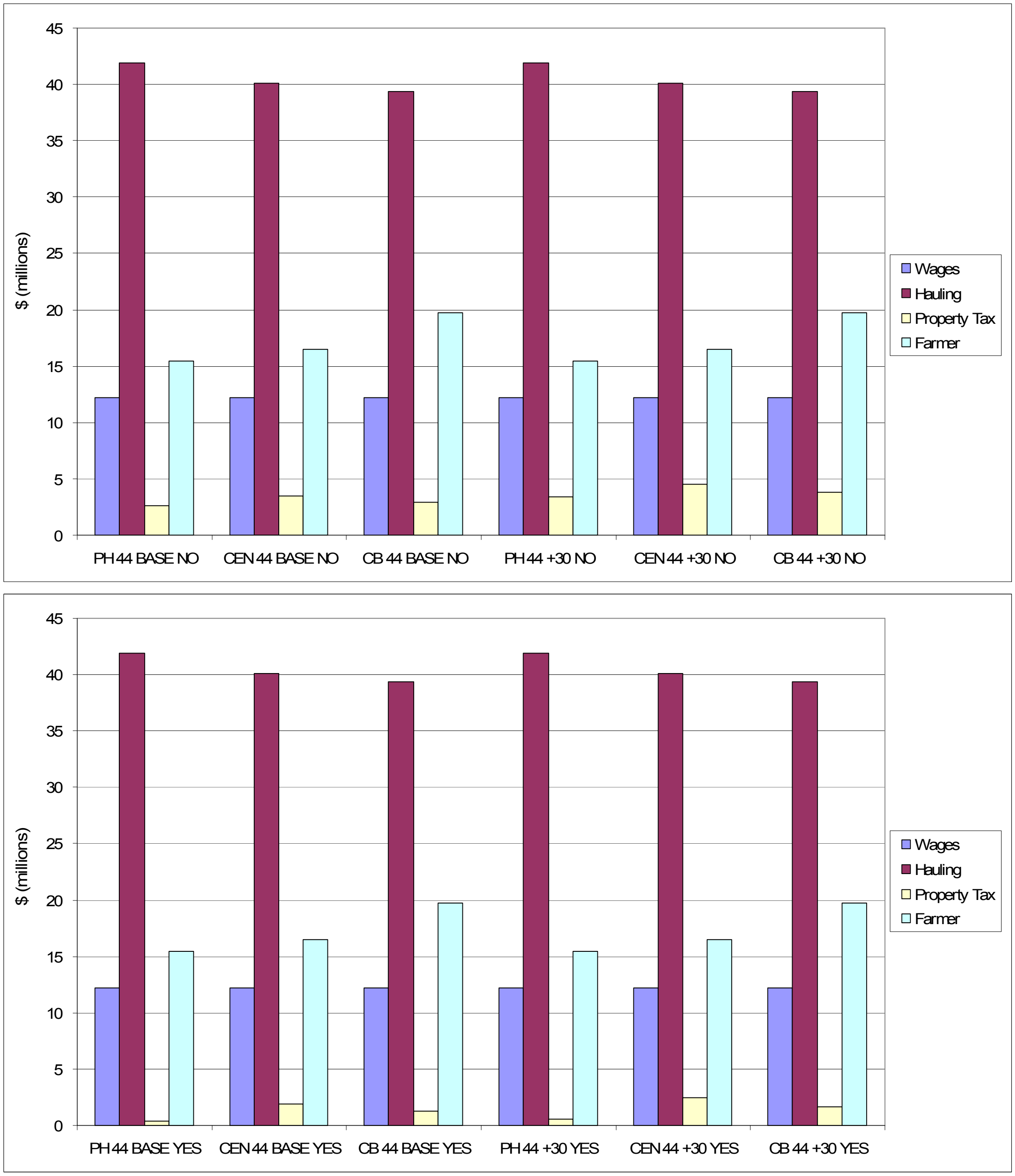

Figure 62. Average economic impact of wages, hauling, property tax, and additional farmer income for the life of a 44 ton/hour MixAclo production facility in the Panhandle, Central, and Coastal Bend Regions of Texas

Note: See Table 17 on page 119 for definition of abbreviations

Pile building and hauling revenues are the largest direct contributor to the local economy with total additional revenue over the analysis period ranging from $39.37 million for the Coastal Bend Region to $41.89 million for the Panhandle Region. Additional income to farmers is highest in the Coastal Bend Region at $19.77 million and lowest in the Panhandle Region at $15.44 million. This means that farmers would receive additional revenue of over $1 million annually. Property tax paid to communities is higher for the Plus 30 initial investment scenario than the Base scenario because of the higher property tax base. Property tax paid to the local government is less than $5 million for all scenarios without incentives and less than $2.5 million with incentives. This is expected as the incentive packages for each region all contain tax abatements for the production facility.

Table 23 presents the economic impacts based on the Regional Industry Multiplier System (RIMS) for a 176 ton/hour MixAlco production facility. Capital spending (output) associated with construction phase are $173.12 million for the Panhandle Region and $164.96 million for the Central and Coastal Bend Regions. For the Plus 30 initial investment scenarios, capital spending increases to $225.05 million for the Panhandle Region and $214.45 million for the Central and Coastal Bend Regions. New household incomes generated from construction phase are $56.20 million for the Panhandle Region and $53.56 million for the Central and Coastal Bend Regions for the Base initial investment scenario. These values increase to $73.06 million and $69.62 million for the Plus 30 initial investment level.

Table 23. Estimated Economic Impact of the Construction (One Time) and Operation (Annual) of a 176 Ton/Hour MixAlco Production Facility Using RIMS Multipliers

	RIMS Mult.	PH 176 BASE NO	CEN 176 BASE NO	CB 176 BASE NO	PH 176 +30 NO	CEN 176 +30 NO	CB 176 +30 NO
				$ (millions)			
Plant Costs		71.34	67.98	67.98	92.74	88.38	88.38
Output	2.427	173.12	164.96	164.96	225.05	214.45	214.45
One Time Earnings	0.788	56.20	53.56	53.56	73.06	69.62	69.62
				$ (millions)			
Output Value		224.07	211.32	207.49	224.07	211.32	207.49
Output	1.962	439.70	414.68	407.15	439.70	414.68	407.15
Annual Earnings	0.349	78.20	73.75	72.41	78.20	73.75	72.41

Note: See Table 17 on page 119 for definition of abbreviations

For the operation phase based on output value, average annual ethanol revenue from 2006 to 2019 is used for calculation of the RIMS economic effects. Total capital spending for the operation phase are $439.70 million, $414.68 million, and $407.15 million for the Panhandle, Central, and Coastal Bend Regions. For both initial investment scenarios, additional annual household income estimate from the operation phase are $78.20 million, $73.75 million, and $72.41 million for the Panhandle, Central, and Coastal Bend Regions.

Figure 63 presents the simulated average wages, hauling, property tax, and additional farmer income for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions with and without incentives. These amounts are the summed annual additional economic benefit from 2005 to 2019 discounted to 2004 dollars. The average additional discounted wages to the community is $27.48 million for all scenarios. A 176 ton/hour production facility employs 76 full time workers.

Hauling costs are a substantial contributor to the local economy. The discounted hauling revenues are $199.93 million, $177.62 million, and $190.26 million for the Panhandle, Central and Coastal Bend Regions. The additional income to farmers is quite large. The average discounted additional revenue to farmers over the 16 year analysis period is $50.71 million for the Panhandle Region, $54.04 million for the Central Region, and $64.90 million for the Coastal Bend Region. Property taxes paid to communities are highest for the Central Region and lowest in the Panhandle Region because of the different property tax rates. Property tax paid to communities is over $8 million for all scenarios without incentives. With incentives, property is less than $6 million for all three regions. The Central Region receives the most amount of taxes because it had the highest property tax rate at $3.040776 per $100 property value.

For all three regions, the benefits to cost ratios are quite large for community development incentives. For a 44 ton/hour production facility, the average benefit (summation of the average additional revenue for wages, hauling, property tax, and farmers) to cost (summation of average taxes forgone and other incentives) is $34 million benefit to $1 million in cost. The benefit to cost ratio increases for a 176 ton/hour production facility to $36 million benefits to $1 million cost. For MixAlco production facility, the probability of success and probability of surviving for 16 years is high indicating communities can be more confident that the production facility will have a positive long-term economic impact. This additional information from incorporating risk analysis to calculate the probability of success can be beneficial to local communities when evaluating the option of offering incentives or not.

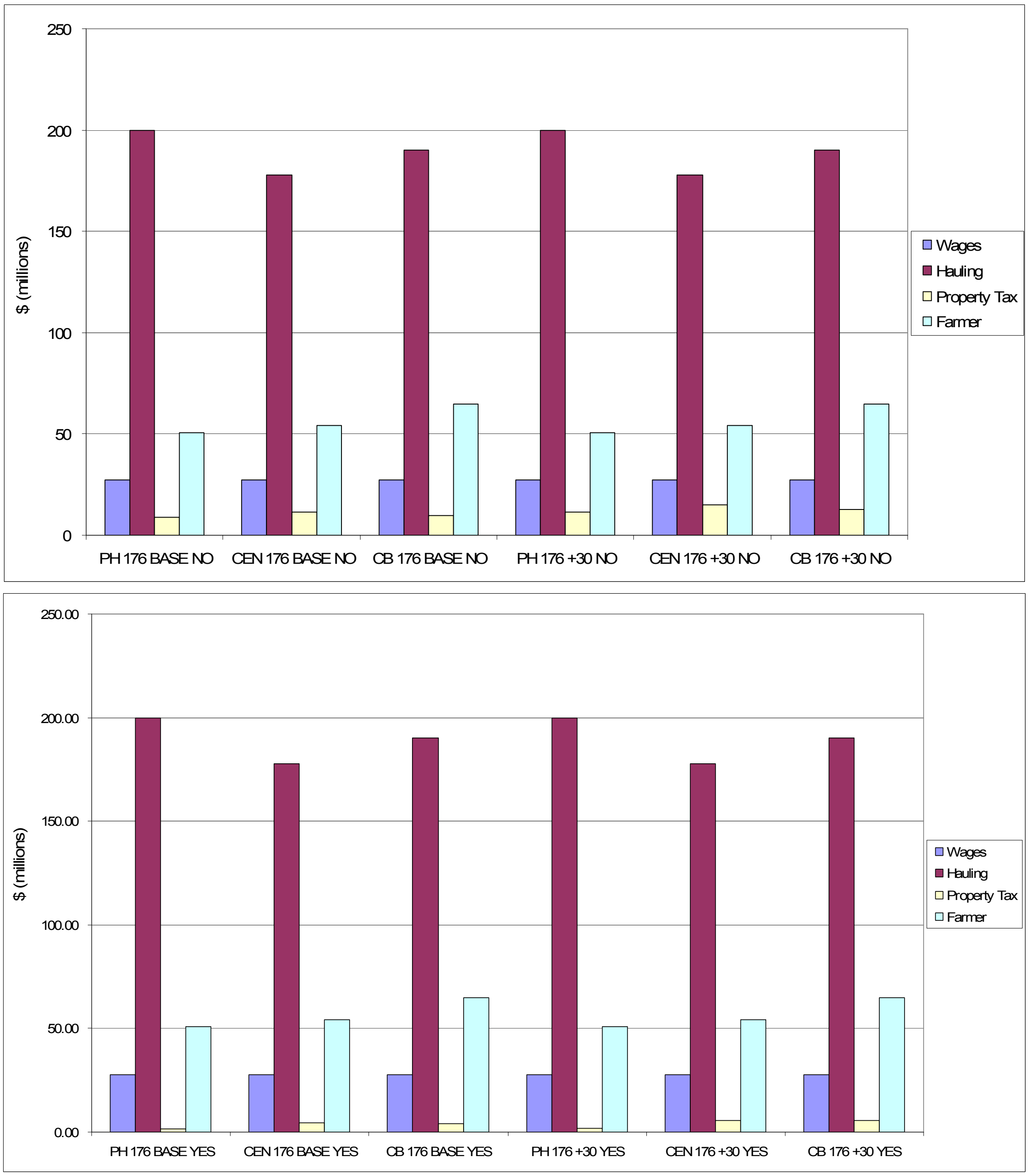

Figure 63. Average economic impact of wages, hauling, property tax, and additional farmer income for the life of a 176 ton/hour MixAclo production facility in the Panhandle, Central, and Coastal Bend Regions of Texas

Note: See Table 17 on page 119 for definition of abbreviations

Sensitivity Analysis

Sensitivity analysis is performed on key variables for the MixAlco production facility. Ethanol yield and price, hydrogen price, silage yield, silage price, steam price, natural gas price, nutrient price, and water price were analyzed to determine their affect on NPV. The sensitivity analysis determines which variables are key contributors to the success or failure of a MixAlco production facility.

Figure 64 presents the calculated elasticities for ethanol yield and price, hydrogen price, silage yield, silage price, steam price, natural gas price, nutrient price, and water price with respect to NPV for a 44 ton/hour production facility. An elasticity is defined as the relationship between a proportional change in one variable relative to a one percent change in another variable. The concept of elasticity can be used whenever there is a relationship between two variables. The horizontal axis represents the calculated elasticity for the corresponding variable.

The sensitivity elasticity graph show ethanol yield and ethanol price have the greatest affect on NPV for a 44 ton/hour facility in any region. Ethanol price and yield, and silage yield had positive elasticities of success. This is expected as almost 95 percent of all income is from ethanol. A one percent increase in ethanol yield or ethanol price for each year will increase NPV by 6 percent in the Panhandle, Central, and Coastal Bend Regions. The elasticity is slightly lower for the Central Region. A one percent increase in silage yield would increase NPV by about 2 percent in each region. The inverse relationship for an elasticity is true as well, a one percent decrease in silage yield would decrease NPV by about 2 percent.

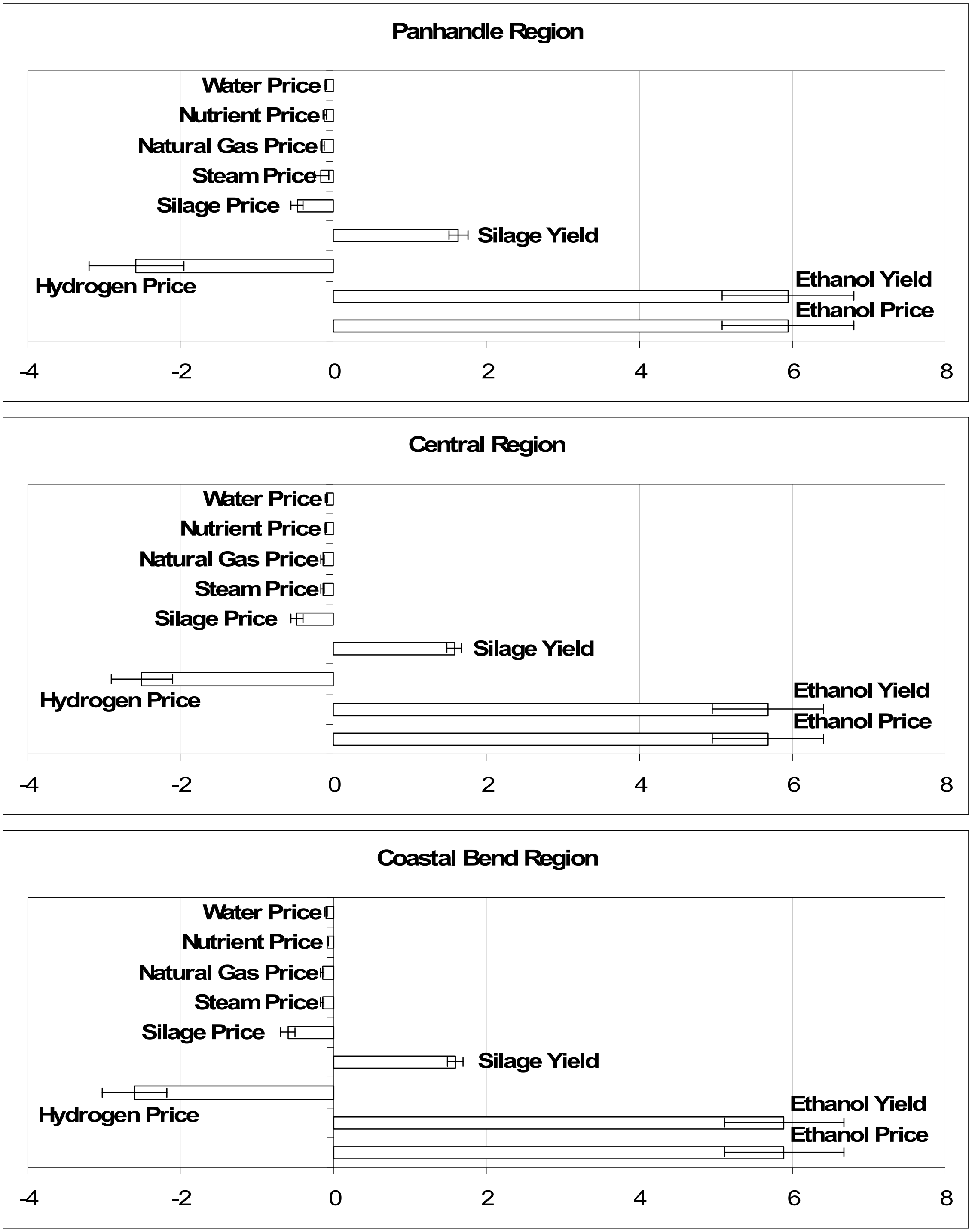

Figure 64. Sensitivity elasticity for net present value with respect to ethanol yield and price, hydrogen price, silage yield and price, steam price, natural gas price, nutrient price, and water price for a 44 ton/hour MixAlco production facility in the Panhandle, Central and Coastal Bend Regions

Note: See Table 17 on page 119 for definition of abbreviations

The ethanol price used for analysis includes the \$0.52/gallon excise tax exemption for blended gasoline. If the tax exemption is removed or is unavailable for biomass produced ethanol, the price of ethanol would decrease by the exemption amount and the feasibility of MixAlco is greatly reduced. A \$0.52/gallon reduction in ethanol price equates to a 37 percent decrease in ethanol price from 2005 to 2019. Using the calculated elasticity for NPV with respect to ethanol price, NPV would decrease an average of 222 percent for a 44 ton/hour production facility for the Panhandle, Central, and Coastal Bend Regions. Therefore, NPV would be negative if the tax exemption is removed.

In terms of cost, hydrogen price and silage price are the two most important variables which affect NPV. The elasticity for all other variables are less than 0.25. For a 1 percent increase in hydrogen price each year, which is less than \$0.01/hcf, NPV would decrease by approximately 2.5 percent. This is expected as 55 percent of total variable cost is hydrogen. If silage price increases by one percent, NPV would decrease by 0.5 percent for the Panhandle and Central Region and 0.60 percent for the Coastal Bend Region. This indicates that silage price has only a small affect on NPV.

Figure 65 presents the elasticity of NPV for a 176 ton/hour MixAlco production facility in the Panhandle, Central, and Coastal Bend Regions. The elasticities are larger for all variables when compared to a 44 ton/hour production facility. Ethanol yield per ton of feedstock and ethanol price are the two main variables affecting NPV. For the Panhandle and Coastal Bend Regions, a one percent increase in ethanol yield or price would result in a 7.5 percent increase in NPV. For the Central Region, the increase in

NPV is slightly lower at 6.5 percent. If silage yield were to increase one percent each year, NPV would increase 1.75 percent for the 176 ton/hour production facility. This is only valid with price remaining at the same level.

If the \$0.52/gallon excise tax exemption for ethanol is removed or is unavailable for biomass produced ethanol, the NPV for a 176 ton/hour MixAlco production facility would be negative. Using the calculated elasticity for NPV with respect to ethanol price, NPV would decrease an average of 271 percent for a 176 ton/hour production facility in the Panhandle, Central, and Coastal Bend Regions. The decrease in NPV is larger when compared to the 44 ton/hour facility anpipeline

d shows the feasibility and probability of economic success is highly dependent on the excise tax exemption for maintaining ethanol price at the current level.

For the cost variables, a one percent increase in hydrogen price would reduce NPV by 3 percent. This is higher than the 44 ton/hour production plant where the elasticity was -2.5 percent because hydrogen is a larger proportion of total cost for the production facility. For a one percent increase in silage price, NPV would decrease 0.75 percent. Again, this is higher than the -0.05 elasticity for a 44 ton/hour production facility. These elasticities indicate that controlling costs, especially hydrogen price, for the larger production plant size is highly important for economic success.

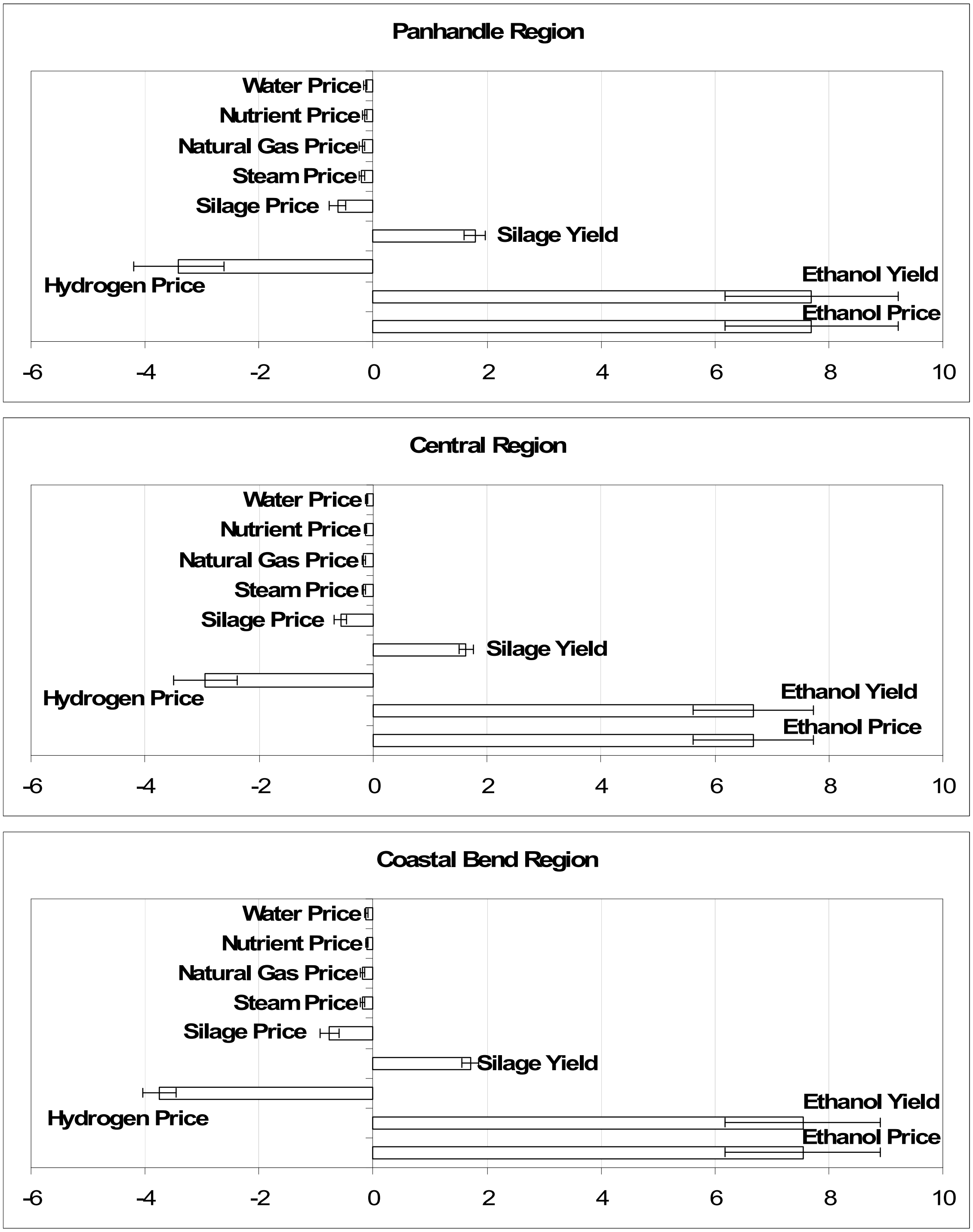

Figure 65. Sensitivity elasticity for net present value with respect to ethanol yield and price, hydrogen price, silage yield and price, steam price, natural gas price, nutrient price, and water price for a 176 ton/hour MixAlco production facility in the Panhandle, Central and Coastal Bend Regions

Note: See Table 17 on page 119 for definition of abbreviations

Table 24. Sensitivity Analysis for Change in Ethanol and Hydrogen Price Necessary to Generate NPV=0, with All Other Factors Constant, for a 44 Ton/Hour and 176 Ton/Hour Production Facility

44 Ton/Hour	Incentive	Ethanol Price	Ethanol Price	Hydrogen Price	Hydrogen Price
		Percent	$/Gallon	Percent	$/hcf
Base Price			1.41		0.74
Panhandle	NO	17.1	1.17	38.9	1.028
Panhandle	YES	17.6	1.16	40.2	1.037
Central	NO	17.2	1.17	39.1	1.029
Central	YES	17.6	1.16	40.0	1.036
Coastal Bend	NO	16.4	1.18	37.3	1.016
Coastal Bend	YES	16.8	1.17	38.3	1.024
176 Ton/Hour	**Incentive**	**Ethanol Price**	**Ethanol Price**	**Hydrogen Price**	**Hydrogen Price**
		Percent	$/Gallon	Percent	$/hcf
Base Price			1.41		0.74
Panhandle	NO	13.6	1.22	25.5	0.93
Panhandle	YES	14.1	1.21	32.2	0.98
Central	NO	14.9	1.20	33.9	0.99
Central	YES	15.5	1.19	35.2	1.00
Coastal Bend	NO	13.1	1.23	29.8	0.96
Coastal Bend	YES	13.5	1.22	30.8	0.97

Note: See Table 17 on page 119 for definition of abbreviations

Table 24 presents the deterministic sensitivity analysis and breakeven prices of ethanol and hydrogen to generate a NPV equal to zero for a 44 ton/hour and 176 ton/hour MixAlco production facility. The base price for ethanol and hydrogen is the average simulated stochastic price from 2005 to 2019. The ethanol price percentage represents the decrease in ethanol price required to generate NPV equal to zero. The hydrogen price percentage represents the amount hydrogen price must increase to generate NPV equal to zero. For the 176 ton/hour production facility, the breakeven price is higher for ethanol price and lower for hydrogen price when compared to the 44 ton/hour production facility. This reaffirms the larger sensitivity elasticities for the 176 ton/hour production facility and shows it is more sensitive to price movements for ethanol and hydrogen.

The base price of ethanol is $1.41 over the planning horizon. For a 44 ton/hour production facility, if ethanol price decreases to $1.17/gallon, the production facility would generate a NPV of zero, holding all other factors constant. The price is slightly higher for the 176 ton/hour production facility. These prices include the $0.52/gallon excise tax exemption and would be lower if exemption was lost. Hydrogen price would have to increase from the base price of $0.74/hcf to $1.03/hcf and $1.00/hcf for a 44 ton/hour and 176 ton/hour production facilities to generate a NPV equal to zero.

Table 25 presents the deterministic sensitivity analysis and breakeven prices of sorghum silage for NPV equal to zero in the Panhandle, Central, and Coastal Bend Regions of Texas. The base silage price is the average price per a ton from 2005 to 2019 for each region. For the Panhandle and Central Region, sorghum silage prices would have to increase over 300 percent to generate a NPV equal to zero. The percentage is lower in the Coastal Bend Region because of the higher average sorghum silage price.

For the 44 ton/hour production facility, the breakeven price for sorghum silage to generate a NPV equal to zero, holding all other factors constant, is approximately $55/ton for all three regions. For the 176 ton/hour facility, the breakeven price is lower, approximately $49/ton of sorghum silage for all three regions. These amounts represent the limit for which a MixAlco production facility would pay for cellulose feedstock to ensure a positive net present value if all other factors remained constant.

Table 25. Sensitivity Analysis for Change in Sorghum Silage Price Necessary to Generate NPV=0, with All Other Factors Constant, for a 44 Ton/Hour and 176 Ton/Hour Production Facility

44 Ton/Hour	Incentive	Silage Price	Silage Price
		Percent	$/Ton
Base Price			17.24
Panhandle	NO	312	53.83
Panhandle	YES	319	54.99
Base Price			18.15
Central	NO	302	54.89
Central	YES	307	55.76
Base Price			21.27
Coastal Bend	NO	261	55.53
Coastal Bend	YES	265	56.43

176 Ton/Hour	Incentive	Silage Price	Silage Price
		Percent	$/Ton
Base Price			17.24
Panhandle	NO	268	46.26
Panhandle	YES	275	47.48
Base Price			18.15
Central	NO	275	49.98
Central	YES	282	51.20
Base Price			21.27
Coastal Bend	NO	228	48.57
Coastal Bend	YES	233	49.50

Note: See Table 17 on page 119 for definition of abbreviations

CHAPTER VI

SUMMARY, CONCLUDING REMARKS, AND IMPLICATIONS FOR FURTHER RESEARCH

With recent increases in oil price, the banning of MTBE as a fuel oxygenated due to water contamination, and new legislation requiring a reduction in air pollution, the ethanol industry has experienced substantial growth with production exceeding 3 billion gallons in 2004. For corn-based ethanol production, there has not been consensus on if the net energy balance is positive or negative (Lorenz and Morris, 1995; Shapouri, et al., 1995). The MixAlco process has been developed as an alternative to corn-based ethanol production using biomass for feedstock.

In this study, key factors related to the feasibility of MixAlco ethanol production in the Panhandle, Central, and Coastal Bend Regions of Texas were analyzed. Though different regions were analyzed, this analysis should not be viewed as a replacement for a specific feasibility study where local situations and relationships could influence the feasibility of a production facility. Included in the analysis where evaluations of incentive packages for each region and benefits to the local economy.

This study contributes to the literature both empirically and methodologically. Empirically, this study presents a unique discussion of the feasibility of a MixAlco production facility. No current economic feasibility study has been performed. If the MixAlco ethanol production process is competitive with current ethanol production processes, than the potential impacts on the fuel oxygenates market, the agriculture sector, and local economies could be substantial.

Methodologically, this study demonstrates the use of stochastic simulation, risk analysis, and scenario analysis to solve location problems. Risk is incorporated into the input variables (silage costs, hauling costs, natural gas cost, electricity cost, hydrogen cost, steam cost, lime costs) and output variables (ethanol production, ethanol price, coal price). Understanding that risk exists allows for sensitivity analysis and comparison of key variables which directly affect the probability of economic success. This gives decision makers a critical assessment before investing large amounts of money into a new and unproven technology.

Summary of Results

Key Output Variables

This study evaluated the economic feasibility and community impacts for two plant sizes (44 ton/hour and 176 ton/hour), the initial investment amount (Base, Plus 30), with and without incentives, and three alternative regions (Panhandle, Central, and Coastal Bend). For all scenarios, the projected financial feasibility results show a positive net present value (NPV) over the 16 year planning horizon with a small probability of being negative.

Net income is expected to remain positive and increase slightly for all scenarios. This is due in part to the $0.02/gallon annual increase in ethanol price caused by an increase in wholesale gas price. However, wholesale gas price is driven by the expected increase in crude oil price. The probability of negative net income is less than 30 percent in the first year for all scenarios and 1 percent for years 2006 to 2019. Net income for the Plus 30 initial investment scenario is lower in all cases due to higher interest costs and higher capital improvement costs.

Because net income remains positive, ending cash balances increase annually. The probability of a negative ending cash balance is less than 5 percent in 2005 and less than 1 percent from 2006 to 2019 for all scenarios. Also, annual dividends paid are positive for all scenarios. However, there is a high probability, greater than 50 percent, that dividends will not be paid in the first year for all scenarios. After 2005, the probability of dividends not being paid is 1 percent. Dividends paid are lower for the Plus 30 initial investment level because of lower annual net income.

Real net worth increases to 2014 and than flattens out for all scenarios because of the increasing deflation factor. Real net worth is highest in the Panhandle Region for the 44 ton/hour and 176 ton/hour production facilities because of the additional initial investments needed for wells and water rights. For the Plus 30 initial investment scenario, real net worth is higher for all scenarios as expected. The probability of ending real net worth being negative is less than one percent for all scenarios

Stochastic Efficiency with Respect to a Function

Stochastic efficiency with respect to a function (SERF) was used to rank the alternative scenarios over a range of risk preferences from risk loving to risk averse. This methodology provide decision makers a cardinal ranking to determine which location and investment was most suitable based on their risk preferences defined by the risk aversion coefficient (RAC).

For both the 44 ton/hour and 176 ton/hour production facility, the Central Region is the preferred location for risk neutral and risk averse decision makers. The Central Region is preferred for both the Base and Plus 30 initial investment levels and with or without the benefits of location incentives. Risk premiums are calculated for risk neutral, moderately risk averse, and risk averse decision makers. The risk premiums are beneficial as they represent the amount of money a decision maker would have to be paid to be indifferent between a preferred scenario and an alternative. This is helpful when comparing incentive packages for alternative regions where the incentives could be greater than the risk premium making it feasible to change locations. The risk premiums vary by risk preferences. Because the risk premiums are consistent for risk averse decision makers, we are more confident that the ranking is robust.

Community Impacts

The economic impacts of locating a MixAlco production facility in the Panhandle, Central, and Coastal Bend Region were analyzed using the Regional Industry Multiplier System (RIMS) and the summation of the simulated discounted wages, hauling costs, property tax, and additional farmer income from 2005 to 2019 for each region. The RIMS method calculated the direct and indirect benefits to the community. The simulation results provide the direct impacts from the MixAlco production facility.

The RIMS method estimated annual additional capital spending of $50 million to $65 million for the 44 ton/hour facility and additional household income of $124 million to $133 million based on annual output value for the production facility. For a 176 ton/hour production facility, the local economy would increase from $407 million to

$440 million in additional spending and $72 million to $78 million in additional household income annually. These economic gains to the local community, measured by the benefit to cost ratio, are quite large indicating that locating a MixAlco production facility in the region could have positive economic impacts on the local economy.

For the simulated direct impacts for the life of the investment, hauling revenues were the largest direct contributor to the region ranging from $42 million for a 44 ton/hour production facility to $190 million for a 176 ton/hour facility. The summed discounted wages were $12 million for a 44 ton/hour facility and $27.5 million for a 176 ton/hour facility. Farmers receive a substantial increase in additional revenue over the 16-year analysis period with a high of $20 million for the 44 ton/hour production facility to $65 million for a 176 ton/hour production facility. Property tax revenue for the local community varies and is dependent on whether a tax abatement is offered or not.

Sensitivity Analysis

Sensitivity elasticities for key variables were estimated to determine which variables had the greatest effect on feasibility in terms of NPV. From the analysis, ethanol price, ethanol yield, and hydrogen price were the three variables with the largest elasticities. A 1 percent annual increase in ethanol price or yield would increase NPV by 6 to 7 percent depending on the plant size. If the $0.52/gallon excise tax exemption for blended gasoline is unavailable, the lower ethanol price would decrease NPV by 222 percent and 271 percent for the 44 ton/hour and 176 ton/hour production facility. The decrease in NPV is larger for a 172 ton/hour facility when compared to the 44 ton/hour facility and shows the feasibility and probability of economic success is highly dependent on the excise tax exemption for maintaining ethanol price at the current level. In terms of cost, if hydrogen price increases 1 percent each year, NPV would decrease by 2.5 to 3 percent. The calculated elasticities for all other input cost variables were less than .25 percent.

Concluding Remarks

The promising results for production of ethanol from the MixAlco process should be viewed with caution. The analysis uses the Energy Information Administration's long-term forecast for wholesale gasoline price where prices are expected to continually increase from 2005 to 2019. Ethanol prices are expected to increase at the same rate reaching a high of $1.56/gallon in year 2019. This is highly optimistic as the historical high price for ethanol is $1.51/gallon in 2001. Also, the excise tax exemption is assumed available for MixAlco produced ethanol. The uncertainty in the world oil market caused by current war in the Middle East could dramatically affect the feasibility of a production facility. These outside factors cannot be controlled.

As a caution, it should be restated here that the MixAlco process is still being refined and the production assumption data used in this analysis are from lab experiments. These numbers, such as ethanol yield per ton of feedstock, could vary in real world conditions. More than likely, MixAlco will follow an adoption curve for new technology where the process is fine tuned over the first few years before full efficiency can be reached.

The results show with the current assumptions, a positive NPV is forecasted with increasing net worth for a 44 ton/hour and 176 ton/hour production facility in the

Panhandle, Central, and Coastal Bend Regions of Texas. Potential investors can use the results to determine the location, plant size, and key variables in deciding if a production facility should be constructed.

Furthermore, the results of this study provide useful information to compare the risk and benefits between the alternative plant sizes and locations. Investing substantial amounts of money in a new technology is a risky decision. Understanding and incorporating variability into the model allows for a probabilistic analysis where a probability range can be assigned for each outcome. The probabilistic framework gives decision makers much more information than a deterministic estimate. Simulation, risk analysis, and SERF are demonstrated as a useful tool for analyzing feasibility and location study problems. SERF is especially useful when the risk preference of a decision maker is unknown.

The results also show the additional business activity associated with a MixAlco production facility would increase capital spending and household income boosting the local economy. The extended economic benefits could be substantial if the MixAlco production facility is profitable. The failure of a production facility would preclude any realization of benefits to the local economy. MixAlco has the potentially to be a feasible alternative to corn-based ethanol production offering substantial economic gains for the community.

Recommendations for Future Analysis

There are several limitations to this study. First, silage yields and silage prices were interpolated from historical grain yields and budgets. These numbers are only best estimates of what the expected forage yield and price would be. Actually data collected from individual farmers would give a better representation of the expected yield and cost for sorghum silage. Yield is heavily dependent on weather, especially for dry-land farming in the Panhandle, Central, and Coastal Bend Regions of Texas.

Second, this study assumed specifically growing silage for energy production. Sorghum silage is used as feedstock because of its high yield characteristics, low costs of production, and adaptability to be grown in different climates. A 20 percent premium was included in the price to entice farmers to harvest sorghum for silage rather than for grain. However, MixAlco would directly compete with the dairy industry for sorghum silage which may raise prices higher than expected. This may cause some dairies to move to alternative locations lowering the available amount of nutrient feedstock. The higher sorghum silage price could dampen the financial outlook for MixAlco.

Residual biomass, such as tree clippings and farming residues, are not considered in this study. Agriculture residues could offer a low cost alternative to growing crops specifically for energy conversion. Studies show sorghum produces one ton of residual matter for every ton of grain produced. Harvesting the sorghum for grain and collecting the residual biomass could be a viable alternative. The ability of MixAlco to convert any biomass material to alcohol fuel makes it an attractive alternative for ethanol production. Large amounts of available residual biomass represent a low cost feedstock source that can be used for energy production (Gallagher, et al., 2003).

Third, electricity price, natural gas price, steam price, coal price, and lime price were not separated by region. The differences in price between regions may be small, but for completeness, a separate price should be used in each region. Also, the prices are average prices for Texas. Better prices may be obtained from negotiations with providers in each region. Also, hedging may be considered to lower costs in each region. Natural gas, coal, and electricity can be hedged to offset the expected increase in energy prices. The additional cost and risk of hedging should be considered.

Fourth, other location incentives may be available. The location incentives used in this study were generalized for each region after discussion with the local Chamber of Commerce and Economic Development Corporations. Each stated that the incentives are project specific and negotiated on an individual basis. They could not provide a complete and specific incentive package for a production facility without the proper information to evaluate.

Fifth, this study does not consider environmental incentive programs that may be available. Programs such as the Environmental Quality Incentive Program (EQIP) and Conservation Partnership Initiative (CPI) offer financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land. These incentives can be applied on top of local and state incentives.

Sixth, negative economic impacts were not considered. The environmental hazards, such as the danger of chemical explosions, could deter communities from allowing a production facility to be located in the region. These considerations would be negotiated on an individual basis with the local governments.

Lastly, this study considers the production of ethanol on the premise and shipping the finished fuel to refineries for blending. Smaller acid production facilities could ship acid to a centrally located, large hydration facility. The initial investment amount for the MixAlco production facility would be reduced by the amount paid for hydration equipment. A large scale hydration facility would have economies of scale advantages when compared to individual hydration facilities at each location.

There may be cost advantages to shipping acids to a central hydration facility located close to a large hydrogen production facility. This would reduce the cost of hydrogen and negate the problems associated with shipping ethanol. The production cost of ethanol would be reduced. However, little data is available on the pricing and shipping cost for acids as well as the costs for large scale production of hydrogen.

A large amount of money is currently being invested by the Department of Energy and private companies in the production of hydrogen. The current price for hydrogen is correlated directly to natural gas price. Hydrogen price is expected to increase as natural gas price increases from historical prices of $2/mcf to $6/mcf in 2019. However, advancements in hydrogen production technology in coal gasification reclamation and the expected growth in large scale production facilities may reduce the price of hydrogen in the future (EIA, 2004). This would certainly increase the potential feasibility for MixAlco production.

Despite the limitations, this study contributed to the literature by showing simulation and risk analysis can be used to analyze location problems and offer decision makers a critical assessment of key variables which directly affect the feasibility of production facility.

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APPENDIX A

INFLATION RATES, EQUIPMENT REQUIREMENTS, GRKS DISTRIBUTION FOR ETHANOL YIELD, AND SIMULATION SUMMARY STATISTICS FOR STOCHASTIC VARIABLES

Table A.1. Inflation Rates for Stochastic and Deterministic Variables

Year	Land	Savings	Operating Loan	Fuel/Fertilizer	Labor	Chemicals	Fixed Costs	Sorghum Price	Sorghum Yield
2004	0.058	0.011	0.043	-0.088	0.007	-0.002	0.018	0.000	0.004
2005	0.033	0.018	0.051	-0.048	0.007	0.029	0.022	0.002	0.004
2006	0.018	0.022	0.052	-0.012	0.007	0.020	0.022	-0.006	0.004
2007	0.028	0.024	0.054	0.020	0.007	0.011	0.022	0.006	0.004
2008	0.040	0.032	0.058	0.016	0.007	0.008	0.022	0.015	0.004
2009	0.033	0.042	0.065	0.017	0.006	0.007	0.023	0.022	0.004
2010	0.027	0.051	0.070	0.024	0.006	0.011	0.025	0.030	0.004
2011	0.037	0.052	0.070	0.031	0.007	0.015	0.027	0.037	0.004
2012	0.041	0.052	0.070	0.030	0.007	0.015	0.029	0.047	0.004
2013	0.040	0.052	0.066	0.032	0.008	0.015	0.029	0.058	0.004
2014	0.040	0.052	0.066	0.032	0.008	0.015	0.029	0.058	0.004
2015	0.040	0.052	0.066	0.032	0.008	0.015	0.029	0.058	0.004
2016	0.040	0.052	0.066	0.032	0.008	0.015	0.029	0.058	0.004
2017	0.040	0.052	0.066	0.032	0.008	0.015	0.029	0.058	0.004
2018	0.040	0.052	0.066	0.032	0.008	0.015	0.029	0.058	0.004
2019	0.040	0.052	0.066	0.032	0.008	0.015	0.029	0.058	0.004

Table A.2. Equipment Requirement and Unit Cost for a 44 Ton/Hour MixAlco Production Facility

Fermentation Phase

Item	44 ton/hour Quantity	176 Ton/Hour Quantity	Equipment Cost
Biomass Loader	1	2	50,000
Lime Screw Conveyor	1	2	5,500
Biomass/Lime Mixer	1	2	50,000
Fermentor	4	16	2,149,896
Saturator Tank	1	2	20,000
Air Blower	1	2	3,000
Carbon Dioxide Blower	1	2	4,000
Circulating Pump	4	6	72,000
Heat Exchanger	4	8	17,200

Dewatering Phase

Item	44 Ton/Hour Quantity	176 Ton/Hour Quantity	Equipment Cost
Compressor	1	3	120,000
Gas Turbine	1	3	280,000
Steam Turbine	1	3	90,000
Condenser	1	2	16,250
Rankine Pump	1	2	1,330
Heat Exchanger	1	2	75,000
Evaporator	1	3	228,299
Sensible Heat Exchanger 1	1	4	40,874
Sensible Heat Exchanger 2	1	4	21,897
Evaporator Pump	1	2	12,000
Evaporator Turbine	1	2	12,000
Lime Mixing Tank	1	2	9,000
Solids Separator	1	3	40,000
Lime Conveyer	1	3	10,000
Non-condensable Stripper Column	1	2	14,000

Table A.2. Continued

Acid Spring Phase			
Item	**44 Ton/Hour Quantity**	**176 Ton/Hour Quantity**	**Equipment Cost**
Reactive Distillation	1	2	42,000
Reactive Distillation Reboiler	1	2	50,000
Countercurrent Heat Exchanger	1	2	16,000
Switching Distillation Column	1	2	46,000
Reboiler Heat Exchanger 1	1	2	7,000
Reboiler Heat Exchanger 2	1	2	7,000
Reboiler Heat Exchanger 3	1	2	6,000
Condenser	1	2	11,000
Mixer	1	3	10,000
Filter	1	3	100,000
Filter Pump	1	2	6,000
Evaporator	1	3	56,388
Compressor	1	3	40,000
Electric Motor	1	4	23,000
Countercurrent Heat Exchanger	1	2	8,726
Turbine	1	2	6,000
Amine Stripper	1	2	12,500
Steam Stripper	1	3	20,000
Calcium Carbonate Conveyor	1	3	8,000
Pump	1	2	1,520
Pump	1	2	1,520
Pump	1	2	1,330
Salt Recovery System	1	3	200,000
Amine Inventory	1	4	100,000

Hydration Phase			
Item	**44 Ton/Hour Quantity**	**176 Ton/Hour Quantity**	**Equipment Cost**
Water Column	1	2	28,000
Water Reboiler	1	2	12,000
Water Condenser	1	2	8,000
Hydrogenation Reactor	1	3	87,000
Pump	1	2	2,250
Filter	1	3	5,000
Alcohol Column	1	2	48,000
Alcohol Reboiler	1	2	17,000
Alcohol Condenser	1	2	10,000
Pump	1	2	1,330

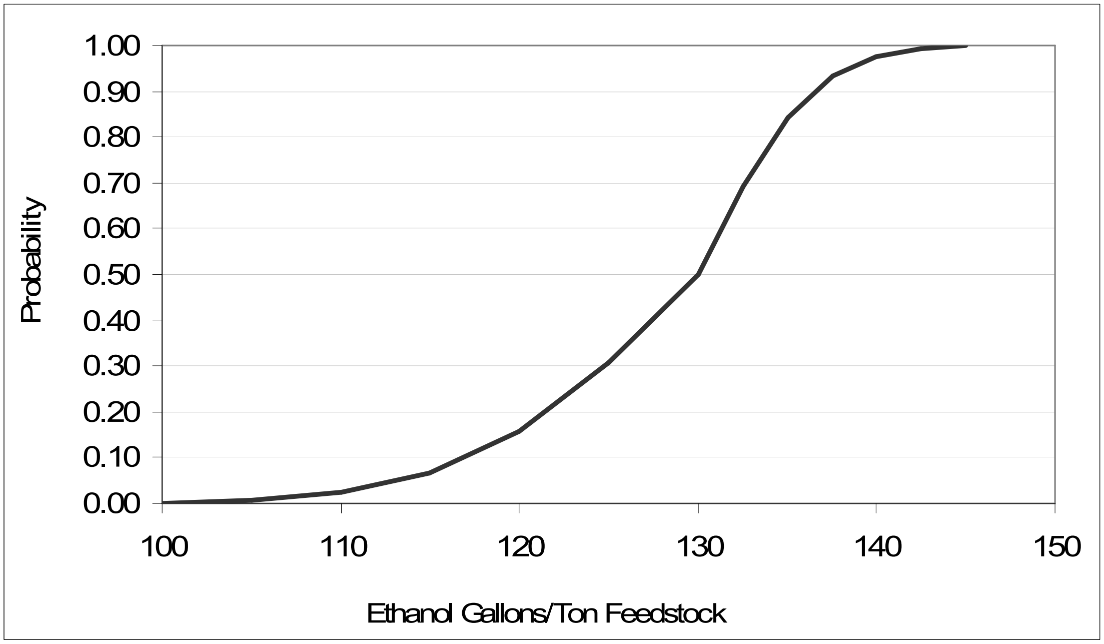

Figure A.1. Cumulative Density Function Graph for Ethanol Yield per Ton of Feedstock

Table A.3. Summary Statistics for Ethanol Yield

	Ethanol Yield
Mean	126
Standard Deviation	15
95 % L.C.I.	118
95 % U.C.I.	134
Minimum	100
Median	130
Maximum	145

Table A.4. Simulation Summary Statistics for Sorghum Silage Yield, Natural Gas Price, Electricity Price, Ethanol Price, Coal Price, Lime Price, Hydrogen Price, and Steam Price

Panhandle Yield	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	7.79	7.76	7.90	7.95	8.07	8.13	8.23	8.36	8.47	8.48	8.52	8.55	8.56	8.60	8.64
St. Dev.	1.62	1.65	1.62	1.62	1.69	1.71	1.74	1.75	1.82	1.77	1.78	1.74	1.84	1.84	1.84
CV	20.76	21.20	20.49	20.39	21.01	21.01	21.14	20.95	21.50	20.89	20.85	20.33	21.48	21.38	21.27
Min	4.61	4.59	4.66	4.72	4.77	4.82	4.88	4.94	5.01	5.03	5.05	5.07	5.08	5.10	5.12
Max	11.44	11.40	11.58	11.72	11.85	11.98	12.11	12.27	12.44	12.48	12.53	12.58	12.63	12.67	12.72

Central Yield	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	12.60	12.59	12.73	12.85	12.94	13.07	13.18	13.30	13.43	13.49	13.51	13.60	13.66	13.70	13.74
St. Dev.	1.67	1.61	1.57	1.62	1.64	1.62	1.64	1.60	1.62	1.71	1.64	1.67	1.67	1.61	1.63
CV	13.24	12.76	12.30	12.57	12.69	12.41	12.47	12.02	12.04	12.64	12.16	12.29	12.25	11.75	11.83
Min	9.07	9.06	9.16	9.25	9.33	9.40	9.48	9.58	9.67	9.71	9.75	9.78	9.82	9.86	9.90
Max	16.05	16.04	16.22	16.38	16.51	16.65	16.78	16.95	17.12	17.19	17.25	17.32	17.39	17.45	17.52

Coastal Bend Yield	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	13.58	13.60	13.66	13.84	13.92	14.06	14.14	14.27	14.40	14.50	14.52	14.62	14.64	14.67	14.73
St. Dev.	1.95	2.04	1.81	1.93	1.93	1.95	1.91	1.93	1.86	2.02	1.93	2.07	2.01	1.91	2.02
CV	14.34	15.00	13.23	13.98	13.85	13.86	13.54	13.52	12.94	13.93	13.31	14.18	13.76	13.04	13.71
Min	10.03	10.03	10.14	10.23	10.31	10.39	10.47	10.57	10.67	10.71	10.76	10.80	10.84	10.88	10.92
Max	18.78	18.78	18.98	19.15	19.30	19.46	19.61	19.80	19.99	20.06	20.14	20.22	20.30	20.38	20.45

Table A.4. Continued

Natural Gas Price	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	4.61	4.57	4.70	4.84	4.77	4.76	4.97	5.30	5.64	5.92	6.27	6.46	6.62	6.68	6.79
St. Dev.	0.53	0.53	0.54	0.57	0.58	0.56	0.58	0.59	0.64	0.70	0.74	0.75	0.79	0.77	0.76
CV	11.52	11.58	11.47	11.72	12.22	11.66	11.70	11.19	11.34	11.79	11.82	11.68	11.95	11.52	11.15
Min	3.76	3.72	3.83	3.95	3.89	3.88	4.06	4.31	4.60	4.83	5.12	5.26	5.39	5.44	5.54
Max	5.65	5.60	5.75	5.93	5.85	5.83	6.10	6.48	6.92	7.26	7.69	7.91	8.10	8.18	8.33

Electricity Price	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.050	0.049	0.050	0.051	0.052	0.052	0.052	0.054	0.055	0.058	0.060	0.062	0.063	0.064	0.066
St. Dev.	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.005
CV	7.79	7.77	7.55	7.81	8.09	7.63	7.73	7.57	7.49	7.67	7.91	7.83	7.98	7.75	7.68
Min	0.044	0.044	0.044	0.045	0.046	0.046	0.046	0.048	0.049	0.051	0.053	0.054	0.055	0.057	0.058
Max	0.057	0.056	0.057	0.058	0.059	0.059	0.060	0.062	0.063	0.066	0.068	0.070	0.072	0.073	0.075

Ethanol Price	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.27	1.34	1.34	1.36	1.37	1.40	1.39	1.41	1.43	1.45	1.47	1.49	1.52	1.54	1.56
St. Dev.	0.13	0.14	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.16
CV	10.00	10.05	9.99	10.17	10.13	10.09	9.96	10.00	10.08	9.99	10.04	10.11	9.99	9.98	10.21
Min	1.05	1.11	1.11	1.12	1.13	1.15	1.15	1.16	1.18	1.20	1.22	1.24	1.26	1.27	1.29
Max	1.55	1.63	1.62	1.65	1.66	1.69	1.69	1.71	1.74	1.76	1.79	1.81	1.85	1.86	1.89

Table A.4. Continued

Coal Price	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	26.75	26.81	27.15	27.49	27.85	28.14	28.42	28.87	29.56	30.11	30.86	31.30	32.01	32.43	32.92
St. Dev.	1.17	1.15	1.19	1.22	1.24	1.24	1.24	1.25	1.29	1.32	1.37	1.37	1.41	1.42	1.42
CV	4.37	4.30	4.37	4.42	4.45	4.40	4.35	4.33	4.38	4.37	4.44	4.37	4.41	4.37	4.30
Min	25.32	25.39	25.71	26.01	26.35	26.63	26.91	27.34	27.99	28.50	29.21	29.65	30.30	30.71	31.17
Max	28.78	28.86	29.22	29.57	29.96	30.27	30.59	31.08	31.81	32.40	33.21	33.70	34.45	34.91	35.43

Lime Price	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	19.36	19.52	19.69	19.85	20.02	20.19	20.35	20.52	20.68	20.85	21.02	21.18	21.35	21.52	21.68
St. Dev.	0.62	0.63	0.63	0.64	0.64	0.65	0.66	0.66	0.67	0.67	0.68	0.68	0.69	0.69	0.70
CV	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22	3.22
Min	17.34	17.49	17.64	17.79	17.94	18.09	18.24	18.38	18.53	18.68	18.83	18.98	19.13	19.28	19.43
Max	20.00	20.18	20.35	20.52	20.69	20.86	21.03	21.21	21.38	21.55	21.72	21.89	22.06	22.24	22.41

Hydrogen Price	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.70	0.69	0.70	0.71	0.70	0.70	0.71	0.73	0.74	0.75	0.77	0.78	0.79	0.79	0.79
St. Dev.	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03
CV	3.20	3.19	3.30	3.56	3.62	3.45	3.65	3.64	3.85	4.13	4.30	4.33	4.49	4.36	4.26
Min	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.68	0.70	0.71	0.72	0.72	0.73	0.73	0.74
Max	0.74	0.74	0.75	0.75	0.75	0.75	0.76	0.78	0.80	0.81	0.83	0.84	0.85	0.86	0.86

Steam Price	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	6.00	6.01	6.09	6.16	6.24	6.31	6.37	6.47	6.62	6.75	6.92	7.01	7.17	7.27	7.38
St. Dev.	0.26	0.26	0.27	0.27	0.28	0.28	0.28	0.28	0.29	0.29	0.31	0.31	0.32	0.32	0.32
CV	4.37	4.30	4.37	4.42	4.45	4.40	4.35	4.33	4.38	4.37	4.44	4.37	4.41	4.37	4.30
Min	5.68	5.69	5.76	5.83	5.91	5.97	6.03	6.13	6.27	6.39	6.55	6.64	6.79	6.88	6.99
Max	6.45	6.47	6.55	6.63	6.71	6.78	6.86	6.97	7.13	7.26	7.44	7.55	7.72	7.82	7.94

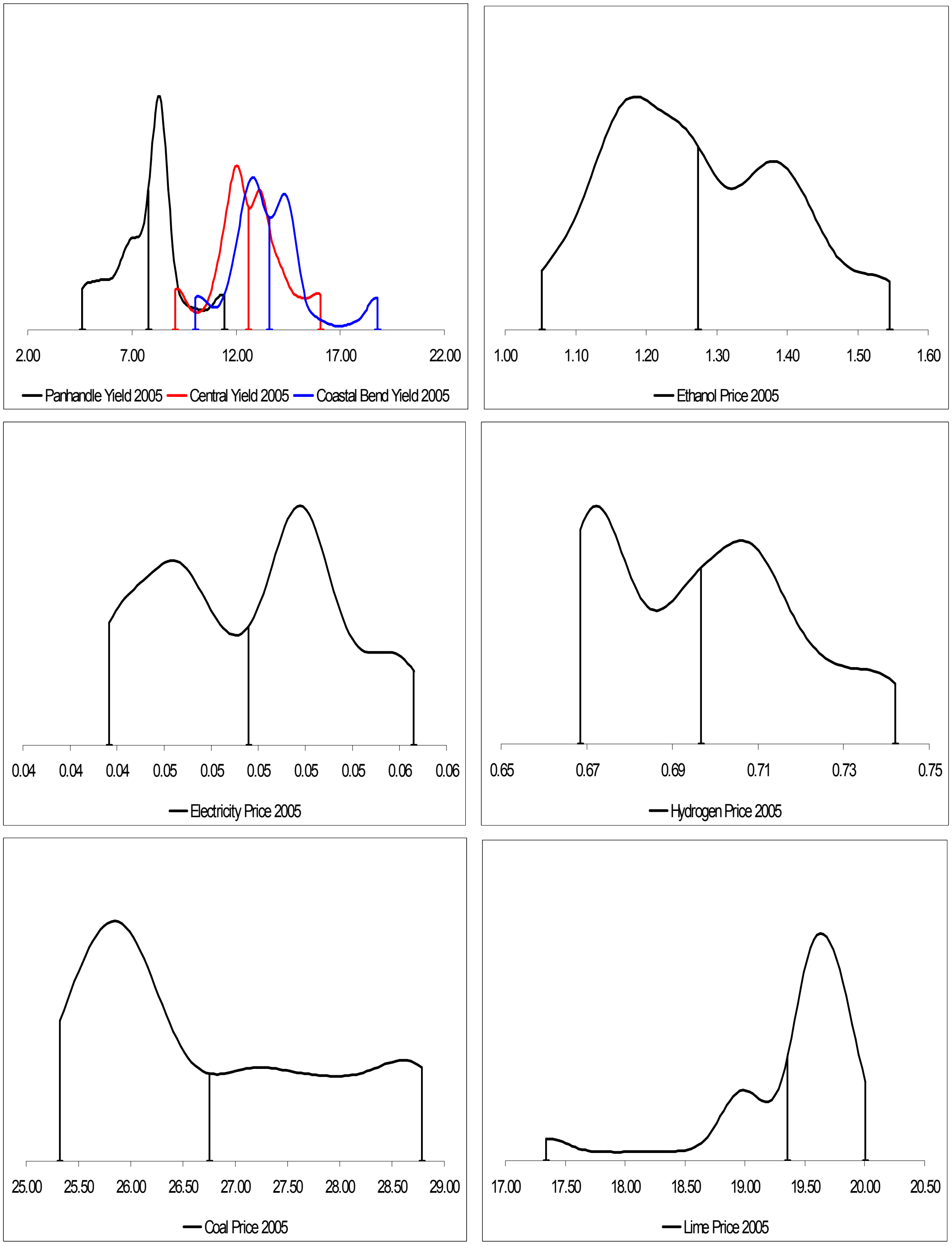

Figure A.2. Probability Density Function Approximations for Silage Yield in Each Region, Ethanol Price, Hydrogen Price, Coal Price, Lime Price, Steam Price, and Electricity Price for Year 2005

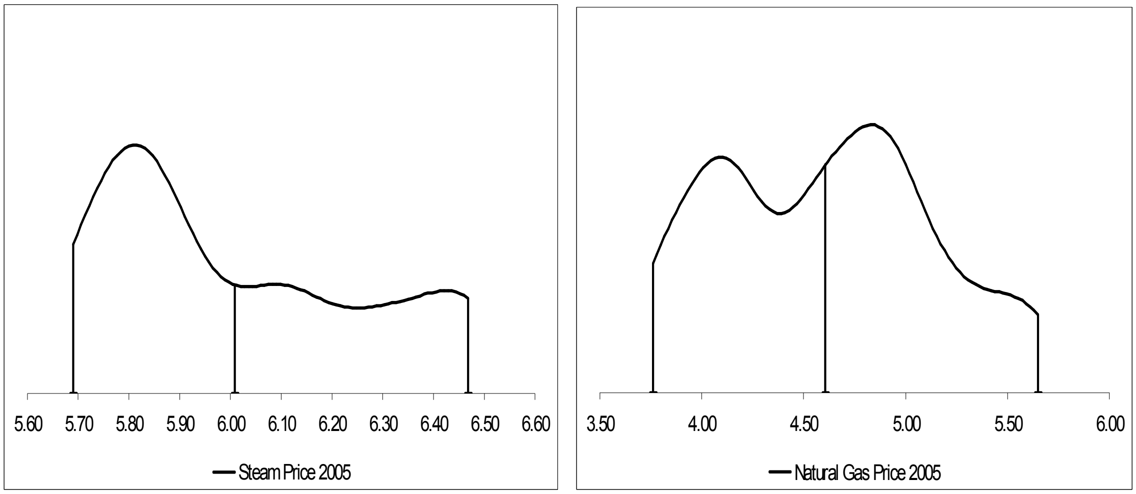

Figure A.2. Continued

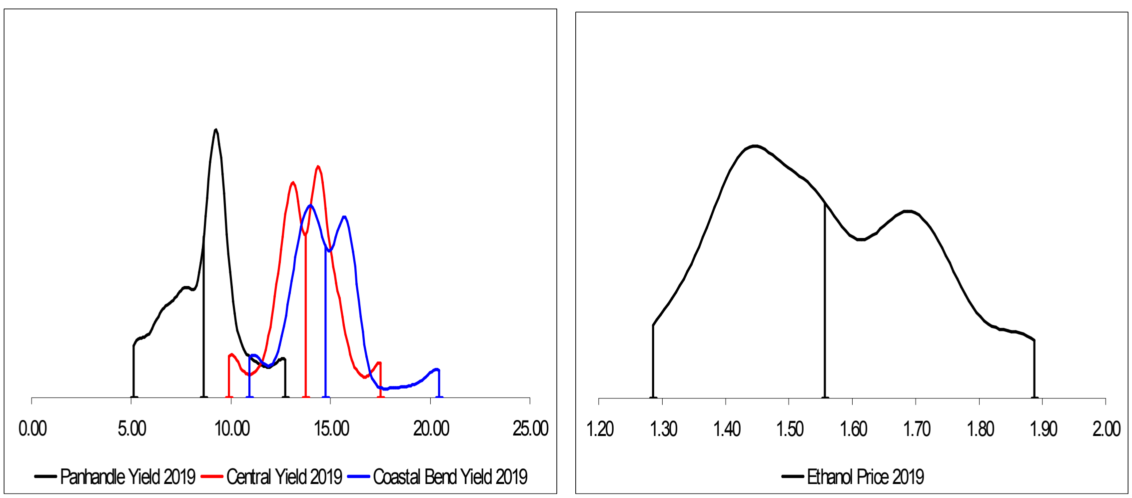

Figure A.3. Probability Density Function Approximations for Silage Yield in Each Region, Ethanol Price, Hydrogen Price, Coal Price, Lime Price, Steam Price, and Electricity Price for Year 2019

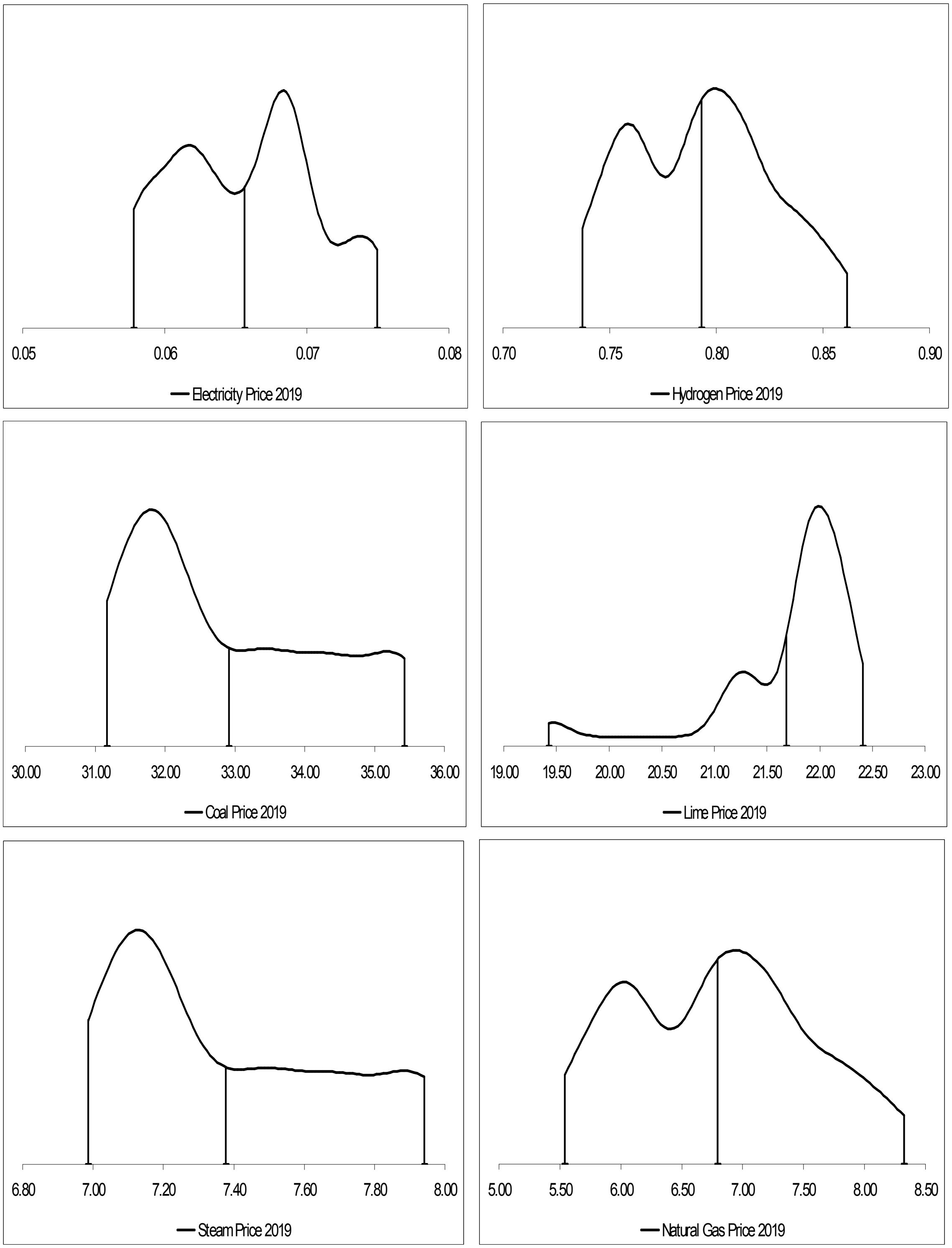

Figure A.3. Continued

APPENDIX B

SIMULATION SUMMARY STATISTICS OF KEY OUTPUT VARIABLES FOR A 44 TON/HOUR MIXALCO PRODUCTION FACILITY AT BASE AND PLUS 30 INITIAL INVESTMENT SCENARIOS WITH NO INCENTIVES

Table B.1. Simulation Summary Statistics for Net Income for a 44 Ton/Hour Production Facility at Base Initial Investment Scenario with No Incentives

PH 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.59	15.01	14.73	15.06	15.65	16.70	15.77	15.72	16.02	16.07	16.38	16.48	17.29	17.89	18.60
St. Dev.	3.73	7.90	7.77	7.73	7.73	8.00	8.18	7.83	7.92	8.24	8.14	8.10	8.80	8.24	8.76
CV	144.10	52.66	52.73	51.35	49.41	47.91	51.86	49.79	49.44	51.23	49.73	49.19	50.91	46.04	47.11
Min	(5.89)	(1.14)	(0.60)	(2.92)	(4.73)	(1.35)	(6.10)	(8.78)	(1.97)	(2.16)	(3.50)	(1.61)	(1.45)	(1.73)	(0.43)
Max	18.68	47.89	43.97	41.42	47.43	44.85	44.08	43.56	47.70	47.74	46.82	52.17	53.68	47.46	49.41
P(NI<0)	29	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.85	15.35	14.99	15.47	15.95	16.99	16.11	16.03	16.19	16.28	16.48	16.78	17.52	18.20	18.69
St. Dev.	3.41	6.97	7.07	7.31	6.94	7.13	7.46	7.43	7.27	7.32	7.19	7.68	7.85	7.80	8.05
CV	119.97	45.44	47.17	47.27	43.53	41.98	46.28	46.35	44.89	44.98	43.62	45.76	44.83	42.88	43.09
Min	(5.56)	(0.27)	(0.19)	(2.73)	(4.30)	(0.82)	(5.65)	(7.73)	(1.28)	(1.54)	(5.49)	(1.63)	(1.22)	(2.01)	(0.76)
Max	16.01	39.12	40.38	36.70	38.54	41.12	39.41	40.32	38.53	36.82	42.29	38.83	39.97	46.23	52.43
P(NI<0)	22	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.91	15.17	14.64	15.10	15.56	16.58	15.63	15.45	15.60	15.61	15.74	15.95	16.55	17.10	17.44
St. Dev.	3.34	7.02	6.90	7.08	6.81	7.07	7.44	7.34	7.33	7.24	7.10	7.70	7.89	7.78	8.00
CV	114.81	46.30	47.18	46.92	43.77	42.65	47.57	47.51	47.01	46.35	45.09	48.27	47.69	45.50	45.86
Min	(5.48)	(0.46)	(0.57)	(3.06)	(4.83)	(1.34)	(6.37)	(7.87)	(1.75)	(2.13)	(6.06)	(2.41)	(2.18)	(2.91)	(2.05)
Max	14.18	41.18	36.57	39.80	34.65	44.46	42.22	41.77	43.55	38.97	37.73	40.36	43.86	47.56	57.51
P(NI<0)	21	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table B.2. Simulation Summary Statistics for Ending Cash Balance for a 44 Ton/Hour Production Facility at Base Initial Investment Scenario with No Incentives

PH 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.78	8.47	14.01	19.65	25.58	31.97	38.03	43.90	49.68	55.41	61.19	66.95	72.94	78.77	84.64
St. Dev.	1.80	3.68	4.90	5.68	6.52	7.39	8.34	9.02	9.66	10.49	11.12	11.68	12.60	13.17	13.75
CV	64.79	43.46	34.99	28.90	25.49	23.11	21.92	20.55	19.46	18.92	18.18	17.45	17.27	16.72	16.24
Min	(3.50)	(0.49)	(1.40)	4.35	5.90	10.72	12.94	18.29	25.42	29.49	29.23	33.01	37.11	38.63	47.29
Max	9.40	21.53	29.50	34.68	50.53	54.98	61.80	71.40	77.35	86.82	94.22	99.47	107.70	116.82	123.88
P(EC<0)	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.82	8.62	14.25	20.06	26.12	32.66	38.91	44.98	50.94	56.90	62.88	68.95	75.25	81.45	87.62
St. Dev.	1.59	3.27	4.47	5.32	6.11	6.71	7.56	8.25	8.93	9.46	10.00	10.67	11.28	11.93	12.53
CV	56.49	37.96	31.34	26.53	23.39	20.56	19.43	18.35	17.54	16.63	15.90	15.47	14.99	14.65	14.30
Min	(3.29)	(0.83)	0.75	6.11	10.64	11.53	16.87	19.85	25.54	30.12	28.70	33.57	42.18	47.50	49.40
Max	8.21	17.97	28.38	35.65	45.79	53.20	62.49	69.57	76.91	80.50	91.07	98.46	104.39	110.76	123.00
P(EC<0)	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.94	8.75	14.32	20.06	26.05	32.50	38.62	44.53	50.31	56.06	61.80	67.59	73.55	79.35	85.07
St. Dev.	1.56	3.27	4.39	5.20	5.98	6.59	7.44	8.14	8.82	9.39	9.91	10.55	11.18	11.82	12.44
CV	52.97	37.42	30.66	25.93	22.98	20.29	19.26	18.28	17.52	16.74	16.04	15.62	15.20	14.90	14.63
Min	(3.12)	(0.33)	1.24	5.94	10.22	10.86	14.12	18.55	24.94	28.47	27.01	31.81	39.45	44.45	45.71
Max	7.61	17.36	27.59	37.60	46.93	53.59	60.50	66.55	73.48	77.32	88.01	96.91	103.20	107.44	116.48
P(EC<0)	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table B.3. Simulation Summary Statistics for Dividends Paid for a 44 Ton/Hour Production Facility at Base Initial Investment Scenario with No Incentives

PH 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.49	3.10	3.00	3.03	3.15	3.35	3.17	3.09	3.08	3.09	3.15	3.17	3.32	3.49	3.64
St. Dev.	0.59	1.54	1.51	1.50	1.50	1.55	1.58	1.51	1.53	1.59	1.57	1.57	1.70	1.60	1.70
CV	121.05	49.58	50.36	49.50	47.55	46.31	49.87	48.65	49.77	51.54	49.90	49.56	51.28	45.77	46.65
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	3.47	9.50	8.68	8.16	9.33	8.82	8.67	8.50	9.24	9.25	9.07	10.11	10.40	9.24	9.64
P(Div>0)	63	99	99	99	99	99	99	99	99	99	99	99	99	99	99

CEN 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.50	3.15	3.04	3.10	3.20	3.40	3.23	3.15	3.11	3.13	3.17	3.23	3.37	3.55	3.66
St. Dev.	0.57	1.36	1.37	1.42	1.34	1.38	1.44	1.43	1.41	1.41	1.38	1.49	1.52	1.51	1.56
CV	114.19	43.03	45.22	45.68	41.98	40.67	44.67	45.45	45.15	45.19	43.59	46.04	45.11	42.59	42.60
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	2.96	7.77	7.97	7.23	7.58	8.09	7.75	7.87	7.45	7.12	8.19	7.51	7.73	9.00	10.23
P(Div>0)	70	99	99	99	99	99	99	99	99	99	99	99	99	99	99

CB 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.50	3.11	2.97	3.03	3.12	3.32	3.14	3.04	3.00	3.00	3.03	3.07	3.18	3.33	3.42
St. Dev.	0.55	1.37	1.34	1.37	1.32	1.37	1.44	1.41	1.42	1.40	1.36	1.49	1.53	1.50	1.55
CV	110.11	43.83	45.19	45.28	42.15	41.29	45.80	46.51	47.23	46.49	44.95	48.53	47.94	45.13	45.26
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	2.62	8.17	7.23	7.83	6.83	8.74	8.30	8.15	8.43	7.54	7.30	7.81	8.49	9.26	11.22
P(Div>0)	71	99	99	99	99	99	99	99	99	99	99	99	99	99	99

Note: See Table 17 on page 119 for definition of abbreviations

Table B.4. Simulation Summary Statistics for Real Net Worth for a 44 Ton/Hour Production Facility at Base Initial Investment Scenario No Incentives

PH 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	11.74	15.70	18.89	21.61	23.96	26.07	27.58	28.65	29.41	29.92	30.24	30.38	30.46	30.48	30.43
St. Dev.	1.54	2.92	3.60	3.87	4.11	4.31	4.50	4.51	4.48	4.50	4.42	4.30	4.29	4.15	4.01
CV	13.14	18.61	19.07	17.89	17.15	16.54	16.33	15.75	15.22	15.03	14.61	14.14	14.08	13.62	13.19
Min	6.36	8.58	7.56	11.19	11.56	13.67	14.02	15.84	18.17	18.80	17.55	17.91	18.26	17.82	19.53
Max	17.42	26.07	30.28	31.84	39.68	39.50	40.42	42.41	42.23	43.39	43.36	42.34	42.29	42.47	41.88
P(RNW<0)	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	8.86	12.92	16.16	18.94	21.34	23.54	25.11	26.23	27.03	27.59	27.96	28.17	28.31	28.39	28.39
St. Dev.	1.37	2.60	3.28	3.62	3.85	3.92	4.08	4.13	4.14	4.06	3.97	3.92	3.84	3.76	3.66
CV	15.44	20.10	20.31	19.12	18.04	16.64	16.27	15.74	15.31	14.71	14.20	13.92	13.56	13.25	12.89
Min	3.62	5.42	6.24	9.44	11.59	11.21	13.21	13.66	15.27	16.10	14.38	15.16	17.05	17.69	17.23
Max	13.48	20.35	26.55	29.55	33.74	35.52	37.85	38.54	39.06	37.71	39.15	39.02	38.22	37.63	38.71
P(RNW<0)	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 44 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	8.96	13.03	16.21	18.94	21.29	23.44	24.95	26.01	26.74	27.23	27.53	27.67	27.73	27.73	27.64
St. Dev.	1.34	2.60	3.23	3.54	3.77	3.85	4.02	4.07	4.08	4.03	3.94	3.88	3.81	3.73	3.63
CV	14.92	19.96	19.90	18.69	17.71	16.41	16.10	15.65	15.27	14.78	14.30	14.03	13.73	13.44	13.14
Min	3.76	5.82	6.60	9.33	11.32	10.82	11.72	13.02	14.99	15.40	13.71	14.52	16.11	16.73	16.15
Max	12.96	19.86	25.97	30.87	34.45	35.75	36.78	37.02	37.47	36.35	37.93	38.45	37.82	36.59	36.81
P(RNW<0)	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table B.5. Simulation Summary Statistics for Net Present Value and Community Impacts for a 44 Ton/Hour Production Facility at Base Initial Investment Scenario No Incentives

PH 44 BASE NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	39.67	12.20	41.89	2.62	15.44
St. Dev.	7.34	0.08	2.45	0.00	2.86
CV	18.52	0.63	5.84	0.00	18.52
Min	19.60	11.99	34.91	2.62	6.89
Max	61.20	12.43	49.05	2.62	24.16
P(<0)	1	1	1	1	1

CEN 44 BASE NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	41.20	12.20	40.11	3.49	16.46
St. Dev.	6.71	0.08	1.35	0.00	1.75
CV	16.30	0.63	3.37	0.00	10.66
Min	21.55	11.99	36.06	3.49	11.28
Max	59.40	12.43	44.25	3.49	21.88
P(<0)	1	1	1	1	1

CB 44 BASE NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	39.71	12.20	39.37	2.93	19.77
St. Dev.	6.65	0.08	1.44	0.00	2.29
CV	16.75	0.63	3.66	0.00	11.60
Min	19.84	11.99	35.93	2.93	13.98
Max	56.30	12.43	44.18	2.93	27.07
P(<0)	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table B.6. Simulation Summary Statistics for Net Income for a 44 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with No Incentives

PH 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.34	14.36	14.05	14.34	14.89	15.89	14.92	14.84	15.13	15.17	15.46	15.54	16.34	17.06	17.81
St. Dev.	3.73	7.90	7.77	7.73	7.73	8.00	8.18	7.83	7.92	8.24	8.14	8.10	8.80	8.24	8.76
CV	279.35	55.02	55.29	53.91	51.92	50.35	54.82	52.73	52.35	54.30	52.69	52.15	53.88	48.29	49.20
Min	(7.15)	(1.78)	(1.32)	(3.63)	(5.48)	(2.15)	(6.97)	(9.68)	(2.86)	(3.08)	(4.45)	(2.53)	(2.41)	(2.55)	(1.22)
Max	17.43	47.25	43.29	40.70	46.67	44.04	43.22	42.67	46.82	46.81	45.89	51.25	52.74	46.65	48.61
P(NI<0)	42	1	1	1	1	1	2	1	1	1	1	1	1	1	1

CEN 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.70	14.79	14.40	14.84	15.28	16.26	15.35	15.23	15.38	15.45	15.64	15.93	16.64	17.44	17.97
St. Dev.	3.41	6.97	7.07	7.31	6.94	7.13	7.46	7.43	7.27	7.32	7.19	7.68	7.85	7.80	8.05
CV	201.00	47.16	49.12	49.28	45.45	43.85	48.59	48.77	47.25	47.38	45.97	48.23	47.18	44.75	44.81
Min	(6.71)	(0.83)	(0.79)	(3.36)	(4.97)	(1.54)	(6.41)	(8.53)	(2.09)	(2.36)	(6.32)	(2.49)	(2.11)	(2.76)	(1.47)
Max	14.86	38.56	39.79	36.08	37.87	40.38	38.64	39.53	37.72	36.00	41.46	37.98	39.09	45.48	51.73
P(NI<0)	34	1	1	1	1	1	2	1	1	1	1	1	1	1	1

CB 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.77	14.61	14.04	14.47	14.89	15.86	14.87	14.67	14.80	14.80	14.91	15.11	15.69	16.35	16.74
St. Dev.	3.34	7.02	6.91	7.08	6.81	7.07	7.44	7.34	7.33	7.24	7.10	7.70	7.89	7.78	8.00
CV	189.42	48.08	49.18	48.96	45.74	44.58	49.99	50.06	49.54	48.90	47.59	50.96	50.29	47.56	47.78
Min	(6.63)	(1.02)	(1.17)	(3.69)	(5.50)	(2.05)	(7.13)	(8.66)	(2.55)	(2.93)	(6.88)	(3.25)	(3.06)	(3.64)	(2.75)
Max	13.04	40.61	35.98	39.17	33.97	43.72	41.45	40.98	42.76	38.17	36.88	39.53	42.99	46.83	56.82
P(NI<0)	34	1	1	1	1	1	2	1	1	1	2	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table B.7. Simulation Summary Statistics for Ending Cash Balance for a 44 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with No Incentives

PH 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.66	7.97	13.12	18.34	23.84	29.81	35.44	40.81	46.02	51.17	56.33	61.44	66.77	71.85	76.91
St. Dev.	1.99	3.79	5.01	5.78	6.61	7.47	8.43	9.12	9.76	10.59	11.23	11.79	12.71	13.28	13.86
CV	74.73	47.59	38.18	31.51	27.72	25.06	23.78	22.34	21.21	20.69	19.93	19.19	19.04	18.49	18.02
Min	(4.04)	(1.42)	(3.33)	2.41	3.53	7.91	9.55	14.37	20.98	24.45	23.27	26.39	30.40	31.15	38.40
Max	9.46	21.13	28.49	33.57	48.67	52.70	59.10	68.52	73.94	82.49	89.61	94.25	101.44	110.19	116.45
P(EC<0)	9	2	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.76	8.21	13.47	18.90	24.58	30.73	36.59	42.23	47.70	53.14	58.59	64.10	69.84	75.39	80.87
St. Dev.	1.74	3.35	4.54	5.40	6.18	6.77	7.63	8.32	9.00	9.53	10.07	10.74	11.36	12.01	12.61
CV	63.13	40.88	33.71	28.55	25.13	22.04	20.84	19.71	18.87	17.94	17.19	16.76	16.26	15.93	15.59
Min	(3.75)	(1.66)	(0.85)	4.68	8.65	9.14	14.10	16.62	21.83	26.25	23.46	27.75	35.77	40.45	41.62
Max	8.30	17.69	27.74	34.65	44.34	51.38	60.38	67.01	73.87	76.67	87.01	93.75	99.20	104.91	116.47
P(EC<0)	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.91	8.39	13.62	19.00	24.63	30.73	36.49	41.98	47.30	52.55	57.78	63.03	68.44	73.62	78.67
St. Dev.	1.70	3.36	4.47	5.27	6.05	6.65	7.50	8.21	8.88	9.46	9.99	10.64	11.26	11.91	12.53
CV	58.57	39.99	32.78	27.75	24.56	21.65	20.56	19.56	18.78	18.00	17.29	16.88	16.46	16.18	15.93
Min	(3.56)	(1.10)	(0.27)	4.61	8.36	8.63	11.49	15.52	21.44	24.45	22.04	26.29	33.35	37.71	38.27
Max	7.72	17.14	27.04	36.69	45.58	51.90	58.56	64.18	70.67	73.83	84.19	92.49	98.34	101.96	110.33
P(EC<0)	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table B.8. Simulation Summary Statistics for Dividends Paid for a 44 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with No Incentives

PH 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.32	3.02	2.90	2.92	3.02	3.22	3.03	2.93	2.89	2.90	2.95	2.97	3.12	3.32	3.49
St. Dev.	0.49	1.54	1.51	1.50	1.50	1.55	1.58	1.50	1.53	1.59	1.57	1.57	1.70	1.59	1.70
CV	152.40	51.01	52.16	51.47	49.54	48.23	52.16	51.31	52.93	54.83	53.08	52.80	54.54	48.04	48.65
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	3.18	9.42	8.58	8.04	9.20	8.69	8.53	8.33	9.05	9.05	8.87	9.91	10.20	9.07	9.48
P(Div>0)	48	99	99	99	99	99	98	99	99	99	99	99	99	99	99

CEN 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.33	3.08	2.95	3.00	3.09	3.28	3.10	3.00	2.94	2.95	2.99	3.04	3.18	3.40	3.52
St. Dev.	0.48	1.36	1.38	1.42	1.34	1.38	1.44	1.43	1.40	1.41	1.38	1.48	1.52	1.51	1.56
CV	146.66	44.07	46.64	47.25	43.49	42.17	46.48	47.68	47.71	47.81	46.06	48.74	47.68	44.46	44.25
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	2.69	7.70	7.89	7.12	7.47	7.96	7.62	7.71	7.28	6.94	8.01	7.33	7.54	8.85	10.09
P(Div>0)	50	99	99	99	99	99	99	99	99	99	99	99	99	99	99

CB 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.33	3.05	2.88	2.93	3.01	3.20	3.01	2.89	2.83	2.83	2.85	2.89	3.00	3.19	3.29
St. Dev.	0.47	1.37	1.34	1.37	1.32	1.37	1.44	1.41	1.41	1.39	1.36	1.48	1.52	1.50	1.55
CV	141.11	44.87	46.65	46.84	43.71	42.83	47.69	48.86	49.96	49.23	47.56	51.43	50.77	47.14	47.04
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	2.35	8.10	7.14	7.73	6.71	8.61	8.17	8.00	8.26	7.36	7.11	7.63	8.30	9.11	11.09
P(Div>0)	53	99	99	99	99	99	98	99	99	99	98	98	99	99	99

Note: See Table 17 on page 119 for definition of abbreviations

Table B.9. Simulation Summary Statistics for Real Net Worth for a 44 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with No Incentives

PH 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	14.45	18.00	20.81	23.19	25.22	27.04	28.29	29.12	29.64	29.94	30.10	30.09	30.04	29.99	29.89
St. Dev.	1.70	3.01	3.68	3.93	4.16	4.36	4.55	4.56	4.52	4.54	4.46	4.34	4.33	4.19	4.04
CV	11.79	16.74	17.69	16.96	16.51	16.12	16.09	15.66	15.25	15.16	14.82	14.41	14.40	13.96	13.53
Min	8.71	10.55	8.72	12.35	12.42	14.26	14.30	15.89	18.04	18.48	16.97	17.20	17.66	17.16	18.65
Max	20.28	28.44	32.11	33.55	40.86	40.39	41.07	42.98	42.57	43.38	43.31	42.15	41.85	42.07	41.43
P(RNW<0)	9	2	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	10.73	14.42	17.29	19.73	21.83	23.76	25.09	25.98	26.56	26.94	27.15	27.23	27.27	27.30	27.26
St. Dev.	1.49	2.66	3.34	3.67	3.89	3.95	4.12	4.16	4.17	4.09	4.00	3.95	3.87	3.79	3.68
CV	13.91	18.47	19.30	18.61	17.83	16.64	16.42	16.03	15.69	15.18	14.73	14.51	14.18	13.87	13.50
Min	5.15	6.59	6.77	10.05	11.80	11.16	12.93	13.17	14.58	15.40	13.19	13.87	15.67	16.28	15.80
Max	15.48	21.94	27.79	30.46	34.28	35.80	37.94	38.38	38.69	37.03	38.43	38.13	37.26	36.61	37.65
P(RNW<0)	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 44 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	10.86	14.57	17.41	19.81	21.87	23.76	25.03	25.86	26.37	26.68	26.82	26.84	26.79	26.74	26.62
St. Dev.	1.46	2.66	3.28	3.59	3.81	3.88	4.05	4.11	4.12	4.06	3.97	3.91	3.84	3.75	3.66
CV	13.45	18.29	18.85	18.12	17.43	16.34	16.19	15.88	15.60	15.21	14.79	14.57	14.32	14.04	13.74
Min	5.32	7.03	7.20	10.01	11.62	10.86	11.52	12.62	14.40	14.63	12.63	13.33	14.84	15.42	14.83
Max	14.99	21.51	27.27	31.84	35.07	36.11	36.95	36.96	37.20	35.81	37.31	37.67	36.97	35.68	35.86
P(RNW<0)	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table B.10. Simulation Summary Statistics for Net Present Value and Community Impacts for a 44 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with No Incentives

PH 44 +30 NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	33.90	12.20	41.89	3.41	15.44
St. Dev.	7.36	0.08	2.45	0.00	2.86
CV	21.71	0.63	5.84	0.00	18.52
Min	13.75	11.99	34.91	3.41	6.89
Max	55.43	12.43	49.05	3.41	24.16
P(<0)	1	1	1	1	1

CEN 44 +30 NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	35.91	12.20	40.11	4.54	16.46
St. Dev.	6.72	0.08	1.35	0.00	1.75
CV	18.72	0.63	3.37	0.00	10.66
Min	16.13	11.99	36.06	4.54	11.28
Max	54.09	12.43	44.25	4.54	21.88
P(<0)	1	1	1	1	1

CB 44 +30 NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	34.53	12.20	39.37	3.81	19.77
St. Dev.	6.66	0.08	1.44	0.00	2.29
CV	19.29	0.63	3.66	0.00	11.60
Min	14.53	11.99	35.93	3.81	13.98
Max	51.13	12.43	44.18	3.81	27.07
P(<0)	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

APPENDIX C

SIMULATION SUMMARY STATISTICS OF KEY OUTPUT VARIABLES FOR A 44 TON/HOUR MIXALCO PRODUCTION FACILITY AT BASE AND PLUS 30 INITIAL INVESTMENT SCENARIOS WITH INCENTIVES

Table C.1. Simulation Summary Statistics for Net Income for a 44 Ton/Hour Production Facility at Base Initial Investment Scenario with Incentives

PH 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.59	15.02	14.76	15.10	15.73	16.81	15.91	15.88	16.20	16.28	16.61	16.71	17.53	18.15	18.86
St. Dev.	3.73	7.90	7.77	7.73	7.73	8.00	8.18	7.83	7.92	8.24	8.14	8.10	8.80	8.24	8.76
CV	144.03	52.62	52.65	51.21	49.17	47.59	51.41	49.28	48.87	50.58	49.04	48.49	50.20	45.40	46.46
Min	(5.89)	(1.13)	(0.58)	(2.88)	(4.66)	(1.23)	(5.97)	(8.62)	(1.79)	(1.96)	(3.27)	(1.38)	(1.20)	(1.48)	(0.16)
Max	18.68	47.90	43.99	41.46	47.51	44.96	44.21	43.72	47.88	47.94	47.05	52.40	53.93	47.72	49.67
P(NI<0)	29	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.85	15.36	15.02	15.51	16.03	17.09	16.23	16.16	16.34	16.43	16.64	16.95	17.68	18.37	18.87
St. Dev.	3.41	6.97	7.07	7.31	6.94	7.13	7.46	7.43	7.27	7.32	7.19	7.68	7.85	7.80	8.05
CV	119.97	45.41	47.09	47.14	43.34	41.72	45.94	45.97	44.50	44.56	43.21	45.33	44.40	42.48	42.67
Min	(5.56)	(0.25)	(0.17)	(2.69)	(4.23)	(0.72)	(5.53)	(7.60)	(1.14)	(1.39)	(5.33)	(1.47)	(1.04)	(1.83)	(0.57)
Max	16.01	39.13	40.41	36.75	38.61	41.23	39.53	40.45	38.67	36.96	42.45	38.99	40.13	46.40	52.62
P(NI<0)	22	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	2.91	15.18	14.66	15.14	15.64	16.69	15.76	15.59	15.75	15.77	15.90	16.11	16.72	17.27	17.62
St. Dev.	3.34	7.02	6.90	7.08	6.81	7.07	7.44	7.34	7.33	7.24	7.10	7.70	7.89	7.78	8.00
CV	119.97	45.41	47.09	47.14	43.34	41.72	45.94	45.97	44.50	44.56	43.21	45.33	44.40	42.48	42.67
Min	(5.48)	(0.45)	(0.55)	(3.02)	(4.75)	(1.23)	(6.25)	(7.73)	(1.60)	(1.97)	(5.90)	(2.25)	(2.00)	(2.73)	(1.86)
Max	14.18	41.19	36.60	39.84	34.73	44.57	42.34	41.91	43.70	39.12	37.89	40.54	44.03	47.73	57.69
P(NI<0)	21	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table C.2. Simulation Summary Statistics for Ending Cash Balance for a 44 Ton/Hour Production Facility at Base Initial Investment Scenario with Incentives

PH 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	3.26	9.39	15.36	21.44	27.80	34.64	41.14	47.43	53.63	59.78	65.70	71.60	77.74	83.73	89.75
St. Dev.	1.81	3.70	4.93	5.72	6.56	7.44	8.39	9.08	9.73	10.55	11.19	11.76	12.68	13.25	13.84
CV	55.37	39.42	32.09	26.66	23.60	21.47	20.40	19.14	18.14	17.65	17.04	16.42	16.31	15.83	15.42
Min	(3.01)	0.41	(0.10)	6.06	8.02	13.27	16.02	21.63	29.34	33.81	33.81	37.72	41.67	43.30	52.44
Max	9.92	22.54	30.96	36.57	52.93	57.81	65.07	75.11	81.49	91.40	98.95	104.34	112.75	122.04	129.28
P(EC<0)	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	3.32	9.58	15.62	21.79	28.17	34.99	41.46	47.72	53.83	59.89	65.99	72.17	78.59	84.91	91.21
St. Dev.	1.60	3.29	4.49	5.36	6.15	6.76	7.61	8.31	8.99	9.53	10.06	10.74	11.35	12.01	12.62
CV	48.33	34.36	28.77	24.58	21.83	19.32	18.36	17.41	16.71	15.90	15.25	14.88	14.44	14.15	13.83
Min	(2.80)	0.11	2.07	7.77	12.62	13.74	19.31	22.45	28.28	32.92	31.85	36.83	45.58	51.01	53.00
Max	8.74	18.99	29.84	37.49	47.97	55.66	65.21	72.48	79.98	83.66	94.38	101.90	107.94	114.43	126.85
P(EC<0)	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	3.40	9.70	15.75	21.86	28.23	34.97	41.37	47.38	53.28	59.13	64.99	70.89	76.97	82.90	88.74
St. Dev.	1.57	3.29	4.42	5.24	6.02	6.64	7.48	8.19	8.87	9.45	9.97	10.62	11.25	11.90	12.53
CV	48.33	34.36	28.77	24.58	21.83	19.32	18.36	17.41	16.71	15.90	15.25	14.88	14.44	14.15	13.83
Min	(2.66)	0.60	2.60	7.67	12.33	13.22	16.84	21.26	27.75	31.49	30.25	35.16	42.92	48.04	49.39
Max	8.10	18.36	29.11	39.52	49.25	56.20	63.40	69.55	76.61	80.55	91.38	100.42	106.82	111.18	120.36
P(EC<0)	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table C.3. Simulation Summary Statistics for Dividends Paid for a 44 Ton/Hour Production Facility at Base Initial Investment Scenario with Incentives

PH 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.49	3.10	3.00	3.04	3.16	3.37	3.20	3.13	3.11	3.13	3.19	3.21	3.37	3.53	3.69
St. Dev.	0.59	1.54	1.51	1.50	1.50	1.55	1.58	1.51	1.53	1.59	1.57	1.57	1.70	1.60	1.70
CV	121.02	49.55	50.28	49.36	47.33	46.00	49.46	48.18	49.22	50.90	49.24	48.86	50.58	45.14	46.02
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	3.47	9.50	8.69	8.16	9.34	8.85	8.70	8.53	9.27	9.29	9.11	10.16	10.45	9.29	9.69
P(Div>0)	63	99	99	99	99	99	99	99	99	99	99	99	99	99	99

CEN 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.50	3.15	3.04	3.11	3.21	3.42	3.25	3.17	3.14	3.16	3.20	3.26	3.40	3.58	3.70
St. Dev.	0.57	1.36	1.37	1.42	1.34	1.38	1.44	1.43	1.41	1.41	1.38	1.49	1.52	1.51	1.56
CV	114.19	43.00	45.15	45.55	41.80	40.43	44.35	45.08	44.76	44.79	43.19	45.60	44.69	42.19	42.20
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	2.96	7.77	7.98	7.23	7.60	8.11	7.78	7.89	7.48	7.15	8.22	7.54	7.77	9.03	10.26
P(Div>0)	70	99	99	99	99	99	99	99	99	99	99	99	99	99	99

CB 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.50	3.12	2.97	3.04	3.14	3.34	3.16	3.06	3.03	3.03	3.06	3.10	3.21	3.37	3.46
St. Dev.	0.55	1.37	1.34	1.37	1.32	1.37	1.44	1.41	1.42	1.40	1.36	1.49	1.53	1.50	1.55
CV	114.19	43.00	45.15	45.55	41.80	40.43	44.35	45.08	44.76	44.79	43.19	45.60	44.69	42.19	42.20
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	2.62	8.17	7.23	7.84	6.84	8.76	8.33	8.18	8.46	7.57	7.33	7.84	8.52	9.29	11.25
P(Div>0)	71	99	99	99	99	99	99	99	99	99	99	99	99	99	99

Note: See Table 17 on page 119 for definition of abbreviations

Table C.4. Simulation Summary Statistics for Real Net Worth for a 44 Ton/Hour Production Facility at Base Initial Investment Scenario with Incentives

PH 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	12.16	16.43	19.88	22.83	25.36	27.63	29.26	30.42	31.24	31.79	32.03	32.10	32.09	32.04	31.92
St. Dev.	1.55	2.94	3.62	3.89	4.13	4.34	4.53	4.54	4.50	4.53	4.44	4.32	4.32	4.18	4.04
CV	12.74	17.88	18.23	17.04	16.30	15.71	15.49	14.93	14.42	14.24	13.87	13.47	13.45	13.04	12.65
Min	6.78	9.30	8.52	12.36	12.90	15.16	15.69	17.52	19.99	20.65	19.37	19.64	19.81	19.29	21.03
Max	17.87	26.87	31.35	33.12	41.19	41.15	42.19	44.27	44.15	45.35	45.24	44.14	44.01	44.12	43.46
P(RNW<0)	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	9.28	13.68	17.17	20.12	22.63	24.90	26.49	27.60	28.37	28.87	29.19	29.35	29.44	29.49	29.44
St. Dev.	1.37	2.61	3.30	3.64	3.88	3.94	4.11	4.16	4.17	4.09	4.00	3.95	3.87	3.79	3.68
CV	14.81	19.10	19.24	18.12	17.12	15.84	15.52	15.05	14.68	14.15	13.69	13.45	13.13	12.84	12.51
Min	4.04	6.17	7.21	10.57	12.83	12.50	14.52	14.96	16.54	17.31	15.63	16.36	18.20	18.80	18.28
Max	13.93	21.16	27.62	30.80	35.11	36.96	39.32	39.99	40.48	39.07	40.46	40.29	39.43	38.79	39.84
P(RNW<0)	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 44 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	9.35	13.78	17.26	20.17	22.67	24.88	26.44	27.44	28.11	28.55	28.79	28.88	28.89	28.85	28.72
St. Dev.	1.34	2.62	3.25	3.56	3.80	3.87	4.04	4.10	4.11	4.05	3.96	3.91	3.83	3.75	3.66
CV	14.81	19.10	19.24	18.12	17.12	15.84	15.52	15.05	14.68	14.15	13.69	13.45	13.13	12.84	12.51
Min	4.16	6.56	7.60	10.51	12.65	12.19	13.19	14.37	16.29	16.69	15.00	15.75	17.30	17.86	17.23
Max	13.38	20.65	27.08	32.18	35.92	37.27	38.34	38.53	38.92	37.73	39.27	39.74	39.05	37.77	37.95
P(RNW<0)	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table C.5. Simulation Summary Statistics for Net Present Value and Community Impacts for a 44 Ton/Hour Production Facility at Base Initial Investment Scenario with Incentives

PH 44 BASE YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	41.26	12.20	41.89	0.41	15.44
St. Dev.	7.37	0.08	2.45	0.00	2.86
CV	17.87	0.63	5.84	0.00	18.52
Min	21.12	11.99	34.91	0.41	6.89
Max	62.89	12.43	49.05	0.41	24.16
P(<0)	1	1	1	1	1

CEN 44 BASE YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	42.38	12.20	40.11	1.89	16.46
St. Dev.	6.74	0.08	1.35	0.00	1.75
CV	15.91	0.63	3.37	0.00	10.66
Min	22.72	11.99	36.06	1.89	11.28
Max	60.66	12.43	44.25	1.89	21.88
P(<0)	1	1	1	1	1

CB 44 BASE YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	40.92	12.20	39.37	1.27	19.77
St. Dev.	6.68	0.08	1.44	0.00	2.29
CV	16.32	0.63	3.66	0.00	11.60
Min	21.03	11.99	35.93	1.27	13.98
Max	57.58	12.43	44.18	1.27	27.07
P(<0)	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table C.6. Simulation Summary Statistics for Net Income for a 44 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with Incentives

PH 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.34	14.38	14.08	14.40	14.99	16.03	15.09	15.05	15.36	15.43	15.74	15.84	16.65	17.38	18.13
St. Dev.	3.73	7.90	7.77	7.73	7.73	8.00	8.18	7.83	7.92	8.24	8.14	8.10	8.80	8.24	8.76
CV	279.07	54.97	55.17	53.71	51.60	49.90	54.19	52.02	51.56	53.38	51.73	51.17	52.89	47.42	48.32
Min	(7.15)	(1.77)	(1.26)	(3.57)	(5.39)	(2.00)	(6.80)	(9.47)	(2.63)	(2.82)	(4.16)	(2.23)	(2.10)	(2.24)	(0.89)
Max	17.43	47.26	43.31	40.75	46.77	44.19	43.39	42.88	47.05	47.07	46.18	51.54	53.06	46.96	48.94
P(NI<0)	42	1	1	1	1	1	2	1	1	1	1	1	1	1	1

CEN 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.70	14.82	14.42	14.94	15.38	16.43	15.50	15.40	15.55	15.66	15.85	16.16	16.87	17.67	18.22
St. Dev.	3.41	6.95	7.07	7.31	6.94	7.12	7.46	7.43	7.28	7.33	7.19	7.72	7.86	7.80	8.02
CV	201.34	46.85	49.03	48.90	45.12	43.36	48.12	48.22	46.84	46.80	45.40	47.77	46.59	44.15	44.01
Min	(6.71)	(0.81)	(0.76)	(3.31)	(4.88)	(1.41)	(6.26)	(8.36)	(1.91)	(2.17)	(6.12)	(2.29)	(1.89)	(2.54)	(1.25)
Max	14.86	38.58	39.82	36.13	37.96	40.51	38.80	39.70	37.89	36.19	41.66	38.18	39.29	45.70	51.95
P(NI<0)	34	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.77	14.62	14.07	14.53	14.99	16.00	15.04	14.85	14.99	15.00	15.11	15.31	15.91	16.58	16.97
St. Dev.	3.34	7.02	6.91	7.08	6.81	7.07	7.44	7.34	7.33	7.24	7.10	7.70	7.89	7.78	8.00
CV	189.42	48.03	49.07	48.76	45.45	44.19	49.45	49.44	48.92	48.26	46.96	50.27	49.61	46.92	47.13
Min	(6.63)	(1.01)	(1.14)	(3.63)	(5.40)	(1.91)	(6.98)	(8.48)	(2.37)	(2.74)	(6.67)	(3.04)	(2.84)	(3.42)	(2.51)
Max	13.04	40.62	36.01	39.23	34.06	43.86	41.61	41.16	42.94	38.36	37.08	39.75	43.20	47.05	57.05
P(NI<0)	34	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table C.7. Simulation Summary Statistics for Ending Cash Balance for a 44 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with Incentives

PH 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	3.26	9.13	14.83	20.60	26.66	33.18	39.35	45.26	51.01	56.67	62.00	67.28	72.78	78.04	83.29
St. Dev.	1.99	3.82	5.04	5.81	6.65	7.52	8.48	9.17	9.82	10.65	11.29	11.86	12.78	13.36	13.94
CV	61.06	41.77	33.97	28.22	24.95	22.66	21.54	20.26	19.25	18.79	18.21	17.62	17.57	17.12	16.74
Min	(3.43)	(0.27)	(1.61)	4.62	6.26	11.18	13.49	18.85	25.98	29.95	29.13	32.40	36.23	37.13	44.93
Max	10.11	22.37	30.30	35.92	51.65	56.22	63.18	73.16	79.10	88.21	95.50	100.29	107.70	116.63	123.10
P(EC<0)	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	3.39	9.44	15.23	21.13	27.20	33.72	39.86	45.72	51.35	56.92	62.51	68.16	74.04	79.74	85.37
St. Dev.	1.75	3.37	4.56	5.41	6.18	6.77	7.63	8.36	9.04	9.58	10.12	10.82	11.45	12.11	12.68
CV	51.51	35.64	29.96	25.59	22.73	20.08	19.14	18.28	17.60	16.83	16.19	15.87	15.46	15.18	14.86
Min	(3.12)	(0.44)	0.86	6.82	11.19	11.99	17.21	19.94	25.31	29.90	27.42	31.84	40.01	44.81	46.10
Max	8.97	18.98	29.59	36.96	47.07	54.46	63.76	70.63	77.67	80.57	91.07	97.96	103.54	109.39	121.14
P(EC<0)	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	3.50	9.60	15.45	21.30	27.41	33.86	39.97	45.58	51.02	56.40	61.76	67.14	72.69	78.01	83.20
St. Dev.	1.71	3.38	4.49	5.31	6.09	6.69	7.55	8.26	8.94	9.52	10.05	10.70	11.33	11.98	12.60
CV	48.85	35.15	29.08	24.91	22.21	19.77	18.88	18.12	17.52	16.87	16.27	15.94	15.59	15.36	15.15
Min	(2.96)	0.10	1.50	6.85	11.07	11.65	14.98	18.98	25.02	28.29	26.12	30.49	37.70	42.19	42.87
Max	8.34	18.40	28.95	39.10	48.49	55.17	62.19	67.94	74.55	77.81	88.34	96.79	102.78	106.54	115.06
P(EC<0)	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table C.8. Simulation Summary Statistics for Dividends Paid for a 44 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with Incentives

PH 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.32	3.02	2.90	2.93	3.04	3.24	3.06	2.97	2.93	2.95	3.01	3.02	3.18	3.38	3.55
St. Dev.	0.49	1.54	1.51	1.50	1.50	1.55	1.58	1.50	1.53	1.59	1.57	1.57	1.70	1.60	1.70
CV	152.36	50.96	52.06	51.29	49.24	47.82	51.63	50.66	52.14	53.94	52.14	51.83	53.55	47.19	47.81
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	3.18	9.42	8.59	8.05	9.22	8.72	8.56	8.37	9.09	9.10	8.92	9.97	10.26	9.13	9.55
P(Div>0)	48	99	99	99	99	99	98	99	99	99	99	99	99	99	99

CEN 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.33	3.09	2.96	3.02	3.11	3.31	3.13	3.03	2.97	2.99	3.03	3.09	3.23	3.44	3.57
St. Dev.	0.48	1.35	1.38	1.42	1.34	1.38	1.44	1.43	1.41	1.41	1.38	1.49	1.52	1.51	1.55
CV	146.96	43.75	46.56	46.89	43.19	41.71	46.06	47.17	47.33	47.23	45.52	48.30	47.10	43.89	43.47
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	2.69	7.71	7.89	7.13	7.49	7.99	7.65	7.75	7.31	6.98	8.04	7.37	7.58	8.89	10.14
P(Div>0)	50	99	99	99	99	99	99	99	99	99	99	99	99	99	99

CB 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.33	3.05	2.89	2.94	3.03	3.23	3.04	2.92	2.86	2.86	2.89	2.93	3.04	3.23	3.33
St. Dev.	0.47	1.37	1.34	1.37	1.32	1.37	1.44	1.41	1.41	1.39	1.36	1.49	1.52	1.50	1.55
CV	141.11	44.83	46.55	46.66	43.44	42.47	47.22	48.29	49.36	48.62	46.96	50.76	50.10	46.54	46.44
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	2.35	8.10	7.15	7.74	6.73	8.64	8.20	8.03	8.29	7.40	7.15	7.67	8.35	9.15	11.13
P(Div>0)	53	99	99	99	99	99	99	99	99	99	99	99	99	99	99

Note: See Table 17 on page 119 for definition of abbreviations

Table C.9. Simulation Summary Statistics for Real Net Worth for a 44 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with Incentives

PH 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	14.97	18.92	22.07	24.72	26.99	29.00	30.40	31.34	31.94	32.30	32.35	32.24	32.09	31.94	31.75
St. Dev.	1.71	3.03	3.70	3.96	4.19	4.39	4.58	4.59	4.55	4.57	4.48	4.36	4.35	4.21	4.07
CV	11.41	16.01	16.78	16.00	15.53	15.13	15.06	14.63	14.23	14.14	13.86	13.53	13.56	13.19	12.82
Min	9.23	11.46	9.98	13.85	14.14	16.17	16.43	18.13	20.35	20.84	19.29	19.41	19.65	19.04	20.55
Max	20.84	29.43	33.44	35.15	42.74	42.45	43.28	45.30	44.96	45.83	45.65	44.38	43.98	44.11	43.37
P(RNW<0)	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	11.27	15.40	18.59	21.25	23.49	25.50	26.85	27.73	28.25	28.56	28.70	28.73	28.70	28.67	28.58
St. Dev.	1.50	2.67	3.35	3.68	3.90	3.95	4.12	4.18	4.19	4.11	4.02	3.98	3.90	3.82	3.70
CV	13.28	17.35	18.04	17.32	16.59	15.49	15.35	15.08	14.82	14.38	14.01	13.85	13.58	13.31	12.96
Min	5.70	7.55	8.03	11.51	13.40	12.82	14.62	14.83	16.19	16.97	14.77	15.37	17.11	17.66	17.11
Max	16.06	22.97	29.14	32.03	36.01	37.60	39.76	40.19	40.45	38.70	40.04	39.68	38.74	38.02	39.01
P(RNW<0)	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 44 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	11.37	15.53	18.75	21.37	23.62	25.58	26.91	27.66	28.10	28.33	28.40	28.35	28.24	28.12	27.94
St. Dev.	1.47	2.68	3.30	3.61	3.84	3.91	4.08	4.13	4.14	4.08	3.99	3.93	3.86	3.78	3.68
CV	12.90	17.26	17.61	16.90	16.24	15.27	15.15	14.94	14.73	14.41	14.05	13.88	13.66	13.43	13.17
Min	5.83	7.98	8.50	11.53	13.32	12.62	13.41	14.35	16.06	16.28	14.25	14.87	16.32	16.83	16.17
Max	15.52	22.51	28.67	33.48	36.91	38.02	38.92	38.84	39.00	37.52	38.96	39.25	38.48	37.12	37.24
P(RNW<0)	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table C.10. Simulation Summary Statistics for Net Present Value and Community Impacts for a 44 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with Incentives

PH 44 +30 YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	35.91	12.20	41.89	0.54	15.44
St. Dev.	7.39	0.08	2.45	0.00	2.86
CV	20.57	0.63	5.84	0.00	18.52
Min	15.68	11.99	34.91	0.54	6.89
Max	57.53	12.43	49.05	0.54	24.16
P(<0)	1	1	1	1	1

CEN 44 +30 YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	37.41	12.20	40.12	2.46	16.46
St. Dev.	6.74	0.08	1.35	0.00	1.76
CV	18.01	0.63	3.37	0.00	10.66
Min	17.59	11.99	36.06	2.46	11.28
Max	55.63	12.43	44.25	2.46	21.88
P(<0)	1	1	1	1	1

CB 44 +30 YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	36.03	12.20	39.37	1.64	19.77
St. Dev.	6.69	0.08	1.44	0.00	2.29
CV	18.56	0.63	3.66	0.00	11.60
Min	16.02	11.99	35.93	1.64	13.98
Max	52.70	12.43	44.18	1.64	27.07
P(<0)	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

APPENDIX D

SIMULATION SUMMARY STATISTICS OF KEY OUTPUT VARIABLES FOR A 176 TON/HOUR MIXALCO PRODUCTION FACILITY AT BASE AND PLUS 30 INITIAL INVESTMENT SCENARIOS WITH NO INCENTIVES

Table D.1. Simulation Summary Statistics for Net Income for a 176 Ton/Hour Production Facility at Base Initial Investment Scenario with No Incentives

PH 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	7.26	42.93	41.63	42.57	44.23	47.27	43.79	43.22	43.80	43.70	44.22	44.07	46.29	47.73	49.49
St. Dev.	11.94	25.14	24.82	24.74	24.67	25.45	26.13	25.00	25.24	26.27	25.90	25.91	28.05	26.24	27.90
CV	164.46	58.56	59.62	58.11	55.78	53.85	59.66	57.85	57.63	60.11	58.57	58.80	60.60	54.98	56.39
Min	(20.80)	(7.05)	(9.15)	(18.52)	(23.39)	(10.41)	(28.84)	(39.78)	(13.05)	(19.65)	(20.96)	(15.39)	(16.64)	(15.45)	(14.09)
Max	58.59	148.38	134.79	126.38	145.30	136.95	133.43	132.22	144.18	144.22	140.20	157.54	162.28	142.58	146.39
P(NI<0)	32	1	2	2	1	1	3	2	2	2	2	3	2	2	2

CEN 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	8.79	46.16	44.77	46.20	47.61	50.71	47.55	46.99	47.25	47.30	47.67	48.30	50.36	52.22	53.46
St. Dev.	11.13	22.68	23.01	23.80	22.63	23.22	24.27	24.19	23.71	23.91	23.44	25.01	25.62	25.41	26.32
CV	126.52	49.13	51.40	51.51	47.52	45.79	51.05	51.48	50.18	50.55	49.19	51.77	50.88	48.65	49.23
Min	(19.02)	(3.61)	(5.40)	(13.74)	(18.56)	(8.45)	(24.12)	(31.78)	(10.44)	(11.23)	(24.24)	(12.31)	(11.53)	(14.67)	(10.18)
Max	51.54	122.73	126.85	114.38	120.29	128.20	122.48	125.80	119.07	112.86	130.87	118.70	123.14	142.53	162.39
P(NI<0)	23	1	1	1	1	1	2	2	1	1	2	2	1	1	1

CB 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	8.32	43.61	41.62	42.92	44.19	47.10	43.60	42.61	42.70	42.39	42.37	42.57	44.08	45.37	45.97
St. Dev.	10.88	22.71	22.44	23.04	22.18	22.95	24.14	23.84	23.83	23.61	23.09	24.94	25.63	25.22	26.11
CV	130.65	52.08	53.93	53.69	50.20	48.74	55.37	55.95	55.80	55.70	54.51	58.60	58.15	55.60	56.80
Min	(19.33)	(5.65)	(8.42)	(16.20)	(23.15)	(11.98)	(29.49)	(34.54)	(14.86)	(19.27)	(28.69)	(17.05)	(18.00)	(21.08)	(17.56)
Max	44.98	126.46	113.25	121.11	106.37	135.35	127.50	125.60	131.56	115.54	113.67	118.97	129.98	142.35	173.40
P(NI<0)	24	1	2	1	1	1	3	3	2	3	2	4	3	3	2

Note: See Table 17 on page 119 for definition of abbreviations

Table D.2. Simulation Summary Statistics for Ending Cash Balance for a 176 Ton/Hour Production Facility at Base Initial Investment Scenario with No Incentives

PH 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	8.43	24.40	39.71	55.30	71.72	89.55	106.02	121.72	136.96	151.93	166.88	181.53	196.81	211.34	225.78
St. Dev.	5.85	11.87	15.84	18.48	21.17	23.88	27.01	29.28	31.43	34.10	36.23	38.07	41.02	42.85	44.77
CV	69.43	48.65	39.88	33.42	29.52	26.67	25.48	24.06	22.94	22.44	21.71	20.97	20.84	20.27	19.83
Min	(12.98)	(5.43)	(13.60)	4.52	7.55	19.42	15.06	30.86	47.67	55.95	52.16	65.21	78.98	86.73	99.26
Max	29.73	66.52	88.94	104.01	151.32	163.16	181.51	209.76	225.81	252.32	273.65	285.88	306.72	333.97	352.12
P(EC<0)	7	2	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	8.91	26.10	42.65	59.74	77.59	96.91	115.08	132.59	149.62	166.53	183.43	200.45	218.13	235.30	252.27
St. Dev.	5.19	10.71	14.64	17.49	20.09	22.05	24.89	27.22	29.44	31.25	33.11	35.28	37.38	39.54	41.54
CV	58.28	41.04	34.32	29.28	25.89	22.75	21.63	20.53	19.68	18.76	18.05	17.60	17.14	16.80	16.47
Min	(11.60)	(5.21)	(3.84)	12.27	25.78	27.03	39.84	49.24	65.94	75.32	62.81	75.81	100.71	115.03	117.61
Max	26.49	56.48	87.87	111.10	141.98	164.13	192.58	213.42	234.83	242.88	275.56	296.41	313.99	331.60	368.46
P(EC<0)	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	8.97	25.39	40.93	56.94	73.65	91.75	108.52	124.44	139.82	154.91	169.82	184.64	199.89	214.42	228.45
St. Dev.	5.16	10.75	14.45	17.19	19.77	21.74	24.63	27.02	29.25	31.21	33.11	35.23	37.41	39.55	41.67
CV	57.54	42.33	35.30	30.20	26.85	23.69	22.70	21.71	20.92	20.15	19.50	19.08	18.71	18.44	18.24
Min	(11.63)	(5.15)	(5.72)	7.76	20.54	19.95	20.60	34.37	49.51	56.01	45.54	57.02	77.57	89.50	88.88
Max	24.14	52.72	82.96	112.76	141.56	160.49	180.98	197.76	217.00	225.88	256.23	279.50	296.97	306.43	332.78
P(EC<0)	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table D.3. Simulation Summary Statistics for Dividends Paid for a 176 Ton/Hour Production Facility at Base Initial Investment Scenario with No Incentives

PH 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.41	8.91	8.50	8.59	8.91	9.49	8.84	8.50	8.36	8.36	8.46	8.43	8.86	9.27	9.68
St. Dev.	1.80	4.90	4.83	4.79	4.78	4.95	5.03	4.79	4.87	5.05	4.97	4.98	5.41	5.07	5.40
CV	127.71	54.96	56.80	55.78	53.60	52.17	56.92	56.35	58.17	60.44	58.76	59.16	61.08	54.64	55.74
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	10.88	29.47	26.66	24.91	28.60	26.97	26.29	25.81	27.91	27.92	27.13	30.52	31.44	27.75	28.55
P(Div>0)	59	99	98	98	99	99	97	98	98	98	98	97	97	98	98

CEN 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.52	9.48	9.06	9.25	9.53	10.13	9.52	9.21	9.03	9.05	9.13	9.24	9.64	10.15	10.45
St. Dev.	1.78	4.42	4.48	4.62	4.39	4.52	4.69	4.66	4.58	4.61	4.50	4.84	4.96	4.92	5.10
CV	117.02	46.66	49.45	49.94	46.06	44.64	49.24	50.59	50.73	50.99	49.31	52.33	51.51	48.50	48.85
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	9.50	24.41	25.07	22.54	23.69	25.23	24.12	24.55	23.02	21.81	25.32	22.95	23.81	27.74	31.68
P(Div>0)	68	99	99	99	99	99	98	98	99	99	99	98	99	99	99

CB 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.46	8.99	8.45	8.62	8.87	9.42	8.77	8.37	8.16	8.11	8.11	8.15	8.44	8.83	9.01
St. Dev.	1.71	4.42	4.36	4.47	4.29	4.46	4.63	4.56	4.58	4.51	4.40	4.77	4.92	4.84	5.02
CV	116.82	49.19	51.60	51.84	48.35	47.37	52.82	54.48	56.09	55.64	54.22	58.43	58.28	54.78	55.68
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	8.23	25.14	22.41	23.85	20.97	26.63	25.10	24.51	25.46	22.33	21.97	23.00	25.15	27.71	33.83
P(Div>0)	66	99	98	99	99	99	97	97	98	97	98	96	96	98	98

Note: See Table 17 on page 119 for definition of abbreviations

Table D.4. Simulation Summary Statistics for Real Net Worth for a 176 Ton/Hour Production Facility at Base Initial Investment Scenario No Incentives

PH 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	38.08	48.98	57.54	64.83	71.10	76.77	80.54	83.03	84.62	85.53	85.95	85.85	85.64	85.31	84.83
St. Dev.	5.02	9.42	11.64	12.58	13.34	13.94	14.59	14.65	14.56	14.62	14.39	14.00	13.97	13.51	13.07
CV	13.17	19.24	20.23	19.40	18.77	18.15	18.12	17.64	17.20	17.10	16.74	16.31	16.31	15.83	15.40
Min	19.73	25.29	18.35	30.27	30.66	35.85	31.39	37.58	43.26	44.36	40.39	43.08	45.52	46.03	47.90
Max	56.35	82.42	93.73	97.98	121.26	119.72	121.32	127.08	125.77	128.58	128.35	124.22	123.06	123.97	121.71
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	28.85	40.78	50.13	58.13	65.05	71.39	75.74	78.73	80.73	82.03	82.78	83.10	83.22	83.23	82.99
St. Dev.	4.45	8.50	10.76	11.91	12.66	12.86	13.45	13.61	13.64	13.40	13.15	12.97	12.73	12.46	12.12
CV	15.43	20.85	21.46	20.48	19.46	18.02	17.76	17.29	16.89	16.34	15.88	15.61	15.29	14.98	14.61
Min	11.27	15.92	15.96	25.83	32.40	30.62	35.09	37.03	41.97	42.91	34.88	37.27	43.24	45.32	43.68
Max	43.92	64.90	83.37	93.09	105.63	110.62	117.61	119.17	120.20	114.78	119.37	118.38	115.86	113.59	116.91
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 176 BASE NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	28.90	40.22	48.86	56.23	62.57	68.38	72.19	74.65	76.19	77.05	77.38	77.28	77.01	76.65	76.04
St. Dev.	4.42	8.53	10.62	11.70	12.46	12.68	13.31	13.52	13.55	13.39	13.15	12.95	12.74	12.47	12.16
CV	15.30	21.22	21.73	20.81	19.91	18.55	18.44	18.10	17.78	17.37	16.99	16.76	16.54	16.27	16.00
Min	11.24	15.97	14.58	22.76	29.10	26.48	24.69	29.60	34.36	34.63	28.02	30.36	35.37	37.27	35.30
Max	41.91	61.91	79.76	94.21	105.36	108.49	111.34	111.33	111.94	107.49	111.69	112.16	110.06	105.66	106.49
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table D.5. Simulation Summary Statistics for Net Present Value and Community Impacts for a 176 Ton/Hour Production Facility at Base Initial Investment Scenario No Incentives

PH 176 BASE NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	103.43	27.48	199.93	8.67	50.71
St. Dev.	23.61	0.22	11.50	0.00	9.39
CV	22.83	0.81	5.75	0.00	18.52
Min	41.62	26.89	166.63	8.67	22.63
Max	170.52	28.18	233.22	8.67	79.32
P(<0)	1	1	1	1	1

CEN 176 BASE NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	117.07	27.48	177.62	11.53	54.04
St. Dev.	22.07	0.22	5.98	0.00	5.76
CV	18.85	0.81	3.37	0.00	10.66
Min	50.77	26.89	159.67	11.53	37.04
Max	176.68	28.18	195.90	11.53	71.84
P(<0)	1	1	1	1	1

CB 176 BASE NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	104.29	27.48	190.26	9.67	64.90
St. Dev.	21.90	0.22	6.97	0.00	7.53
CV	21.00	0.81	3.66	0.00	11.60
Min	37.36	26.89	173.65	9.67	45.91
Max	157.77	28.18	213.54	9.67	88.89
P(<0)	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table D.6. Simulation Summary Statistics for Net Income for a 176 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with No Incentives

PH 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	3.15	40.82	39.39	40.22	41.73	44.60	40.99	40.32	40.86	40.71	41.18	40.98	43.15	44.96	46.85
St. Dev.	11.94	25.14	24.82	24.74	24.67	25.45	26.12	25.00	25.24	26.27	25.90	25.92	28.06	26.25	27.91
CV	379.06	61.60	63.00	61.50	59.12	57.08	63.74	62.00	61.78	64.54	62.89	63.24	65.03	58.38	59.57
Min	(24.91)	(9.16)	(11.55)	(20.85)	(25.86)	(13.03)	(31.75)	(42.86)	(16.00)	(22.65)	(24.09)	(18.42)	(19.82)	(18.15)	(16.72)
Max	54.48	146.26	132.53	124.03	142.79	134.32	130.62	129.32	141.29	141.17	137.16	154.53	159.21	139.89	143.76
P(NI<0)	46	2	3	3	2	2	4	3	3	3	3	4	4	3	2

CEN 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	5.04	44.33	42.82	44.14	45.40	48.33	45.03	44.38	44.60	44.59	44.90	45.49	47.49	49.72	51.08
St. Dev.	11.13	22.68	23.01	23.80	22.62	23.22	24.27	24.19	23.71	23.91	23.44	25.01	25.63	25.41	26.32
CV	220.79	51.17	53.74	53.93	49.83	48.04	53.90	54.51	53.16	53.62	52.21	54.98	53.97	51.11	51.52
Min	(22.77)	(5.45)	(7.38)	(15.81)	(20.76)	(10.80)	(26.72)	(34.48)	(13.10)	(13.93)	(26.96)	(15.11)	(14.46)	(17.13)	(12.54)
Max	47.78	120.91	124.91	112.33	118.09	125.76	119.96	123.22	116.39	110.19	128.14	115.92	120.31	140.07	160.06
P(NI<0)	37	1	1	1	1	1	3	2	2	2	2	3	2	2	2

CB 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	4.56	41.84	39.53	41.01	42.09	44.75	41.10	40.15	40.21	39.91	39.77	39.83	41.23	42.87	43.93
St. Dev.	10.88	22.61	22.44	23.13	22.19	22.91	24.13	23.57	23.91	23.74	23.01	24.97	25.62	25.25	26.39
CV	238.42	54.05	56.77	56.40	52.72	51.21	58.71	58.70	59.46	59.49	57.87	62.69	62.13	58.90	60.07
Min	(23.09)	(7.49)	(10.40)	(18.25)	(25.35)	(14.31)	(32.07)	(17.01)	(17.50)	(21.96)	(31.37)	(19.79)	(20.90)	(23.49)	(19.92)
Max	41.23	124.60	111.32	119.07	104.10	132.93	124.99	123.01	128.87	112.91	110.85	116.24	127.14	139.95	171.13
P(NI<0)	38	1	3	3	2	2	4	3	3	4	3	4	5	3	3

Note: See Table 17 on page 119 for definition of abbreviations

Table D.7. Simulation Summary Statistics for Ending Cash Balance for a 44 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with No Incentives

PH 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	7.98	22.70	36.66	50.84	65.85	82.25	97.24	111.27	124.62	137.62	150.50	162.98	175.99	188.02	199.76
St. Dev.	6.51	12.31	16.26	18.90	21.57	24.27	27.43	29.72	31.89	34.60	36.75	38.63	41.60	43.44	45.38
CV	81.60	54.22	44.35	37.18	32.76	29.50	28.21	26.71	25.59	25.14	24.42	23.70	23.64	23.10	22.72
Min	(14.75)	(9.96)	(20.52)	(2.95)	(1.40)	8.99	2.64	16.74	31.62	37.87	32.50	43.36	54.83	60.81	69.84
Max	29.95	64.93	85.62	100.40	145.24	155.66	172.60	200.11	214.31	238.90	258.22	268.34	286.00	311.78	327.30
P(EC<0)	11	3	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	8.68	24.71	40.04	55.86	72.44	90.48	107.36	123.42	138.80	154.00	169.12	184.28	200.04	215.08	229.73
St. Dev.	5.70	11.00	14.91	17.77	20.33	22.28	25.16	27.51	29.73	31.57	33.45	35.65	37.76	39.93	41.94
CV	65.64	44.50	37.23	31.80	28.07	24.62	23.43	22.29	21.42	20.50	19.78	19.34	18.88	18.56	18.26
Min	(13.13)	(7.90)	(9.13)	7.63	19.49	19.25	28.79	38.72	53.76	60.61	45.68	56.80	79.74	91.88	92.16
Max	26.73	55.48	85.79	107.77	137.16	158.06	185.56	204.94	224.78	230.89	262.00	280.80	296.73	312.29	346.88
P(EC<0)	7	2	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	8.80	24.17	38.49	53.36	68.92	85.83	101.36	115.99	129.84	143.35	156.60	169.62	182.99	195.40	207.30
St. Dev.	5.68	11.02	14.72	17.49	20.07	21.98	24.98	27.23	29.52	31.57	33.42	35.64	37.79	39.91	42.19
CV	64.57	45.58	38.25	32.77	29.13	25.61	24.64	23.48	22.73	22.02	21.34	21.01	20.65	20.42	20.35
Min	(13.08)	(7.67)	(10.73)	3.22	14.53	11.58	10.14	22.50	36.02	40.83	29.26	38.93	57.59	67.41	64.49
Max	24.46	52.00	81.13	109.76	136.96	154.71	174.54	189.94	207.73	214.94	243.26	264.61	280.79	288.22	312.41
P(EC<0)	7	2	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table D.8. Simulation Summary Statistics for Dividends Paid for a 176 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with No Incentives

PH 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.91	8.65	8.18	8.21	8.51	9.05	8.39	7.96	7.75	7.73	7.82	7.78	8.20	8.73	9.18
St. Dev.	1.47	4.91	4.83	4.78	4.77	4.95	5.01	4.76	4.83	5.02	4.94	4.95	5.37	5.05	5.38
CV	162.31	56.70	59.09	58.21	56.08	54.66	59.74	59.85	62.39	64.92	63.15	63.57	65.48	57.81	58.60
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	9.92	29.21	26.33	24.53	28.19	26.54	25.82	25.26	27.28	27.26	26.48	29.87	30.78	27.20	28.04
P(Div>0)	45	98	97	98	98	99	97	97	97	96	97	96	96	97	98

CEN 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.00	9.26	8.78	8.92	9.17	9.73	9.11	8.71	8.47	8.47	8.54	8.65	9.03	9.65	10.00
St. Dev.	1.51	4.42	4.48	4.62	4.38	4.52	4.67	4.64	4.57	4.59	4.48	4.81	4.94	4.91	5.09
CV	150.04	47.72	51.05	51.77	47.79	46.46	51.31	53.25	53.93	54.24	52.46	55.58	54.76	50.84	50.93
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	8.61	24.20	24.79	22.21	23.33	24.82	23.69	24.05	22.44	21.23	24.73	22.35	23.20	27.25	31.23
P(Div>0)	48	99	99	99	99	99	97	98	98	98	98	97	98	98	99

CB 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.95	8.78	8.15	8.32	8.53	9.04	8.36	7.89	7.63	7.59	7.56	7.59	7.85	8.34	8.63
St. Dev.	1.42	4.41	4.36	4.47	4.28	4.45	4.61	4.52	4.57	4.50	4.36	4.73	4.87	4.82	5.05
CV	149.48	50.21	53.49	53.80	50.20	49.22	55.13	57.21	59.84	59.33	57.67	62.32	62.01	57.79	58.52
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	7.33	24.92	22.14	23.52	20.60	26.22	24.68	24.01	24.87	21.76	21.36	22.41	24.53	27.22	33.39
P(Div>0)	48	99	98	97	98	98	96	97	96	96	97	95	95	97	97

Note: See Table 17 on page 119 for definition of abbreviations

Table D.9. Simulation Summary Statistics for Real Net Worth for a 176 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with No Incentives

PH 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	46.96	56.51	63.80	69.95	75.17	79.87	82.77	84.45	85.26	85.50	85.35	84.76	84.14	83.56	82.92
St. Dev.	5.58	9.77	11.95	12.86	13.59	14.16	14.82	14.87	14.77	14.84	14.60	14.20	14.16	13.69	13.25
CV	11.89	17.29	18.73	18.39	18.09	17.73	17.90	17.60	17.32	17.36	17.10	16.76	16.83	16.39	15.97
Min	27.47	30.58	21.77	33.34	32.79	37.12	31.66	37.16	42.18	42.72	38.49	40.78	42.89	43.46	45.00
Max	65.79	90.03	99.79	103.68	125.19	122.70	123.48	128.89	126.80	128.93	128.13	123.51	121.59	122.58	120.14
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	35.02	45.70	53.85	60.73	66.65	72.10	75.64	77.86	79.14	79.84	80.08	79.97	79.75	79.57	79.22
St. Dev.	4.88	8.73	10.96	12.09	12.81	13.00	13.59	13.76	13.77	13.54	13.28	13.11	12.86	12.59	12.24
CV	13.95	19.10	20.35	19.91	19.22	18.03	17.97	17.68	17.40	16.96	16.59	16.39	16.12	15.82	15.46
Min	16.32	19.80	17.71	27.91	33.29	30.53	33.19	35.49	39.76	39.79	31.06	33.10	38.79	40.74	39.06
Max	50.49	70.12	87.48	96.06	107.43	111.53	117.89	118.64	118.97	112.82	116.96	115.46	112.67	110.22	113.41
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 176 +30 NO	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	35.12	45.27	52.71	59.04	64.43	69.38	72.40	74.15	74.99	75.27	75.11	74.58	73.94	73.37	72.67
St. Dev.	4.87	8.75	10.82	11.90	12.65	12.82	13.49	13.62	13.67	13.54	13.27	13.10	12.87	12.58	12.32
CV	13.86	19.32	20.53	20.16	19.63	18.49	18.64	18.37	18.23	17.99	17.67	17.57	17.40	17.15	16.95
Min	16.37	19.99	16.53	24.91	30.16	26.06	23.11	27.38	31.54	31.31	24.54	26.52	31.25	33.02	30.98
Max	48.55	67.36	84.05	97.42	107.31	109.57	111.93	111.14	111.07	105.98	109.52	109.51	107.24	102.63	103.35
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table D.10. Simulation Summary Statistics for Net Present Value and Community Impacts for a 176 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with No Incentives

PH 176 +30 NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	84.39	27.48	199.93	11.27	50.71
St. Dev.	23.68	0.22	11.50	0.00	9.39
CV	28.06	0.81	5.75	0.00	18.52
Min	22.62	26.89	166.63	11.27	22.63
Max	151.45	28.18	233.22	11.27	79.32
P(<0)	1	1	1	1	1

CEN 176 +30 NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	99.66	27.48	177.62	14.99	54.04
St. Dev.	22.11	0.22	5.98	0.00	5.76
CV	22.19	0.81	3.37	0.00	10.66
Min	33.13	26.89	159.67	14.99	37.04
Max	159.23	28.18	195.90	14.99	71.84
P(<0)	1	1	1	1	1

CB 176 +30 NO	NPV	Wages	Hauling	Property Tax	Farmer
Mean	87.43	27.48	190.23	12.57	64.88
St. Dev.	21.98	0.22	6.98	0.00	7.54
CV	25.14	0.81	3.67	0.00	11.62
Min	20.17	26.89	173.65	12.57	45.91
Max	140.87	28.18	213.54	12.57	88.89
P(<0)	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

APPENDIX E

SIMULATION SUMMARY STATISTICS OF KEY OUTPUT VARIABLES FOR A 176 TON/HOUR MIXALCO PRODUCTION FACILITY AT BASE AND PLUS 30 INITIAL INVESTMENT SCENARIOS WITH INCENTIVES

Table E.1. Simulation Summary Statistics for Net Income for a 176 Ton/Hour Production Facility at Base Initial Investment Scenario with Incentives

PH 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	7.26	42.97	41.70	42.71	44.47	47.63	44.24	43.74	44.40	44.37	44.97	44.84	47.08	48.55	50.33
St. Dev.	11.94	25.14	24.82	24.74	24.67	25.45	26.13	25.00	25.24	26.27	25.90	25.91	28.05	26.24	27.91
CV	164.38	58.52	59.52	57.92	55.48	53.44	59.05	57.16	56.85	59.21	57.60	57.80	59.59	54.06	55.45
Min	(20.79)	(7.02)	(9.02)	(18.38)	(23.14)	(10.03)	(28.40)	(39.24)	(12.47)	(18.99)	(20.22)	(14.62)	(15.83)	(14.64)	(13.22)
Max	58.59	148.41	134.86	126.52	145.55	137.32	133.87	132.75	144.78	144.89	140.94	158.30	163.09	143.40	147.22
P(NI<0)	32	1	2	2	1	1	3	2	2	2	2	3	2	2	2

CEN 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	8.79	46.20	44.86	46.38	47.90	51.14	48.05	47.55	47.86	47.95	48.35	49.01	51.09	52.98	54.24
St. Dev.	11.13	22.68	23.01	23.80	22.63	23.22	24.27	24.19	23.71	23.91	23.44	25.01	25.62	25.41	26.32
CV	126.52	49.09	51.29	51.32	47.23	45.40	50.52	50.88	49.54	49.86	48.49	51.02	50.15	47.96	48.52
Min	(19.02)	(3.58)	(5.31)	(13.57)	(18.27)	(8.01)	(23.62)	(31.23)	(9.84)	(10.57)	(23.54)	(11.62)	(10.79)	(13.92)	(9.38)
Max	51.54	122.77	126.94	114.55	120.58	128.63	122.98	126.34	119.66	113.50	131.56	119.40	123.85	143.28	163.16
P(NI<0)	23	1	1	1	1	1	2	2	1	1	2	2	1	1	1

CB 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	8.32	43.65	41.69	43.07	44.43	47.46	44.01	43.07	43.18	42.89	42.89	43.11	44.64	45.95	46.57
St. Dev.	10.88	22.71	22.44	23.04	22.18	22.95	24.14	23.84	23.83	23.61	23.09	24.95	25.63	25.22	26.11
CV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Min	(19.33)	(5.61)	(8.35)	(16.06)	(22.90)	(11.62)	(29.08)	(34.07)	(14.38)	(18.76)	(28.16)	(16.53)	(17.43)	(20.49)	(16.95)
Max	44.98	126.49	113.33	121.26	106.61	135.71	127.92	126.06	132.04	116.04	114.18	119.53	130.53	142.92	173.99
P(NI<0)	24	1	2	1	1	1	3	3	2	3	2	3	3	2	2

Note: See Table 17 on page 119 for definition of abbreviations

Table E.2. Simulation Summary Statistics for Ending Cash Balance for a 176 Ton/Hour Production Facility at Base Initial Investment Scenario with Incentives

PH 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	9.97	27.37	44.10	61.10	78.94	98.20	116.10	133.18	149.80	166.12	181.51	196.62	212.38	227.40	242.33
St. Dev.	5.87	11.94	15.93	18.59	21.30	24.03	27.17	29.44	31.60	34.28	36.42	38.27	41.23	43.07	45.00
CV	58.92	43.62	36.13	30.42	26.98	24.47	23.40	22.10	21.09	20.64	20.06	19.46	19.41	18.94	18.57
Min	(11.43)	(2.56)	(9.25)	10.17	14.52	27.78	25.28	42.47	60.65	70.22	67.22	80.71	94.81	102.02	116.12
Max	31.41	69.76	93.65	110.11	159.06	172.30	192.09	221.79	239.21	267.15	288.97	301.63	323.01	350.80	369.47
P(EC<0)	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	10.71	29.76	48.17	66.78	86.00	106.56	125.81	144.24	162.07	179.64	196.95	214.42	232.55	250.19	267.63
St. Dev.	5.22	10.77	14.73	17.60	20.21	22.19	25.04	27.37	29.61	31.43	33.29	35.47	37.59	39.76	41.77
CV	48.74	36.19	30.57	26.35	23.50	20.82	19.90	18.98	18.27	17.50	16.90	16.54	16.16	15.89	15.61
Min	(9.81)	(1.60)	1.56	19.16	34.01	36.33	50.79	60.42	77.89	88.71	76.63	90.03	115.43	130.19	133.13
Max	28.40	60.35	93.69	118.48	150.82	174.24	203.83	225.62	247.85	256.50	289.71	311.01	329.05	347.12	384.59
P(EC<0)	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	10.48	28.49	45.59	62.82	80.77	99.79	117.48	133.73	149.44	164.87	180.13	195.31	210.95	225.85	240.28
St. Dev.	5.18	10.81	14.53	17.30	19.89	21.87	24.77	27.16	29.41	31.38	33.28	35.40	37.59	39.75	41.87
CV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Min	(10.12)	(2.11)	(1.23)	13.48	27.41	27.69	29.70	43.78	59.24	66.02	55.93	67.74	88.69	100.97	100.63
Max	25.75	55.99	87.90	119.01	149.12	168.99	190.42	207.53	227.11	236.27	267.08	290.78	308.63	318.44	345.22
P(EC<0)	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table E.3. Simulation Summary Statistics for Dividends Paid for a 176 Ton/Hour Production Facility at Base Initial Investment Scenario with Incentives

PH 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.41	8.92	8.51	8.61	8.96	9.56	8.92	8.60	8.48	8.48	8.60	8.57	9.01	9.43	9.84
St. Dev.	1.80	4.90	4.83	4.79	4.78	4.95	5.04	4.79	4.87	5.05	4.98	4.99	5.42	5.07	5.40
CV	127.69	54.92	56.70	55.61	53.34	51.79	56.43	55.74	57.43	59.58	57.85	58.25	60.14	53.79	54.88
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	10.88	29.47	26.67	24.94	28.65	27.05	26.37	25.92	28.03	28.05	27.28	30.66	31.60	27.90	28.72
P(Div>0)	59	99	98	98	99	99	97	98	98	98	98	97	98	99	98

CEN 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.52	9.49	9.08	9.29	9.58	10.21	9.62	9.31	9.15	9.17	9.26	9.38	9.78	10.29	10.60
St. Dev.	1.78	4.42	4.48	4.62	4.39	4.52	4.69	4.66	4.59	4.62	4.50	4.84	4.97	4.93	5.11
CV	117.02	46.63	49.36	49.77	45.79	44.27	48.78	50.04	50.12	50.33	48.65	51.63	50.80	47.86	48.19
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	9.50	24.42	25.08	22.57	23.75	25.31	24.21	24.65	23.13	21.93	25.45	23.08	23.95	27.89	31.83
P(Div>0)	68	99	99	99	99	99	98	98	99	99	99	98	99	99	99

CB 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.46	8.99	8.47	8.64	8.91	9.49	8.85	8.46	8.25	8.21	8.21	8.26	8.54	8.94	9.13
St. Dev.	1.71	4.42	4.36	4.47	4.29	4.46	4.64	4.56	4.58	4.52	4.40	4.77	4.93	4.85	5.02
CV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	8.23	25.14	22.43	23.88	21.02	26.70	25.18	24.60	25.55	22.43	22.07	23.11	25.25	27.82	33.94
P(Div>0)	66	99	98	99	99	99	97	98	98	97	98	96	97	98	98

Note: See Table 17 on page 119 for definition of abbreviations

Table E.4. Simulation Summary Statistics for Real Net Worth for a 176 Ton/Hour Production Facility at Base Initial Investment Scenario with 1Incentives

PH 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	39.40	51.33	60.76	68.77	75.65	81.82	85.98	88.77	90.57	91.61	91.76	91.40	90.94	90.37	89.66
St. Dev.	5.03	9.48	11.71	12.65	13.42	14.02	14.68	14.73	14.64	14.70	14.46	14.07	14.04	13.58	13.13
CV	12.78	18.46	19.27	18.39	17.74	17.14	17.07	16.59	16.16	16.05	15.76	15.39	15.44	15.02	14.65
Min	21.06	27.57	21.55	34.11	35.05	40.73	36.92	43.39	49.27	50.48	46.37	48.78	50.91	50.85	52.83
Max	57.78	84.99	97.18	102.13	126.14	125.06	127.03	133.09	131.98	134.94	134.43	130.01	128.60	129.27	126.78
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	30.39	43.69	54.19	62.93	70.35	77.02	81.54	84.56	86.49	87.65	88.15	88.23	88.13	87.93	87.47
St. Dev.	4.47	8.55	10.83	11.98	12.74	12.95	13.53	13.69	13.72	13.48	13.22	13.04	12.80	12.53	12.19
CV	14.72	19.58	19.98	19.04	18.10	16.81	16.59	16.19	15.86	15.38	15.00	14.78	14.52	14.26	13.94
Min	12.80	18.79	19.93	30.51	37.59	36.04	41.01	42.63	47.50	48.66	40.37	42.50	48.25	50.10	48.21
Max	45.56	67.97	87.65	98.11	111.20	116.51	123.69	125.27	126.23	120.62	124.99	123.75	120.98	118.48	121.61
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 176 BASE YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	30.20	42.67	52.29	60.23	67.05	73.07	77.04	79.30	80.65	81.32	81.47	81.21	80.77	80.25	79.49
St. Dev.	4.44	8.58	10.68	11.77	12.54	12.76	13.38	13.59	13.62	13.46	13.22	13.02	12.80	12.53	12.22
CV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Min	12.53	18.38	17.88	26.65	33.43	31.00	29.61	34.30	38.87	38.92	32.15	34.30	39.15	40.88	38.73
Max	43.29	64.51	83.39	98.47	110.13	113.45	116.44	116.22	116.62	111.94	116.00	116.31	114.03	109.44	110.12
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table E.5. Simulation Summary Statistics for Net Present Value and Community Impacts for a 176 Ton/Hour Production Facility at Base Initial Investment Scenario with Incentives

PH 176 BASE YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	108.64	27.48	199.93	1.37	50.71
St. Dev.	23.70	0.22	11.50	0.00	9.39
CV	21.81	0.81	5.75	0.00	18.52
Min	46.57	26.89	166.63	1.37	22.63
Max	175.99	28.18	233.22	1.37	79.32
P(<0)	1	1	1	1	1

CEN 176 BASE YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	122.13	27.48	177.62	4.34	54.04
St. Dev.	22.15	0.22	5.98	0.00	5.76
CV	18.14	0.81	3.37	0.00	10.66
Min	55.78	26.89	159.67	4.34	37.04
Max	181.99	28.18	195.90	4.34	71.84
P(<0)	1	1	1	1	1

CB 176 BASE YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	108.20	27.48	190.26	4.19	64.90
St. Dev.	21.97	0.22	6.97	0.00	7.53
CV	20.31	0.81	3.66	0.00	11.60
Min	41.17	26.89	173.65	4.19	45.91
Max	161.88	28.18	213.54	4.19	88.89
P(<0)	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table E.6. Simulation Summary Statistics for Net Income for a 176 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with Incentives

PH 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	3.15	40.86	39.49	40.40	42.04	45.06	41.55	40.99	41.62	41.56	42.13	41.95	44.15	45.99	47.91
St. Dev.	11.94	25.14	24.82	24.74	24.67	25.45	26.13	25.00	25.24	26.28	25.90	25.92	28.06	26.25	27.91
CV	378.65	61.53	62.85	61.23	58.70	56.49	62.87	61.00	60.65	63.22	61.49	61.78	63.56	57.07	58.25
Min	(24.90)	(9.12)	(11.35)	(20.68)	(25.55)	(12.56)	(31.18)	(42.18)	(15.26)	(21.80)	(23.14)	(17.45)	(18.81)	(17.13)	(15.64)
Max	54.48	146.30	132.62	124.20	143.10	134.79	131.17	129.98	142.05	142.02	138.09	155.48	160.22	140.92	144.81
P(NI<0)	46	2	3	3	2	1	3	3	3	3	3	3	3	2	2

CEN 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	5.04	44.38	42.93	44.36	45.77	48.88	45.67	45.10	45.37	45.42	45.77	46.38	48.41	50.67	52.06
St. Dev.	11.13	22.68	23.01	23.80	22.62	23.22	24.27	24.19	23.71	23.91	23.44	25.01	25.63	25.41	26.32
CV	220.79	51.10	53.60	53.66	49.43	47.50	53.15	53.65	52.25	52.65	51.22	53.92	52.94	50.15	50.55
Min	(22.77)	(5.40)	(7.27)	(15.59)	(20.38)	(10.25)	(26.08)	(33.76)	(12.34)	(13.10)	(26.08)	(14.23)	(13.52)	(16.18)	(11.54)
Max	47.78	120.96	125.02	112.55	118.46	126.30	120.60	123.92	117.15	111.01	129.00	116.81	121.22	141.02	161.03
P(NI<0)	37	1	1	1	1	1	2	2	2	2	2	3	2	2	1

CB 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	4.57	41.83	39.77	41.05	42.30	45.20	41.63	40.62	40.69	40.35	40.30	40.47	41.95	43.63	44.38
St. Dev.	10.88	22.71	22.44	23.04	22.18	22.95	24.14	23.84	23.82	23.61	23.09	24.95	25.64	25.23	26.11
CV	238.01	54.30	56.44	56.13	52.43	50.78	57.99	58.70	58.55	58.52	57.31	61.65	61.11	57.82	58.84
Min	(23.09)	(7.44)	(10.30)	(18.06)	(25.03)	(13.85)	(31.54)	(36.64)	(16.90)	(21.31)	(30.70)	(19.13)	(20.19)	(22.76)	(19.16)
Max	41.23	124.65	111.41	119.26	104.41	133.39	125.52	123.59	129.48	113.54	111.50	116.94	127.83	140.66	171.87
P(NI<0)	38	1	3	3	2	2	4	3	3	4	3	4	4	3	3

Note: See Table 17 on page 119 for definition of abbreviations

Table E.7. Simulation Summary Statistics for Ending Cash Balance for a 176 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with Incentives

PH 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	9.91	26.45	42.21	58.18	75.00	93.21	110.01	125.80	140.89	155.59	168.99	182.02	195.59	208.20	220.53
St. Dev.	6.53	12.37	16.34	19.00	21.69	24.40	27.57	29.86	32.03	34.75	36.91	38.78	41.76	43.62	45.56
CV	65.84	46.77	38.72	32.65	28.92	26.18	25.06	23.74	22.74	22.33	21.84	21.31	21.35	20.95	20.66
Min	(12.79)	(6.29)	(14.92)	4.35	7.63	19.80	15.66	31.51	48.12	56.02	51.61	62.99	74.86	80.54	91.09
Max	32.01	68.94	91.48	108.05	154.90	167.11	185.84	215.21	231.15	257.51	277.40	288.03	306.26	332.71	348.83
P(EC<0)	7	2	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	11.00	29.42	47.12	64.87	83.19	102.80	121.03	138.24	154.59	170.59	186.21	201.89	218.18	233.77	248.98
St. Dev.	5.72	11.06	14.99	17.87	20.45	22.41	25.29	27.66	29.89	31.73	33.60	35.81	37.94	40.12	42.14
CV	52.00	37.58	31.81	27.54	24.58	21.80	20.90	20.01	19.33	18.60	18.05	17.74	17.39	17.16	16.93
Min	(10.80)	(3.23)	(2.12)	16.52	30.04	31.26	42.84	53.11	69.10	77.68	63.22	74.82	98.33	111.00	111.71
Max	29.15	60.38	93.16	117.11	148.33	170.82	199.73	220.28	241.12	247.97	279.67	299.03	315.47	331.56	366.84
P(EC<0)	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	10.75	28.12	44.49	60.85	77.92	95.98	112.67	127.58	141.76	155.59	169.18	182.61	196.42	209.30	221.53
St. Dev.	5.70	11.12	14.83	17.60	20.17	22.14	25.09	27.52	29.75	31.76	33.68	35.84	38.06	40.22	42.38
CV	53.02	39.56	33.33	28.93	25.89	23.07	22.27	21.57	20.99	20.41	19.91	19.63	19.37	19.22	19.13
Min	(11.12)	(3.74)	(4.87)	10.61	23.39	21.71	21.77	34.48	48.37	53.51	42.40	52.44	71.55	81.78	79.20
Max	26.51	56.14	87.37	117.64	146.47	165.39	186.38	202.16	220.35	227.88	256.71	278.55	295.16	302.99	327.66
P(EC<0)	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table E.8. Simulation Summary Statistics for Dividends Paid for a 176 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with Incentives

PH 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.91	8.66	8.19	8.25	8.56	9.14	8.49	8.08	7.89	7.89	8.00	7.97	8.39	8.92	9.38
St. Dev.	1.47	4.91	4.83	4.78	4.77	4.95	5.01	4.77	4.84	5.03	4.95	4.96	5.38	5.05	5.39
CV	162.28	56.64	58.96	57.98	55.71	54.14	59.05	59.00	61.36	63.75	61.87	62.25	64.17	56.64	57.43
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	9.92	29.22	26.35	24.57	28.25	26.63	25.93	25.39	27.43	27.43	26.66	30.05	30.97	27.40	28.25
P(Div>0)	45	98	97	98	98	99	97	97	97	96	97	97	96	98	98

CEN 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	1.00	9.27	8.80	8.96	9.24	9.84	9.23	8.85	8.61	8.63	8.71	8.82	9.20	9.83	10.19
St. Dev.	1.51	4.42	4.48	4.62	4.38	4.52	4.68	4.64	4.57	4.60	4.49	4.82	4.95	4.91	5.10
CV	150.04	47.66	50.92	51.52	47.43	45.96	50.70	52.49	53.06	53.33	51.53	54.62	53.80	49.96	50.05
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	8.61	24.20	24.81	22.25	23.40	24.93	23.82	24.19	22.59	21.39	24.90	22.52	23.38	27.43	31.42
P(Div>0)	48	99	99	99	99	99	98	98	98	98	98	97	98	99	99

CB 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	0.95	8.78	8.19	8.32	8.57	9.12	8.46	8.00	7.72	7.67	7.66	7.70	7.99	8.49	8.72
St. Dev.	1.42	4.43	4.36	4.46	4.28	4.46	4.62	4.54	4.56	4.49	4.38	4.73	4.88	4.82	5.01
CV	149.48	50.44	53.20	53.57	49.96	48.87	54.56	56.78	59.04	58.50	57.12	61.44	61.16	56.83	57.42
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max	7.33	24.92	22.16	23.56	20.66	26.31	24.78	24.12	24.99	21.88	21.48	22.54	24.67	27.36	33.53
P(Div>0)	48	99	98	97	98	98	97	97	97	96	97	96	95	97	97

Note: See Table 17 on page 119 for definition of abbreviations

Table E.9. Simulation Summary Statistics for Real Net Worth for a 176 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with Incentives

PH 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	48.62	59.48	67.88	74.95	80.93	86.26	89.67	91.72	92.79	93.20	92.69	91.77	90.81	89.92	88.98
St. Dev.	5.60	9.82	12.01	12.93	13.67	14.24	14.89	14.94	14.84	14.90	14.66	14.26	14.22	13.75	13.30
CV	11.51	16.51	17.70	17.25	16.89	16.50	16.61	16.29	15.99	15.99	15.81	15.54	15.66	15.29	14.95
Min	29.15	33.49	25.89	38.31	38.48	43.43	38.69	44.55	49.82	50.50	46.08	48.00	49.71	49.68	51.20
Max	67.56	93.22	104.09	108.89	131.28	129.38	130.64	136.45	134.60	136.92	135.74	130.75	128.49	129.17	126.43
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CEN 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	37.01	49.43	59.05	66.87	73.43	79.28	83.02	85.27	86.46	86.96	86.87	86.45	85.92	85.46	84.84
St. Dev.	4.90	8.78	11.02	12.16	12.89	13.08	13.67	13.83	13.84	13.61	13.34	13.17	12.92	12.65	12.30
CV	13.25	17.76	18.66	18.19	17.55	16.49	16.46	16.22	16.01	15.65	15.36	15.23	15.03	14.80	14.50
Min	18.32	23.51	22.86	33.96	39.93	37.54	40.78	42.69	46.86	47.11	38.03	39.72	45.12	46.76	44.77
Max	52.57	74.01	92.89	102.42	114.48	118.97	125.54	126.32	126.54	120.15	123.98	122.16	119.05	116.29	119.24
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CB 176 +30 YES	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	36.79	48.40	57.12	64.13	70.11	75.30	78.50	79.94	80.52	80.52	80.11	79.36	78.52	77.75	76.82
St. Dev.	4.89	8.83	10.90	11.98	12.71	12.92	13.56	13.76	13.78	13.62	13.38	13.18	12.96	12.68	12.37
CV	13.28	18.24	19.08	18.68	18.13	17.16	17.27	17.22	17.12	16.91	16.70	16.61	16.50	16.31	16.10
Min	18.05	23.11	20.84	29.94	35.74	31.97	29.40	33.37	37.26	36.74	29.76	31.49	36.00	37.55	35.28
Max	50.30	70.64	88.64	102.78	113.30	115.81	118.33	117.25	116.92	111.53	114.87	114.63	112.13	107.29	107.80
P(RNW<0)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

Table E.10. Simulation Summary Statistics for Net Present Value and Community Impacts for a 176 Ton/Hour Production Facility at Plus 30 Initial Investment Scenario with Incentives

PH 176 +30 YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	90.98	27.48	199.93	1.79	50.71
St. Dev.	23.76	0.22	11.50	0.00	9.39
CV	26.12	0.81	5.75	0.00	18.52
Min	28.96	26.89	166.63	1.79	22.63
Max	158.33	28.18	233.22	1.79	79.32
P(<0)	1	1	1	1	1

CEN 176 +30 YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	106.02	27.48	177.62	5.64	54.04
St. Dev.	22.19	0.22	5.98	0.00	5.76
CV	20.93	0.81	3.37	0.00	10.66
Min	39.44	26.89	159.67	5.64	37.04
Max	165.82	28.18	195.90	5.64	71.84
P(<0)	1	1	1	1	1

CB 176 +30 YES	NPV	Wages	Hauling	Property Tax	Farmer
Mean	92.08	27.48	190.26	5.45	64.90
St. Dev.	22.03	0.22	6.97	0.00	7.53
CV	23.93	0.81	3.66	0.00	11.60
Min	24.94	26.89	173.65	5.45	45.91
Max	145.92	28.18	213.54	5.45	88.89
P(<0)	1	1	1	1	1

Note: See Table 17 on page 119 for definition of abbreviations

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