FUNDAÇÃO GETÚLIO VARGAS
ESCOLA DE ADMINISTRAÇÃO DE EMPRESAS DE SÃO PAULO

TATIANA ANGELA CABRAL SCHNURR

Brazil and the USA:
Rethinking the future of Ethanol for stronger Mutual Wins

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Dissertação apresentada à Escola de Administração de Empresas de São Paulo da Fundação Getúlio Vargas, como requisito para obtenção do título de Mestre Profissional em Gestão Internacional.

Campo do Conhecimento: GESTÃO E COMPETITIVIDADE EM EMPRESAS GLOBAIS

Orientador Prof. Dr. JACI CORRÊA LEITE

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Resumo

A produção de etanol e a dominação da indústria, historicamente, tem sido uma fonte de discórdia para seus dois principais produtores. Os EUA com seu etanol de milho e o Brasil com sua etanol de cana, são os dois maiores produtores mundiais de etanol (1º EUA; 2º Brasil) e tem competido pela participação de mercado mundial há décadas. A partir de Dezembro de 2011, os EUA levantaram as tarifas e os subsídios que foram instalados para proteger sua indústria de etanol, o que muda o campo de jogo da produção mundial de etanol para o futuro. Atualmente em todo o mundo, o etanol é usado em uma proporção muito menor comparativamente a outros combustíveis. Esta pesquisa analisa o nível potencial de colaboração entre os EUA e o Brasil, facilitando um diálogo entre os stakeholders em etanol. A pesquisa consiste principalmente de conversas e entrevistas, com base em um conjunto de perguntas destinadas a inspirar conversas detalhadas e expansivas sobre os temas de relações Brasil-EUA e etanol. Esta pesquisa mostra que o etanol celulósico, que é também conhecido como etanol de segunda geração, oferece mais oportunidades de parceria entre os EUA e o Brasil, como há mais oportunidades para pesquisa e desenvolvimento em conjunto e transferência de tecnologia nesta área. Enquanto o etanol de cana no Brasil ainda é uma indústria próspera e crescente, o milho e a cana são muito diferentes geneticamente para aplicar as mesmas inovações exatas de um etanol de primeira geração, por outro. As semelhanças entre os processos de fermentação e destilação entre as matérias-primas utilizadas nos EUA e no Brasil para o etanol de segunda geração torna o investimento conjunto nesta área mais sensível. De segunda geração é uma resposta para a questão "alimentos versus combustíveis". Esta pesquisa aplica o modelo de co-opetição como um quadro de parceria entre os EUA e o Brasil em etanol celulósico. A pesquisa mostra que enquanto o etanol pode não ser um forte concorrente com o petróleo no futuro imediato, ele tem melhores perspectivas de ser desenvolvido como um complemento ao petróleo, em vez de um substituto. Como os EUA e o Brasil tem culturas de misturar etanol com petróleo, algo da estrutura para isso já está em vigor, a relação de complementaridade seria fortalecido através de uma política de governo clara e de longo prazo. A pesquisa sugere que apenas através desta colaboração, com toda a partilha de conhecimentos técnicos e estratégias econômicas e de desenvolvimento, o etanol celulósico será um commodity negociado mundialmente e uma alternativa viável a outros combustíveis. As entrevistas com os interessados em que esta pesquisa se baseia foram feitas ao longo de 2012. Como a indústria de etanol é muito dinâmica, certos eventos podem ter ocorrido desde esse tempo para modificar ou melhorar alguns dos argumentos apresentados.

Palavras Chave: Etanol, Biocombustíveis, EUA, Brasil, Relações Internacionais, Co-opetição

Abstract

Ethanol production and the domination of the industry has historically been a source of contention for its two main producers. The USA with its corn ethanol and Brazil with its sugarcane ethanol are the first and second largest worldwide producers of ethanol and have competed for global market share for decades. As of December of 2011, the USA lifted longstanding tariffs and subsidies that were installed to protect the US ethanol industry, which changes the playing field of global ethanol production for the future. Currently in the world, ethanol is used in a comparatively much smaller proportion to other fuels. This research analyzes the potential level of collaboration between the USA and Brazil by studying and facilitating the dialogue between key stakeholders in ethanol. The research consists mainly of interactive conversations, based on a set of questions designed to inspire detailed and expansive conversations on the topics of US-Brazilian Relations and Ethanol. This research shows that cellulosic ethanol, which is also known as second-generation ethanol, provides more opportunities for partnership between the US and Brazil as there are more opportunities for joint Research and Development and technology transfer in this area. While sugarcane ethanol in Brazil is still a thriving and growing industry, corn and sugarcane are too genetically disparate to apply the same exact innovations of one first-generation ethanol on the other. The similarities in the fermentation and distillation processes between the raw materials used in the US and Brazil for second-generation ethanol makes joint investment in this area more sensible. Second-generation is an answer to the food vs. fuel issue. This research applies the co-opetition model as a framework of partnership between the US and Brazil in cellulosic ethanol. The research shows that while ethanol may not be a strong competitor with petroleum in the immediate future, it has better prospects of being developed as a complement to petroleum rather than a substitute. As the US and Brazil have ethanol-petroleum mixing cultures some of the structure for this is already in place, the complementary relationship would be fortified through clear and long term government policy. The research suggests that only through this collaboration, with all the sharing of technical expertise and economic and developmental strategies, will cellulosic ethanol be a world traded commodity and viable alternative to other fuels. The stakeholder interviews on which this research is based were done throughout 2012. As the ethanol industry is very dynamic, certain events may have occurred since this time to modify or enhance some of the arguments presented.

Key Words: Ethanol, Biofuels, USA, Brazil, International Relations, Co-opetition

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Dedication

I would like to thank my parents for their enduring support and the inspiration they gave me to pursue this topic. Dad, your interest in the environment led me to this worthwhile pursuit. Mom, you always helped me preserve my Brazilian heritage even though I was born and raised in the USA. This upbringing led to a lifelong interest in the relations between the USA and Brazil.

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List of Abbreviations and Acronyms

BNDES Brazilian Development Bank
BNEF Bloomberg New Energy Finance
CTC Sugarcane Technology Center
EBI Energy Biosciences Institute
EIA Energy Information Administration
EIU Economist Intelligence Unit
ENT Energy Security Trust
EPA Environmental Protection Agency
EST Energy Security Trust
FAPESP Foundation for Research Support of the State of São Paulo
FGV Fundação Getúlio Vargas
OECD Organization for Economic Co-operation and Development
PAN Peroxyacetyl Nitrate
PARTS Players, Added Values, Rules, Tactics, and Scope
PWC PricewaterhouseCoopers
R&D Research and Development
RFS Renewable Fuels Standard
UK United Kingdom
UN United Nations
UNESP Sao Paulo State University Júlio de Mesquita Filho
UNICA Sugarcane Industry Association
URR Ultimately Recoverable Resources
USA United States of America
WTP Willingness to Pay

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1 Objective

Ethanol has been a source of fascination, hope, frustration, and controversy for many years. This work is focused on analyzing the potential for ethanol cooperation between the USA and Brazil, the two largest global producers of ethanol, through organizing the **First International Forum on Biofuels**. The congress will take place at The University of Miami and will be organized mainly through a partnership between the Idea Consulting Group and the University of Miami. This thesis will be done in collaboration with Idea and will involve organizing the event and actively researching while participating in the planning and dialogue. This thesis will explore the potential for cooperation between the USA and Brazil and identify major stumbling blocks for a mutually beneficial ethanol partnership. The research before the Forum includes interviewing six Forum participants in the months leading up to the congress. The three from Brazil are Luis Roberto Pogetti, Roberto de Rezende Barbosa, and Tadeu Andrade and the three from the USA are Albert Fishlow, Chris Somerville, and Thomas Trebat.

Some of the major Brazilian stakeholders which have already agreed to participate in the Forum or are being mobilized include Petrobras, the Brazilian Development Bank (BNDES), the Brazilian Sugarcane Industry Association (UNICA), Sugarcane Technology Center (CTC), Bunge, Copersucar, Cosan, Ministerio do Desenvolvimento, Fundação Getúlio Vargas (FGV), Foundation for Research Support of the State of São Paulo (FAPESP), etc. Some of the major American stakeholders who have already agreed to participate in the Forum or are being mobilized are Cargill, Dow, Dupont, Energy Biosciences Institute (EBI), the University of California Berkeley, Columbia University, the University of Miami, the Secretary of Energy/Agriculture, etc. Albert Fishlow, one of the most well renowned scholars in Brazilian-American relations, has agreed to be the keynote speaker.

The object of the Forum is to promote a partnership and the object of the thesis is to qualitatively observe the potential of partnership by assessing the opinions and commentary of the stakeholders who can facilitate or deride a partnership. The method for analysis will be Action Research. The thesis will not compare benefits or disadvantages of ethanol vs. other fuels; it will only focus on the partnership and collaboration of the USA and Brazil in the development of ethanol as a competitive alternative to other fuels.

2 Background: Why is this important right now?

2.1 Global Context

Recently, there has been series of events that have drawn attention to ethanol and whether it can gain steam as a world-class commodity or whether it will die on the vine. World leaders have demonstrated their interests in finding ways to become less dependent on fossil fuels and consequently less vulnerable to major oil producing countries. However the discovery of new petroleum reserves off the coast of Brazil and in the Unites States has caused widespread excitement, possibly leading to less urgency in the research and development of ethanol.

There still remains long standing argument that there is a depletion of world petroleum reserve and the need to find alternative fuels to sustain world industry, however many believe that petroleum is not going anywhere. So it is a time to analyze the real payoff for investing in the ethanol industry and how can it grow in a world where petroleum still holds power.

Another interesting factor about the present time is that the USA and Brazil are experiencing a combination of unique international relations. Brazil is an emerging power and the USA is looking to it with what seems to be a newfound respect and strategy. Leaders seem to be laying the groundwork for a new type of relations that is marked by unique equality and much of the dialogue has highlighted the mutual interest of the two in developing biofuels. In March 2011, President Barack Obama made a trip to Brazil and spoke about the need for the USA and Brazil to establish a meaningful partnership in respect to ethanol to replace the world's dependence on fossil fuels.

Perhaps due to the 2008 economic downturn and also to Brazil's recent economic success, the USA has modified its approach to being more partnership-oriented approach in its relations with Brazil. This was highlighted in Obama's rhetoric on his 2011 visit to Brazil. Obama expressed a need for partnership between the USA and Brazil in regards to ethanol and made the issue about replacing fossil fuel usage with ethanol as a global necessity for the future. He had previously expressed his support of biofuels in his 2008 campaign and later in his reelection speech in 2012.

"The only long-term solution to the world's dependence on fossil fuels is clean energy technology, and that is why the United States and Brazil are deepening our cooperation on biofuels, and why we're launching a U.S.-Brazil Green Economy Partnership. Because we

know that the development of clean energy is one of the best ways to create new jobs and industries in both our nations. "

President Barack Obama – March 19, 2011
Brazil-U.S. Business Summit

Taking a cue from this Presidential initiative, the University of Miami has teamed up with the Idea Consulting Firm (based in Sao Paulo) to organize the **First International Forum on Biofuels** that will take place in Florida in April 2013. Many key stakeholders, including former Brazilian presidential candidate Marina Silva, have committed to speak and participate in the event. As part of the research and organization leading up to the forum, six of the participants of the forum were interviewed about various aspects of US-Brazil relation and ethanol. The contents of these interviews will be used by the Idea Consulting Firm and the University of Miami to help build constructive discussion on how to build a win-win situation for both countries in ethanol and what this scenario would look like for stakeholders from each country.

2.2 Viability and Current Production

At this point, ethanol is not being fully used in a manner that indicates that it is a viable competitor or practical alternative to other fuels. In a 2008 research study published in Elsevier, American Consumers were found to prefer the use of petroleum to ethanol, even if they have a positive **willingness to pay** (WTP) to avoid pollution.

"Results indicate that overall perceptions of ethanol are positive, but ethanol is not the globally-preferred transportation-energy alternative, even among consumers with a positive WTP" (Petrolia, Bhattacharjee, Hudson, and Herndon, 2008, p. 121).

Although ethanol has historically had a positive image and its production has been lauded and implicitly supported, its production in the USA has mainly been the result of long standing US subsidies and tariffs by the US government. The governmental support has been so strong that the USA has recently been an exporter of ethanol to Brazil, the world's second largest exporter of ethanol and the USA's main competitor. New global implications on the future of ethanol arose as the 45-cent per barrel tax credit and 54-cent tariff on ethanol

imports was lifted in December of 2011 (Parker, 2011). This tariff was imposed as a protection for American farmers that naturally highlighted the competitive relationship that the USA and Brazil had in respect to ethanol. This tariff combined with other tax incentives gave the US ethanol industry preferential treatment (Zheng, Vedenov, and Wetzstein, 2007). Subsidies are generally used to protect and incentivize fledgling industries and the production of ethanol in the US reached export levels, showing that it no longer needed the government intervention that it had historically received.

Second-generation ethanol has been under development in recent years. This biofuel made from non-edible materials has promised to alleviate some of the food vs. fuel controversy that surrounds first-generation ethanol. Although the promise of ethanol made from inedible raw materials has been very appealing, the materialization of commercial cellulosic ethanol plants has been slower than anticipated (Danko, 2013). The breakdown of the inedible materials requires unique processes and enzymes. The first wave of cellulosic ethanol plants have moved from development to commercialization and are projected to reach full capacity in the next few years (Guzman, 2012). A recent Reuters article explained what has been some of the hold up, *"The second-generation method recovers sugars bound up inside the tough cellulosic plant matter. However the cost and instability of the process have so far prevented it from moving beyond the laboratory"* (Gomes, 2013). As the industry is so new, many are adopting a wait and see approach to whether it will be viable in the long term (Lynn, 2013).

2.3 The Future of Biofuels

The future of the development of ethanol is not completely certain. The US' ethanol has been for the most part corn based but switch grass as a second-generation ethanol has been considered as a more efficient and practical alternative (Pimentel and Patzek, 2005). This would alleviate certain concerns about the elevated prices of food in using corn for ethanol. It is not completely certain how the lifts on the subsidies and incentives will effect the development and research on the production of ethanol in the USA and whether it will deter advancements on efficiency of ethanol production. President Barack Obama has been a big supporter of green energy and historically supported cellulosic ethanol (*Barack Obama's Campaign Promises*, 2008). However the discovery of new oil deposits in the USA may slow down his urgency in the development of biofuels (Klare, 2012). The Renewable Fuels Standard is a source of hope for second-generation ethanol. Modified in 2009 to include

increasing levels of cellulosic ethanol in US gas blends, "*Under the federal Renewable Fuel Standard, gasoline and diesel producers are required to blend 36 billion gallons of biofuel a year into their products by 2022, including 16 billion gallons of cellulosic fuel"* (Herndon, 2012). These increasing percentages and quantities give cellulosic ethanol producers a safeguard when investing and building their businesses.

Up until late 2012 the higher demand for sugar and oil in Brazil has slowed ethanol production (Bullion, 2012). Despite this apparent slowing down for ethanol, some researchers believe that there will be an uptick in production. According to research published in the International Sugar Journal in 2012, demand for ethanol should increase in the upcoming years.

"... there are few immediate benefits seen for Brazil's more sustainable cane-based ethanol industry from the expiry of a historic import tariff, mainly due to tight supplies and high domestic demand for both motor fuel and sugar. However, by 2016, Brazil expects this situation to improve significantly, based on sectoral expansion through the opening of new mills, and environmental legislation in California which will favour cane-based ethanol over domestic maize-based suppliers. The US is also seeing fresh trade challenges to its booming ethanol sector, both from the European Union, which has seen the development of its infant industry stymied by increasingly competitive US imports subsidized by a blending incentive, and China, which has launched an ongoing anti-dumping investigation into soaring US exports of ethanol-derived distillers dried grains used for as animal feed in that territory" (Bullion, 2012 p.79).

With a predicted increase in demand for ethanol coming from Brazil, the USA, China, and Europe, this may be an excellent time to consolidate expertise between the USA and Brazil and to work towards making ethanol, primarily second-generation ethanol, a world traded commodity and a more widely used fuel resource.

3 Research Question and Hypothesis

This thesis will analyze how the USA and Brazil can reach a better win-win situation in the development of ethanol. The research will present the historically competitive relationship that the USA and Brazil have had with ethanol and also how it has impacted the development of ethanol as a commodity. The research will also analyze the current atmosphere for potential partnership taking new legislation, economics, and other research into account. The hypothesis of this research is that only a firm cooperation between Brazil and the US will provide the means of turning ethanol into a world-traded commodity. This cooperation should/could involve multiple levels, including but not limited to technical, economic, and political. The way that this partnership can flourish will be under the co-opetition model, where both parties engage in a cooperative competition. Basic models of co-opetition have been described using game theory and this model often works with companies that are in the same market. For example, both companies invest in research and development that will better their product or make their production more efficient but at the same time compete for the market share that has been increased because of this innovation. The idea is that by cooperation the market will expand, or the size of the pie will expand. The competition aspect comes from who gets a bigger slice of the pie. The benefit of cooperating is that the size of the overall market increases and therefore each company increases its earnings overall, yet the two entities still compete openly in the market. Co-opetition also occurs between companies in the same industry that are looking to lower costs. Cost lowering is done by partnership, while still remaining competitors (Brandenburger and Nalebuff, 1996).

4 Literature Review

4.1 US-Brazil Relations

With the rise of Brazil as one of the emerging powers to watch over the next century, much has been written and speculated over the state of and future of US-Brazil relations. With Brazil's rise and the US declining from its hegemonic position and facing a multi-polar global power distribution, the two countries are looking at an unprecedented shift in power dynamics. Although some would assess the relationship to be positive and growing, others would say that there are hurdles of understanding and prioritization in US-Brazil Relations and little real overlapping areas of strategic interest. Some of the major issues within the relationship are Trade, Global Energy and the Environment, China, and the Middle East. There are many different views on how these issues impact relations between these countries.

According to Matias Spektor, professor at FGV in Rio, the foundation for positive US-Brazil relations is an acknowledgment that they are both important to each other's future in that a prosperous Brazil is a good thing to the USA and that having a friend in Washington is beneficial to Brazil.

"Brazil and the United States need each other to cope with the daunting problems that require very deep cooperation in the twenty-first century: climate change, trade, financial stability, food security. These are all big issues where you cannot reach a deal without having the United States and Brazil at the table" (Spektor, 2011).

Whenever Rousseff and Obama meet, the importance of one nation to the other needs to be explicitly stated between the two presidents. The two countries need to build a narrative that includes the fact that in 21st century Brazil is a rising power and has more influence internationally. The meetings between the first African American President in the USA and the first female president in Brazil are symbolically powerful as it ties two of the most racially and ethnically diverse nations in the world (Spektor, 2011).

According to a 2011 report issued by the Stratfor Analysis, US-Brazil relations face obstacles because there are little overlapping strategic interests between the two and they are opposed on transient and existential issues. According to this report, the relations between US and Brazil have been a lot of talk and no action, highlighting the Obama visit to Brazil in 2011 (*Barriers to U.S.-Brazilian Cooperation*, 2011). This report downplayed the importance of the dialogue of the presidential meetings as simply lip service while Spektor claims that it

is the most important outcome of these meetings. An article published by *The Economist Intelligence Unit* shortly after Obama's trip to Brazil stated that other more important global issues such as the crisis in Libya upstaged the trip. The trip was criticized as a "*spring break*" for the President. Still there was discussion over the promotion of development of renewable fuels and various forms of exchange, scientific to educational, between the two countries (*Upstaged*, 2011). In 2012, Rousseff visited Washington and the major dialogues that were elevated in 2011 were reviewed, and there seemed to be a reemphasis of the major themes, with more emphasis on infrastructure investment and international business issues. A joint statement from President Obama and President Rousseff issued from The White House in April 2012 stated that *"They welcomed the growth of the U.S.-Brazil trade and investment relationship, illustrated by a record $74 billion in two-way trade in 2011"(Joint Statement by President Obama and President Rousseff*, 2012*).*

Although many may have different opinions on the importance of the meeting between the two presidents, it seems that there has been some change in the dialogue between the two nations with Obama explicitly highlighting the importance of Brazil to the US in his pointing out that Brazilian US imports support 250,000 jobs back home in the US (*Upstaged*, 2011) and the open invitation for Brazilians to come to the USA and shop. In March of 2011 he stated how the rise of Brazil as the worlds seventh largest economy was remarkable and that Brazil was not the country of the future but having its moment now and that the USA would be supportive in helping Brazil develop, including becoming its best customer once pre-salt was extracted and available for consumption (*On the first day of his visit, Obama emphasizes US-Brazil trade relations*, 2011). Rousseff has a more pragmatic and US-friendly approach than Lula, who focused more on South-South relations, which has also helped to improve relations between the US and Brazil (*Pragmatic Diplomacy*, 2011).

One of the most important issues is Trade; however most see this issue as not progressing rapidly, at least in the near future. Trade is conflicting, both countries want to create more jobs and export more, but both need to agree on loosening barriers, Brazil wants to export more to the USA but it would need to equally open up barriers, if that is the case then the USA would flood the market with very competitive goods (*Barriers to U.S.-Brazilian Cooperation*, 2011). Brazil has historically been a very closed market and practiced heavy import substitution. Spektor also noted the limitation on the discussion about trade, *"We first need to get the conversation going again to restore the atmosphere, to establish a personal relationship between the two presidents and lay the ground for future progress on trade"* (Spektor, 2011). Although the trade issue is somewhat of a standstill, it may be one of most

important elements to US-Brazil relations, and one that may affect many other areas of the relationship, so while it is important to create the right atmosphere for these talks, it is also important not to table the issue for too long. Trade in energy may be what really prompts both parties to the table, both with petroleum and ethanol.

Another issue that has effected US-Brazil relations is the Middle East and how much Brazil is willing to actively support and align itself with US Foreign Policy. Some believe that Brazil has for the most part supported the USA in most of its international endeavors and this coupled by that fact that Brazil is a stable democracy will further deepen ties between the two nations (Almeida, 2009). Others see Brazil as historically taking a sort of hands-off approach to the affairs of the rest of the world and focused more on domestic affairs. The US will want Brazil to take a more active role in foreign affairs (*Barriers to U.S.-Brazilian Cooperation*, 2011). As Brazil becomes more of a global power with greater influence, this pressure will undoubtedly grow. As Brazil continues to appear more on the global stage, it will undoubtedly go through a learning process in international affairs, however it need not follow the lead of the US exactly, which has a reputation of over involvement in international affairs.

However some of Brazil's forays into the international arena have been met with mixed reactions, such as when Brazil's President Lula's meeting with Iran's President Ahmadinejad to negotiate a deal with the west. The two Presidents seemed to be getting rather friendly, which was confusing to other western countries and possibly damaging to Brazil's global ambitions. Rousseff has taken a more pragmatic approach, distancing herself from Iran and publically voicing her opinions against human right violations (*Pragmatic Diplomacy*, 2011).

Rousseff was a political prisoner, tortured under the dictatorship, one would expect that she would voice her opinions more boldly on threats to human rights abroad. In fact, Rousseff has kept some of the style of her predecessors, demonstrated when she abstained from the United Nations Security Council resolution rid Libya of Col. Muammar el-Quaddafi, which was later criticized by the Unites States Ambassador to the United Nations Susan Rice. Human Rights Watch has also criticized Brazil's fence sitting position on Syria (Spektor, 2011). However, it may be a false assumption to think of President Rousseff as hypocritical, *"…she is resisting the pull from Paris, London, and Washington to coerce governments that have fallen in their disrepute. And she is denouncing the dangers inherent in the rising tide of humanitarian interventionism"* (Spektor, 2011). Rousseff emphasizes the need for "*responsibility while protecting*" to avoid imperialism while trying to aid other nations. Rousseff may need to be clearer in her practical stance and point of view in the future, to

avoid the continued impression of Brazil as just idly standing by as international atrocities occur.

Energy has been an issue at the forefront of US-Brazil relations and it has been a cause for hope as well as conflict. In an article entitled "Ethanol Diplomacy", written by Wilson Almeida from the Catholic University of Brasilia, relations between the US and Brazil were predicted to strengthen because the US would depend more on Brazil for ethanol. According to the article, The US' energy demands will continue to increase while its capacity will decrease. Dependence on oil imports represented 35% in 1973, 55% in 2001, and it is projected to be 76% in 2020. This growing demand for energy coupled with the diminishing globally known energy reserves would make the US more dependent on Brazil in the future as the biggest producer of sugar cane based ethanol in the world, a highly more efficient form of ethanol than that of corn (Almeida, 2009).

However, there have been serious drops in ethanol production in Brazil through late 2012 due to the high price of sugar, a globally traded commodity, and what was the artificially lower price of gasoline. Brazil has actually imported more ethanol from the USA, even after the tariff lifted in late 2011. Brazil has higher gas mixing requirements than the USA for cars and almost all cars sold in Brazil are flex fuel, so it has a relatively high built in domestic demand because of this (Cruz, 2011).

The USA also has an increasing positive future prospective on its oil reserves with its shale-gas boom. In December 2011, *"The total value of US oil and gas deals in the quarter rose by 135% from the same period a year earlier, with 46 deals totaling $48.8 billion"* (Platt, 2011). Obama has stated on various occasions such as his 2008 election campaigns, his 2011 trip to Brazil, and his 2012 acceptance speech for reelection that he is concerned with the global dependence on harmful fossil fuels. It is not only an environmental and supply issue to the US, but also deeply political due to its relations with the Middle East. However in 2012, Obama's rhetoric seemed to become more inclusive and embracing towards fossils fuels, while still maintaining his support of green energy. While Obama reaffirmed the importance of Green Energy in a 2012 State of the Union Address, he also celebrated the growth of domestic oil and gas output and promised more offshore drilling (Klare, 2012). Obama may see ethanol and gas as not being entirely substitutes, but somewhat like compliments as they are blended and the more energy resources the better. As this was before the elections, Obama may have been trying to appease his Republican counterparts, only time will tell whether Obama continues to push policy towards the development of Green Energy. Although energy reserves are always a concern, it is not clear cut as to how the energy issue

will play out in US-Brazil relations, it is dependent on several factors such as public policy, proven energy reserves, global political factors (outside the US and Brazil), climate changes, etc.

4.2 The Viability of Ethanol

There has been much debate over the importance of ethanol as a viable fuel alternative to petroleum. Some of the main issues are how Ethanol compares to Petroleum in terms of mileage and price; the latter is a dynamically shifting and dependent on other factors, and whether or not world petroleum reserves are depleting. It is clear that ethanol provides a relatively small portion of the world's fuel demands, and during its history ethanol has been protected and aided by subsidies and trade tariffs so as to protect it from competitors and provide incentives in the industry. But the question remains, is the investment in ethanol a smart investment for the future? Some authors such as Sorrell, Spears, Bentley, Brandt, & Miller argue that we are approaching petroleum's peak and in order to maintain the world running at its current rate there must be sufficient investment in ethanol at least 20 years before the depletion of petroleum. There are a number of opposing views on the viability of ethanol as a world trade commodity and adequate replacement for petroleum.

The pros of using ethanol include not emitting the harmful gases that petroleum gives off, using less of imported petroleum in fuels for small vehicles, and keeping more money in the country (USA or Brazil) and out of the hands of what some may deem questionable regimes. The US has long been concerned about its dependence on foreign oil and the development of homegrown substitute is a positive and necessary alternative to some. A few of the cons include getting fewer miles per the gallon, questionable environmental gains, and possible damaging effects on the food supply (Weisenfelder, 2012). Ethanol provides fewer miles per gallon across the board. Ethanol also takes a good deal of energy to produce and provides less energy than petroleum, although sugarcane has been proven to be more efficient than corn ethanol (Yuill, 2009). In 2012 the UN called for a suspension to US mandated corn ethanol production due to concerns on world food supply and reports from Cornell University's David Pimentel that argued that corn ethanol is a costly and inefficient substitute to gasoline, containing only 61% of gasoline's energy and having higher production refining costs (Brooks, 2012). It is also unclear as to what are the real environmental gains by using ethanol because there is substantial amount of energy needed to produce ethanol, especially for corn ethanol as sugar ethanol uses other parts of the sugarcane for fuel production. Also

there are tailpipe gases in the use of ethanol, they are less damaging overall than petroleum, but may not be substantially so (Weisenfelder, 2012).

It should be addressed that the discourse on ethanol changes significantly when talking about corn ethanol and sugar ethanol. The concerns of food shortage issues, fuel efficiency, and costs of production are more dramatic with corn ethanol than they are with sugar cane. In a 2009 *Harvard International Review* article David Pimentel, one of the strongest voices against corn ethanol, wrote that the environmental effects of corn ethanol production are damaging because of soil erosion, emission of greenhouse gases from nitrogen use, and the emission of pollutants such as peroxyacetyl nitrate (PAN) and nitrous oxide. He also states that the production of corn ethanol has increased the price of several foods that are linked to corn production, mainly because corn is a feedstock, which has contributed to global hunger (Pimentel, 2009). A 2012 PricewaterhouseCoopers (PwC) report found that the impact of federal ethanol policies, namely the U.S. Environmental Protection Agency's Renewable Fuel Standard (RFS) has a negative impact on the US chain restaurant industry, commodity prices, and the food supply chain (*PwC Study: Renewable Fuel Standard Is Estimated to Cost Chain Restaurants Billions*, 2012). There are plenty of critics that say that corn ethanol is wrongfully deemed a solution to the long-term energy needs of the USA.

However some project that the global demand of ethanol will rise substantially over the next few years, with the USA being the biggest producer of ethanol in the world and with Brazilian ethanol production vulnerable to global sugar prices, it may not be the wisest idea to pull out of the corn ethanol market. Based on the Global Management Consulting and Market Research firm Lucintel, the global demand for ethanol is projected to see double digit growth through 2017, despite the controversies that surround the issue regarding sustainability, shortages on the food supply, etc. It states that the largest ethanol production comes from North America and Europe had the highest growth rate (*Growth Opportunities in the Global Biodiesel Market 2012–2017: Trends, Forecasts, and Market Share Analysis*, 2012). Brazil's ethanol production has slumped due to high sugar prices that were present up until recently and the artificially low price of gas. With rising demand of ethanol and the innate volatility in the Brazilian ethanol market due to the price taking nature of commodities, it may still be attractive to stay in the ethanol business despite the criticisms against the industry. The US may need to invest more into other raw materials for producing ethanol, such as switch grass. Using grass should lessen the arguments on global food supply issues and keep the US competitive in the ethanol global ethanol market.

Sugar ethanol seems to get more global support due to its higher fuel efficiencies and

less damaging associated impacts. Sugar ethanol produces 3,370 liters of ethanol per acre while corn produces barely a third of that total, 1,400 liters per acre (Yuill, 2009). Sugar ethanol also uses part of the plant to fuel production of ethanol making it less damaging. Ethanol producers also produce sugar and can easily switch between the two depending on the demands for each commodity. Many believe that sugar cane is a viable substitute for petroleum and will contribute to international development because the industry still has the potential for growth and more productions will create many more jobs and increase global trade (Hira, 2011). According to research published in the International Sugar Journal in 2012, demand for ethanol should increase in the years to come. With a predicted increase in demand for ethanol coming from Brazil, the USA, China, and Europe, this may be an excellent time to consolidate expertise between the USA and Brazil and make ethanol a world traded commodity and a more widely used fuel resource (Bullion, 2012).

While sugarcane seems to have certain advantages over corn, ethanol production in Brazil has still slumped because of the vulnerability of the industry to other factors in global commodity demands. When the US corn ethanol subsidy and tariffs lapsed in 2011, Brazil was facing a growing domestic demand while productions slumped (*U.S. Ethanol Subsidies End as Brazilian Production Shrinks*, 2011). This highlights inherent vulnerabilities in the Brazilian ethanol industry. It is widely accepted that Brazil is home to the most advanced technology in sugarcane ethanol development but due to unforeseeable conditions, Brazilian ethanol production can drop in a way that it can't meet its own domestic demands.

The issue of price comparison depends mostly on the price of petroleum and because ethanol is blended into petroleum the two can be considered compliments as well as substitutes, which complicates the matter. According to a 2012 USA Today article, while E85 (85% ethanol blend) fuel prices are lower, when adjusting for miles to the gallon they are substantially higher (Woodyard, 2012). The Brazilian market has evolved a bit more with ethanol consumption at a required minimum of 18% of ethanol-gas blends (*Biofuels Mandates Around the World*, 2011). Studies have been done that show that Brazilian consumers will choose ethanol based on consumer preferences and relative prices (Silva Filho, Pacini, Silva, Lima, and Guasti, 2011).

One recurring argument for the development of biofuels is the belief that the world will max out its petroleum reserves at some time in the not too distant future and in order to keep the world running and progressing there needs to be a viable alternative that has been sufficiently developed by the time this happens. In a study conducted by UK Energy Research Centre, researchers concluded on a range for the peak of global petroleum production.

"The timing of the global peak for conventional oil production is relatively insensitive to assumptions about the size of the global resource. For a wide range of assumptions about the global URR of conventional oil and the shape of the future production cycle, the date of peak production can be estimated to lie between 2009 and 2031. Although this range appears wide in the light of forecasts of an imminent peak, it may be a relatively narrow window in terms of the lead time to develop substitute fuels…Delaying the peak beyond 2030 requires optimistic assumptions about the size of the recoverable resource combined with a slow rate of demand growth prior to the peak and/or a relatively steep decline in production following the peak" (Sorrell, Spears, Bentley, Brandt, & Miller, 2009 p.170).

According to Wilson Almeida, the USA is the highest energy consumer and its production of petroleum does not come close to meeting its growing energy demands. Energy consumption will increase by 50% in the next 25 years, with non- Organisation for Economic Co-operation and Development (OECD) countries increasing by 19% and developing countries increasing their consumption by 85%. He further states that the world is running out of known oil reserves and that coupled with secondary factors like the Iranian crisis are causes of the most recent oil crisis (Almeida, 2009).

Although this argument of global petroleum reserve depletion is a compelling one, it is weakened by the reports of a new oil boom in the USA and excitement about pre-salt reserves of the coast of Brazil. The US has *proven reserves*, which are oil reserves *"…you can take to the bank"* (DiPeso, 2011, page. 97). The US Energy Information Administration (US EIA) stated that proven reserves in 2009 were at 20.68 billion barrels. In 2010 the USA consumed about 19.2 million barrels of petroleum and crude oil products per day, about 7 billion barrels for the year. There are other sources of energy that are classified as technically recoverable but because of unknown factors regarding quantity, quality, and the cost of extraction of the energy, these may not be viable or cost effective sources of energy for the US. The total amount of energy that is retrievably worthwhile in the USA is unknown, but the fact that it is potentially a lot intrigues many domestic consumers and producers. The USA may have potentially a lot of energy, but it is up to policymakers if the US will invest and focus on building up its domestic oil industry (DiPeso, 2011).

In late 2012, Exxon announced that US oil boom will continue and that coupled with higher fuel efficiency will make North American a net exporter of oil by the middle of the next decade (Downing, 2012). Talk that the US will reduce petroleum imports has been popular among politicians. Even President Barack Obama, who was such an ardent advocate

of green energy in the past, has reduced his criticism of fossil fuels, mostly because concerns over dependency of imports has been reduced.

"But today, says the EIA, the outlook is very different. The agency now predicts that total US liquids production will climb to 12.1 million barrels by 2025—a 38 percent increase over the 2005 projection. If accurate, this increase, combined with an expected slowdown in the demand for oil (because of the current sluggish economy and longer-term improvements in automobile fuel efficiency), will produce a sharp drop in the amount of oil that will have to be imported in 2025—from the 2005 estimate of 19 million barrels per day to just 8 million in the 2012 projection. If it materializes, this import drop could prove highly beneficial for the US economy and foreign policy."(Klare, 2012)

Although the prospects of less oil imports seem positive, some argue that the fact that the USA will still use oil as its main source of energy will keep it vulnerable to and somewhat dependent on the regions in Africa and the Middle East in the future (Klare, 2009). In a December 2011 article in Global Finance Sandy Wong wrote,

"Foreign buyers accounted for 76% of the total value of US oil and gas mergers and acquisitions in the third quarter of this year, with 22 deals valued at $37.3 billion, according to PwC US. The total value of US oil and gas deals in the quarter rose by 135% from the same period a year earlier, with 46 deals totaling $48.8 billion" (Wong, 2011).

The positive aspects of increased reserves of easily accessible oil in the USA have been a cause for optimism about the US' economic future, and eased up on the urgency for developing alternate fuels.

Pre-salt reserves bring a lot of excitement and expectation to Brazil's energy industry, but the means of extracting these reserves is still a daunting challenge because of capital investment and technological issues. However, the knowledge that these reserves exist has attracted domestic and foreign investors (Abrantes and Cohen, 2011). The fact that pre-salt is on the table may halt the need to advance research on ethanol development in Brazil, at least for policymakers. The debate on the longevity fossil fuels that are feasibly extractable is a hot one. There are many unknowns such as the prospect of future technology that will make extraction of energy that is currently difficult to reach more cost effective, the quantity of the energy, the quality, etc (DiPeso, 2011). What is a commonly accepted idea is that the world

will at some point in the future, distant or near, run out of petroleum, which will bring countless security and economic dangers to many of the world's most powerful and oil dependent nations. The prospect of developing renewable energy may fortify nations politically; possessing renewable energy that is highly developed can act as leverage in the international political arena.

4.3 Second-Generation Ethanol

Second-generation is a comparably newer industry that presents an appealing solution to the dilemma of competing with the worlds food supply, as the raw materials are inedible. Corn stover and bagasse, which are residues from production of first-generation ethanol, are used to make second-generation ethanol. In a 2012 study published by BioMed Central, the researchers analyzed the cost competitiveness of second-generation ethanol made from sugarcane bagasse.

"Among the viable processes, steam pretreatment followed by enzymatic hydrolysis is one of the most promising approaches for ethanol production from lignocellulose, and this configuration was adopted in the present study for the 2G ethanol production from sugar cane bagasse and leaves using separate hydrolysis and fermentation. Other techno-economic studies on ethanol production based on more or less the same process concept have been performed previously for various materials, e.g., switch grass, tall fescue, hardwood, softwood, straw, poplar, salix, corn stover, and sugar cane bagasse" (Macrelli, Morgensen, and Zacchi, 2012).

The study concluded that ethanol made from sugarcane bagasse is competitive with first-generation starch based ethanol in Europe. The study also shows that second-generation ethanol can be made from a wide variety of raw materials and that the process of fermentation does not differ much from one second-generation raw material to another. This is valuable when it comes to applying innovation found in the fermentation process of one country's predominant raw material for second-generation ethanol to another's, sugarcane bagasse to wood chips or switch grass for example.

There has been excitement generated over cellulosic ethanol over the last few year, however it is not until recently that second-generation ethanol has moved closer to the commercialization stage. In a January 2010 publication, the technology for producing

cellulosic ethanol was described as being in its "nascent" phase but was poised to grow with the right government policy and financial support *(Cellulosic Ethanol - Next Wave Second Generation Bioethanol. 2010).* Second-generation ethanol can be produced in ethanol plants that specialize in first-generation ethanol but as of late 2012 there has been more talk of plants that produce second-generation ethanol exclusively that have or will be reaching commercial capacity in the next few years. "*Cellulosic biofuel companies will boost production almost 20-fold in 2013 as the first high-volume refineries go into operation, signaling a shift from an experimental fuel into a commercially viable industry"(Herndon, 2012)*. GraalBio has declared that it will be open for business by the end of 2013.

"Brazilian startup GraalBio says that by December of this year it will begin operating South America's first, and one of the world's only, commercial-scale cellulosic ethanol refineries. Located in the town of São Miguel dos -Campos, the $150 million plant is expected to produce 82 million liters of biofuel yearly using waste from the miles of sugarcane fields surrounding it. That figure is 10 times that of current facilities, which are operating at demonstration scale. GraalBio founder Bernardo Gradin says the plant will succeed by integrating the processing steps using state-of-the art technologies developed in Italy, Denmark, and elsewhere. The company is also looking to create a better form of sugarcane which would produce over three times more biomass"(Lynn, 2013).

The Brazilian ETH and Danish Inbicon plant is expected to open operations in 2015 (Gomes, 2013). These two cases also highlight some Brazilian-European partnerships in second-generation ethanol. Brazil, along with the USA will be looking to Novozymes to provide enzymes that will break down the tough second-generation ethanol raw material. Novozymes has announced that it will be looking to establish enzyme production facilities in Brazil (*Novozymes to supply first advanced biofuels factory in Brazil*, 2012). Which will no doubt strengthen the connections between Brazil and Europe in second-generation ethanol development.

The Oregon based ZeaChem announced in 2013 that it is currently operational and ramping up to capacity. ZeaChem is among the first operational cellulosic biorefineries in the world and its opening is good news to many as the plant's expected capacity will help the US reach its cellulosic fuel production goals in the future.

"*ZeaChem says it makes ethanol from wood from a fast-growing hybrid poplar variety farmed nearby as well as locally sourced agricultural residues. The demonstration plant has an annual production capacity of 250,000 gallons…. Under the Energy Independence and Security Act of 2007, the U.S. was supposed to produce 500 million gallons of cellulosic ethanol in 2012, but all that arrived was a mere 20,000-gallon dribble early last year" (Danko, 2013).*

While there is a lot of excitement over cellulosic ethanol many are adopting the wait and see approach for cellulosic ethanol plants such as GraalBio and ZeaChem, as second-generation does not have the history that first-generation ethanol has. (Lynn, 2013)

Many are very optimistic about cellulosic ethanol and believe that the industry is on its way to being cost competitive with first-generation ethanol. According to an industry survey done by research company Bloomberg New Energy Finance (BNEF), cellulosic ethanol should be cost competitive with corn ethanol by 2016. Costs in the industry have greatly reduced owing to the sharp drop in the cost of enzymes that break down the complex sugars found in the inedible raw material, however capital expenditures will need to be reduced in order for the industry to match the costs of producing corn ethanol.

"The survey collected data and predictions on the production costs of 11 leading players in the cellulosic ethanol industry. All use a technique, commonly called enzymatic hydrolysis, to break down and convert the complex sugars in non-food crop matter, and a fermentation stage to turn the results into ethanol. The results showed that in 2012, the cost of cellulosic ethanol production was $0.94 per litre, around 40% higher than the $0.67 per litre cost of producing ethanol from corn, which dominates the US biofuel market and is competitive with US gasoline. By 2016, respondents thought the price of cellulosic ethanol would match that of corn-based ethanol"(Cellulosic Ethanol heads for Cost-Competitiveness by 2016, 2013).

The article emphasizes the need to focus on capital costs over the next few years and highlights the growth of cellulosic ethanol in Brazil. Although 5 out of the 10 of the semi-commercial plants in the world that have either been announced, commissioned, or due online shortly are located in the USA, Brazil is gaining momentum in the area, with two plants having been announced so far. As with first-generation ethanol Brazil and the USA seem to be the forerunners in cellulosic ethanol development. *(Cellulosic Ethanol heads for Cost-Competitiveness by 2016, 2013).*

Indeed the US has a good deal of incentive to invest in cellulosic ethanol given the increase in cellulosic ethanol fuel amounts in gasoline due to the Renewable Fuel Standard and Obama's new initiatives in Green Energy. The Renewable Fuel Standard was set in 2007 by the Environmental Protection Agency (EPA), with increasing targets each year of cellulosic ethanol in gasoline. The EPA may lower the targets based on industry output, however if output is sufficient then blending targets remain (Herndon, 2012). This policy gives the industry a secure foreseeable demand. Also, Obama has spoken often and passionately since his reelection about Green Energy. Obama has spoken to congress about committing two billion dollars over the next ten years to the Energy Security Trust (EST). In summary, Obama's plan is to use royalties from the oil and gas industry to fund green energy and eventually wean the US of oil. Some have criticized this plan as promoting fossil fuels. Obama's has pointed to electric cars as a good alternative to petroleum fueled cars (Adams, 2013). Electric cars, while not emitting carbon emissions directly, if the power source is traced back, you will find the electricity is generated by gas and coal fired stations (Rowley, 2011). While pushing for electric cars, it may be wise to look into green energy sources that would generate the electricity for these cars. Ethanol, namely second-generation ethanol could provide this source of green energy that powers the stations, which generate electricity for these cars that Obama has in mind.

The US and Brazil seem to have a good deal at stake in the development of cellulosic ethanol and the cellulosic ethanol market. As this is the case, joint investment in R&D and innovation towards lowering capital costs and improving the technology involved in the breakdown of the complex sugars and the fermentation of cellulosic ethanol would be greatly beneficial to companies in the USA and Brazil. Both countries would benefit from a model that allowed the technology transfer while enabling them to stay competitive.

4.4 Co-opetition

A relatively new approach to viewing inter-firm interactions combines elements of cooperation and competition, the amalgam is co-opetition. This theory is a more complex multi-dimensional view of business. It goes beyond the business as war mentality and adds a level of cooperation or peace to how competitors are traditionally viewed. Competitors can bring more resources to the table, in the form of innovation or R&D for example, and increase the market for a good or service, so they cooperate upstream, then compete to divide up the pie and downstream (Brandenburger & Nalebuff, 1996).

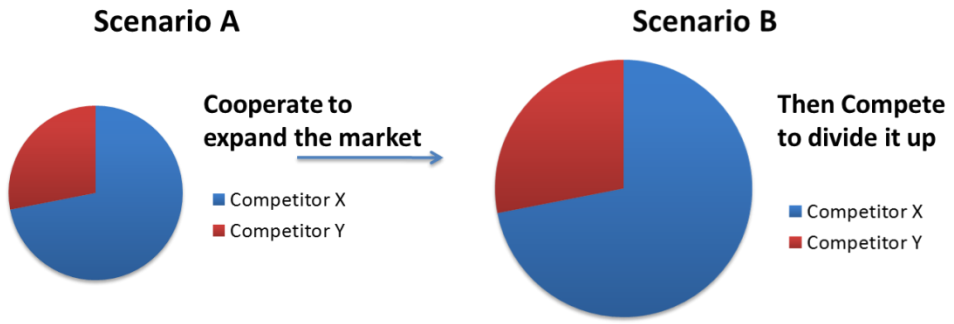

Figure 1 - Co-opetition Model (Brandenburger and Nalebuff, 1996)

Co-opetitive strategies are applied to all players within the Value Net of a Company. Customers, suppliers, competitors, and *complementors* make up the Value Net. A complementor is a company that provides goods that complement the good your company produces. For example, auto companies and insurance companies are complementors. All these roles are interdependent, and one company may be your competitor in one instance, then your supplier or complementor in another instance. The trick is being able to shift paradigms. Petroleum may be viewed as a competitor to ethanol in one instance, then a complementor in the next. The Value Net is depicted on a vertical and horizontal axis.

"*Along the vertical dimensions of the Value Net are the company's customers and suppliers. Resources such as raw materials and labor flow from the company to its customers. Money flows in the reverse direction, from customers to the company and from the company to suppliers. Along the horizontal dimensions are the company's competitors and complementor"(Brandenburger & Nalebuff, 1996, page 18).*

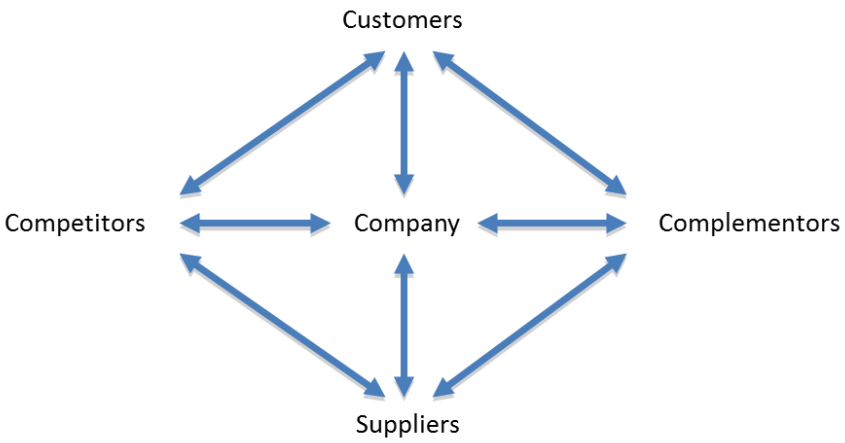

Figure 2 - The Value Net (Brandenburger and Nalebuff, 1996)

Each line in the Value Net represents a relationship that is important to the company, and this is where game theory is applied. (Brandenburger & Nalebuff, 1996)

Co-opetition uses game theory to combine aspects of cooperation and partnership in each business relationship. The idea is that business is not all win-lose but that in certain cases it can be win-win. A game is described as having PARTS (Players, Added Values, Rules, Tactics, and Scope). Players make up the Value Net. Each player has Added Value, which is defined as the size of the pie when you are in the game minus the size of the pie when you are out of the game. Added Value is Player's power in the game. Rules are structure and regulations that govern a game. Rules can allow you to negotiate in transactions or not, to share certain types of information or not, etc. Rules however are not always fixed; they can be changed to create better wins. Tactics are actions that are related to managing and shaping the perceptions of your competitors. Scope is related to the size of the game. In reality everything is interrelated so it is all one big game, however it is too hard to comprehend and analyze a game of this size, so boundaries are created to better map out and play smaller games (Brandenburger & Nalebuff, 1996).

Game theory is applied to all the relationships within the Value net. Game theory involves analysis of perceptions, namely that of your competitors, which requires one to put yourself squarely in someone else's shoes. This process is called *Allocentricism*, and involves trying to make decisions based on your competitor's perception of the game, as well as your competitor's perception of your perceptions and so on and so on. Perceptions are crucial to Game Theory as it will shape the actions of all those involved (Brandenburger & Nalebuff, 1996). An example that Brandenburger and Nalebuff use to describe the benefit of analyzing the other player's perceptions is the division of a pie. Intuitively one may think that cutting a pie down the middle and then letting the other player choose which half he/she wants is the most fair way to divide the pie, but actually perceiving the pie from the other player's point of view may allow you to arrive at a better win-win scenario. For example if you know that the other player prefers crust and that you prefer filling, you would split the pie in a way that would be better for both parties.

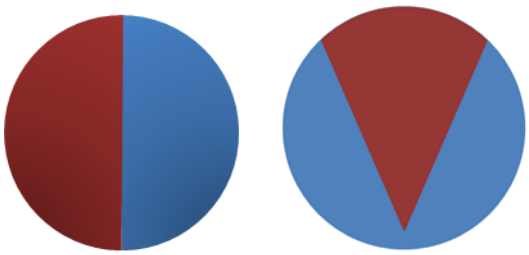

Figure 3 - Perception's role in Co-opetition (Brandenburger and Nalebuff, 1996)

Understanding the other's perception of the game allows you to come better prepared to the bargaining table. In late 2012, Brazilian based Copersucar bought a majority stake in the US based Eco-Energy making it the largest ethanol company in the world. Negotiations are over and the deal has been closed, however it is a good case to apply allocentricism. Eco-Energy may have put itself in the shoes of Copersucar to analyze the benefit of having a policy like the Renewable Fuel Standard which will guarantee demand for years to come for Copersucar (Nielsen & Kassai, 2012). Brazilians in the ethanol market complain that Brazil does not have similar policies to safeguard their investments. After the purchase Luis Roberto Pogetti, Copersucar's Chairman, stated in a conference call, *"The U.S. mandate is here to stay. Eco-Energy can offer oil companies the complete package and Copersucar is the provider of sugar-cane ethanol in this package"* (Nielsen & Kassai, 2012). Likewise Copersucar may have put itself in Eco-Energy's shoes to analyze the value of having access to sugar-cane ethanol that will meet the growing ethanol blending requirements in the USA. These are two companies from different continents, which most likely have different perceptions. Being able take on the other's worldview is invaluable for negotiations.

You can apply game theory in business when analyzing relationships with suppliers and competitors for win-win situations. In some cases, competitors can be a real blessing. One example is the case of commercial airplanes manufacturers and commercial airlines. If you are a commercial airline, the existence of a competitor to buy a portion of the planes made by your supplier will help to reduce the cost of these planes overall. Your supplier should have a good amount of customers; otherwise it might not make sense for your supplier to be in the plane manufacturing business since it is costly and capital intensive. The game here is to encourage a healthy number of competitors. The presence of competitors brings added value and makes the pie bigger by reducing costs. You also want your competitor airlines to have a good customer base so that they do not feel tempted to engage in price wars and consequently make the pie smaller for all. Going after your competitor's loyal customers may not be the best win-win as this will further tempt your competitor into a price war. In this case the better

strategy would be to reward your own loyal customers, as airlines have done with frequent flyer programs, so that they use your services more (Brandenburger and Nalebuff, 1996).

Some have criticized the idea of co-opetition and dismissed it as just being a form of collusion. They emphasize the corporation portion of co-opetition as being a threat to a free moving competitive environment. However, co-opetition offers something that collusion does not, benefits to the consumer by way of better products and services (Brandenburger & Nalebuff, 1996). Competitors collaborate to expand the pie, by contributing to R&D for example, once the pie is bigger, all compete to divide it up. There is still all the natural market forces of supply and demand that drive natural pricing downstream, it is just the portion that expands the pie that is cooperative. Competitors are interested because if they have the same percentage or even a bit smaller percentage of the total of a bigger market than they are making more profits (Walley, 2007). Since co-opetition is a highly dynamic relationship, it is important to keep tabs on the effects it is having for all those involved. Is it still bringing increased benefit for the co-opetitors and customers?

Co-opetition is a complex theory that involves many players that are constantly engaged in a dynamic shifting of roles, certain facets of an industry and the nature of the relationships of the competitors are more conducive to the rise of co-opetition. Members of the *value net* are constantly shifting roles. A value net is a relational view of one company to the other groups that it interacts with, it is made up of customers, suppliers, competitors, and *complementors*. One company within your value net can play several roles are once or at different times. Complements are linked to each other's demand in that having one product increases the utility of having the other and vice versa. For example, peanut butter and jelly are complements. Your competitor may one day be your *complementor* and then your supplier (Brandenburger & Nalebuff, 1996).

Certain conditions are more conducive to co-opetition than others and the co-opetitive relationships within the value net are fragile and run the risk of going sour. For instance, co-opetitive relationships happen more frequently in global industries. The more unstable the industry, the more distance in technological know how, the more distance between organizational systems, and the more difference in cultures between companies, the better the conditions for co-opetition (Padula and Dagnino, 2007). The presence of all or some of these things conditions cause companies to seek more complex relationships with their competitors for the mutual benefit of all parties.

Some believe that with the complex shifts involved in co-opetition there is a risk of disrupting the strategies that make a company successful. In tightly knit systems there may be

more of a risk of unraveled systems within the company and that co-opetition may act as a wrench in the system. Since positive complementors may have negative effects, it is important to make sure that co-opetition has strong centralized directions (Bonel & Rocco, 2007). As co-opetitive strategies involve many moving parts, it is important to train managers on when to employ co-opetitive strategies, how to make the transition to a co-opetitive strategy, and how to successfully manage a co-opetitive strategy once it is in place.

5 Methodology

5.1 Action Research

The methodology applied in this work will be Action Research. This is a type of research where the researcher is an active participant in the process. Action and research are interwoven so the two are simultaneously being done at all times. It is not the case that action is taken as a means to learn or research is done as a means to act, Action Research combines researching and acting in a dual process. Action research is applied for the betterment of communities in the study of worthwhile topics that will improve humanity (Reason & Bradbury, 2001). The process can characterized as constant process of observation, reflection, and improvement for all those involved. The researcher therefore is a facilitator and key to process of change, not just a passive observer.

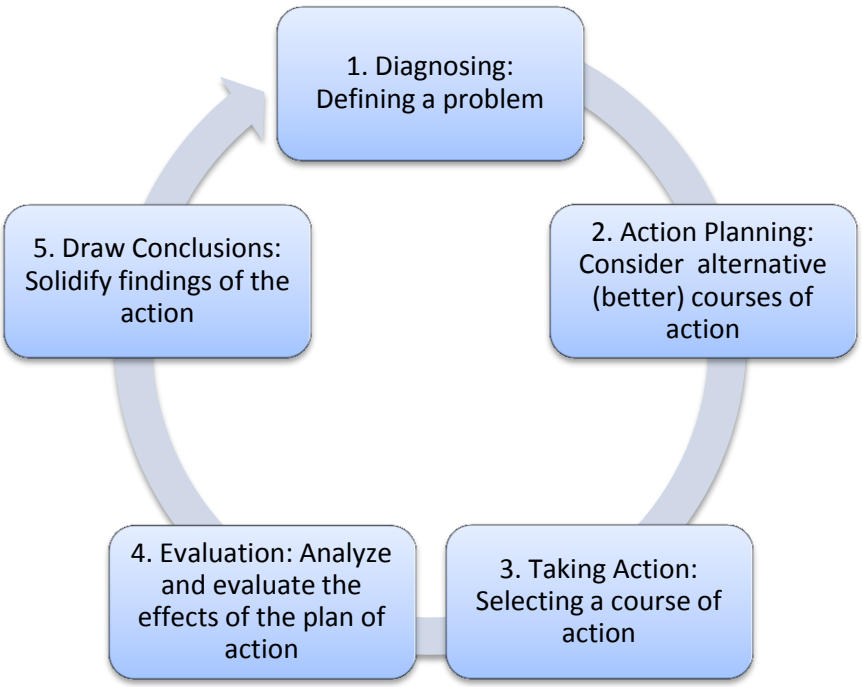

Figure 4 - Action Research Model (Adapted from Obrien, 1998)

Action Research was chosen as a methodology in order to best facilitate constructive discussion and as a means of possibly questioning misconceptions and drawing attention to opposing perceptions on US Relations or the ethanol Industry. In this way the dialogue for partnership can find possibly new solutions or strategies. The role of facilitator here is to build

bridges.

5.2 Research Process

The way Action Research will be applied in this thesis is through the interviewing of stakeholders in the months leading up to the Congress. In this forum various questions will be posed that will deal with the future of ethanol and more specifically, how the USA and Brazil can form and alliance that will create stronger positioning for ethanol as a main go-to fuel alternative in the future. The Forum will have 30 participants, 15 from the USA and 15 from Brazil. The goal is to balance the participants between academia, government, and business. Academics will come from FGV, Columbia University, Stanford, UC Berkeley, among others. The government representatives will come from the Ministry of Agriculture of Brazil, the Vice President of Brazil Michel Temer, Florida Government, among others. The representatives of business will be Cargill, Copersucar, among others.

Albert Fishlow – is the former director of the Columbia Institute of Latin American Studies and was previously the Paul. A Volcker Fellow for International Economics at the Council of Foreign Relations. He received his PhD from Harvard University and Dr. Fishlow has served as deputy assistant secretary of inter-American affairs and was awarded the National Order of the Southern Cross from the government of Brazil. He is one of the foremost experts on Brazilian-American relations.

Thomas Trebat - is Director of the Columbia Global Center in Rio de Janeiro, Brazil. Prior to joining Columbia Prof. Trebat was Managing Director and Head of the Latin America team in the Economic and Market Analysis department of Citigroup.

Chris Somerville- is the director of the Energy Bioscience Institute (EBI) of UC Berkeley since 2007. He is also a professor in the Department of Plant and Microbial Biology at UC Berkeley. He has also held the position of director of the Plant Biology department at the Carnegie Institution for Science and held teaching positions at Stanford University, Michigan State University, the University of Alberta, and the University of Illinois.

Luis Roberto Pogetti– is the former CEO and current Chairman of the Board of Copersucar. He is also a member of the board at Única and Vice Chairman of the Board at Uniduto

Logística S.A. He is former president of CTC. He holds an MBA and a Post Graduation degree in Finance from Getúlio Vargas.

***Roberto de Rezende Barbosa* –** is the president of Grupo NovaAmerica and Chief Executive Officer of CTC. His family has been in the sugarcane business for seventy years, and in 1975 he assumed the family business. He has been a director of Cosan Ltd. since 2009. He holds degrees in Business and Industry.

***Tadeu Andrade* –** is the Director of Universidade Canavieira. He is the former R&D Director of CTC. He studied at the Universidade Estadual Paulista Júlio de Mesquita Filho (UNESP).

6 Analysis of Interviews

There are varying opinions on what could be gained by the USA and Brazil reaching a form of partnership in respect to Ethanol. When speaking on the subject, most stakeholders were in favor of creating some sort of partnership; however the dynamics of this partnership and what would be ultimately gained from it varied depending on each individual's perspective. Throughout the interview process, many discussed the viability of ethanol, the possibility of technology transfers, hedging climactic risks, second-generation ethanol, expanding markets and creating volume, and creating a state of co-opetion to strengthen the market. Some of the opinions were conflicting while other seemed to support one another. By compiling these opinions one can examine how perceptions on the same topic can differ or overlap and how we can harness these perceptions towards more productive collaboration.

6.1 State of Ethanol

Most that were interviewed distinguish between ethanol made from corn or sugar and second-generation ethanol made from biomass. The latter is being developed now and still requires further research and development, as the energy is harder to extract. While first-generation ethanol is made from sugars and vegetable oils, raw materials for ethanol that can also be used directly to feed human populations or as a feedstock to animals, second-generation ethanol is made from agricultural residues or waste, or woody chips, which makes the fuel harder to extract (*Biofuel Technologies*, 2011). The former is the more traditional first-generation ethanol which, in the form of corn from the USA and sugar from Brazil, has been the bulk of world's supply, as the USA and Brazil have been the Number 1 and 2 producers of ethanol for quite some time.

However, many stakeholders voiced their concerns over corn ethanol. As Chris Somerville notes, corn has reached its limit in development. Echoing some of the known literature on corn ethanol, Tadeu Andrade highlighted that corn competed more directly with the world's food supply. Many critics of the American corn ethanol industry and its historic protection through tariffs and subsidies have also cited the danger that this domestic industry poses to the world's food supply and consequently global food prices (Brooks, 2012).

Albert Fishlow also touched on the shortcomings of corn as an expensive fuel

alternative that threatens to raise the price of food globally by being an incidental product of meat and poultry, however he also stated the sugar ethanol is not the most efficient alternative source, although it is certainly a better one than corn. Ethanol producers in Brazil respond to global prices and will switch to sugar if the global demand, or in turn the pricing, is more attractive. Since it currently is not a heavily subsidized industry, it does not compete with the global supply of food in the way the corn ethanol industry did, especially when it was heavily subsidized. Albert Fishlow mentioned that alternative sources of renewable energy in forms such as grass and tree limbs were being researched right now and may present better alternative fuel solutions. Albert Fishlow credits the size of the Brazilian Sugar ethanol industry more to the fact that is started early, in the 1970s, however he does not see the longevity of the sugarcane ethanol industry as the Brazilian and American governments were more focused on extracting the newly discovered sources of petroleum that have been discovered in recent years in both countries in the form of shale oil and pre-salt. Albert Fishlow sees a more productive partnership between the USA and Brazil in finding ways to increase the world's food supply through technology transfer. Thomas Trebat also noted that pre-salt has "*totally dominated government thinking*", to the detriment of ethanol. Although he is somewhat more optimistic about the future of ethanol, he does point out that the industry will need large-scale innovation for it to make sense.

Albert Fishlow certainly sees that focus on petroleum reserves as a threat to the ethanol industry. He noted that since the 1970s there have been articles published saying that at some point the world's petroleum supply will run out. As he recalls, these articles always highlight that the world is approaching its end in fossil fuels and ignite fear that is supposed to motivate further development of ethanol, however he concludes, *"…everybody's been saying that for many years, the difficulty in part is that they are constantly finding new reserves."* Mr. Fishlow points out that you can go back to the 1970s and find instances where one was going to hit the peak in terms of oil that was available and suddenly we find new reserves. Mr. Fishlow also points out, aside from the new oil sources that have been found of the coast of Brazil and places such as Alaska, that the coast of Africa is also being explored, as one would expect that since Brazil and Africa were at one point one land mass, there would likely be oil reserves of its coast as well. So in a sense, Albert Fishlow discredits the reports that we are approaching the apex of our oil supply, therefore weakening the argument for ethanol.

Similarly Luis Roberto Pogetti affirms that the threat of using up our petroleum reserves is not likely to happen, as was once believed. As he puts it,

"The evaluation of the availability of ethanol is totally different from what it was ten years ago. Ten years ago I heard a lot that day that petroleum energy would be used up, because it is a finite reserve that is constantly being consumed. Presently, the view of the world is that there is a lot of petroleum available in the world….the argument that petroleum will someday end is not really a factor anymore in discussing the variables involved in ethanol development. So renewable energy won't exist because petroleum is going to run out, because it won't run out. Now the issue that exists today regarding petroleum is not whether it's going to run out or not but rather the cost of extraction, and the environmental cost of extraction."

Luis Roberto Pogetti continued to name examples of costly incidents involving the extraction of petroleum. Including the potentially high cost of the extraction of pre-salt petroleum off the coast of Brazil and the environmentally costly incident of the BP oil spill of the coast of the US. As Luis Roberto Pogetti stated,

"You have pre-salt that has an elevated cost of extraction. You also have the risk of what happened off the coast of United States with British Petroleum. So after that the cost of extraction looked like it is pretty high. There are issues surrounding extraction of oil from sand, sand oil, principally in Canada. And there's also the shale oil in the US which right now is becoming a fever, very popular. It uses a process that's called cracking, which is like breaking the rocks for the gas to be extracted. There are environmental issues that are brought up which involve cleaning the water that they use to extract the gas, that contaminate these waters."

The new oil deposits found in the USA have been met with great excitement but some of have highlighted the potentially high extraction costs and the uncertainty about the nature of the reserves. This goes back to a recurring argument that while the US may have found new sources of petroleum derived energy, it is next to impossible to accurately ascertain the exact amount of the energy and the quality, furthermore the cost of extraction, which are linked to the quality of the energy reserves, can make it so it is not worthwhile to recover the petroleum energy (DiPeso, 2011). However these doubts do not seem to deter the excitement over these newly found energy sources, as Albert Fishlow confirms, as long as there is pre-salt and other petroleum based energy deposits in the USA, that's where the focus will be.

Chris Somerville discussed how the US is becoming a net exporter of petroleum, a

surprising turn of events due to the recently found fuel sources, and the US will rely on these new found petroleum sources for domestic consumption and international trade. Ethanol is also less calorically powerful than petroleum, as Mr. Rezende Barbosa points out, the price of ethanol can only be up to 70% of petroleum in Brazil for it to be worthwhile to consumers. He believes that there needs to be further development of motors that can use ethanol more efficiently, otherwise this will be the "*knife*" that threatens ethanol.

Most ethanol stakeholders will admit that the chances of ethanol completely substituting petroleum derivatives are slim; however Ethanol's prospects shift if you start to view it more as a compliment to petroleum than a straight substitute. Luis Roberto Pogetti points out that if we set our sights on replacing 15% of the world's petroleum usage with gasoline than it will be a big step for ethanol. He also affirms that this mix of gasoline and ethanol is the best mix for cars. Ethanol provides less mileage but more power to smaller vehicles, which is why the mix is ideal. As Mr. Pogetti stated,

"I do not see ethanol as a direct competitor to fossil fuels. It should meet another demand, the demand for the environment…. So along this line, a project for shale gas, sand oil, pre-salt, etc. Should not interfere with projects to develop ethanol. Why? Because these fuels have their role and ethanol serves its own purpose, which is complementary. It's a renewable energy that is able to mitigate some of the effects that it has on the environment."

As Mr. Pogetti continued to explain his point of view, straight petroleum usage is best suited to large scale industry and the blend of ethanol and gasoline is best suited for small vehicles because ethanol helps to oxygenate the fuel, mitigating some impacts on the environment, and is the best combination for small vehicles in terms of potency, or speed and power, and mileage.

In the USA, 95% of the US gasoline contains ethanol in a low-key blend, mostly E10 which is a mixture of 10% ethanol and 90% gasoline. The low level blend of ethanol is used to oxygenate the fuel and reduce emissions of harmful air pollutants. The environmental protection agency (EPA) has approved the use of up to 15% ethanol blends, or E15, in model cars from 2001 and newer. The US renewable fuels standard requires fuel in the US to contain a minimum volume of renewable fuels and requires renewable fuels to be blended in increasing amounts each year. There are also higher levels of ethanol blends in the USA, up to E85, for flex fuel cars; however these fuels are harder to find at gas stations, primarily concentrated in the Midwestern region of the United States (*Ethanol Fuel Basics*, 2012). In

Brazil, the mandatory ethanol level was dropped from 25% to 18% in 2011 (Loveday, 2011). However Brazil has a larger flex fuel market than the USA, where ethanol is a large part of Brazil's clean energy, second only to hydroelectric power. Almost all of Brazil's vehicles are flex fuel and cars have the option of running on 100% ethanol (Mclvor, 2010). So clearly both countries have a culture of blending, Mr. Pogetti seeks to promote the blending of ethanol into petroleum to expand the global ethanol market.

Chris Somerville affirms that the demand for ethanol is there and sites large capital investment into his research organization as proof of the interest, the key may lie in diversifying the product. If there wasn't a drought in the USA in 2012 there would be no way for the USA to use all of its ethanol, however as ethanol is volatile due to climactic variables, the supply in any one region is not entirely predictable. Looking at different regions with varying raw materials and different producers, as well different fuel blends, such as using sugar to make other types of fuels, would diversify the product.

As Chris Somerville affirms, 10% of all fuels could come from Brazil; however it needs large scale investment to develop these sources of energy. Chris Somerville adds that his organization in the USA has a great deal of respect for Brazil and what is has done for the renewable fuels industry but notes that it would benefit from American technology. Brazil may have the raw materials but needs research and development as well as the capital to develop these sources.

Another aspect of ethanol, namely Brazilian ethanol, which has been highlighted throughout several interviews, is the enormous potential for sugarcane ethanol to create jobs, especially in Brazil. Tadeu Andrade explained how Brazil has barely scratched the surface in terms of using the land that is capable of producing sugarcane in Brazil, in comparison to other crops that Brazil produces; sugarcane has a small percentage of the total agricultural mix in Brazil. Sugarcane has the potential to be developed in regions of Brazil that have higher unemployment rates, bringing jobs to these regions, which will stimulate the local economies and provide tax dollars to the government. As Mr. Andrade stated,

"The development of ethanol in Brazil is at the frontier of such areas as Goias, Maranhão, Tokanchi, Matto Grosso, etc. So these are areas of very little job opportunities. One person takes care of thousands of inhabitants. If these areas were occupied by sugarcane, it would generate thousands of jobs. This would generate jobs in rural and urban areas…"

Roberto de Rezende Barbosa also highlights the enormous capacity for sugarcane production

that still lies within Brazil. He added that productivity in the lands that are currently being used could also improve, however this is a longer process that involves research and development and trials over a period of time. He admits that increasing the quantity of land used to grow ethanol will provide a quicker increase to the supply of ethanol that Brazil produces. When speaking of corn in the USA, Tadeu Andrade explains that the market is much closer to capacity than in Brazil and suggests a commitment by the USA to develop Brazilian ethanol, namely exploring second-generation ethanol. He explained that the incentive for the USA to develop Brazilian ethanol would be to have a source or renewable energy that doesn't compete directly with feed stocks as corn does, which would keep food prices in check. By developing Brazilian ethanol, the USA would also help develop a supply of ethanol for itself and the world, making a larger supply would make ethanol more affordable.

6.2 Technology Transfer

Throughout all the interviews, a common theme was hopefulness about the beneficial role of technology in a USA-Brazil partnership. While there were positive attitudes towards the transformative qualities of technology, there were differing opinions on what it could do and how it could be used. Also, some had doubts about the capacity to share intellectual property, while others saw it as a naturally occurring process that would happen sooner or later. Some saw it as a unifying force between the United States and Brazil, while others viewed technology as more specific to each country and not transferable. It is worthwhile to access the different perceptions of technology to understand whether and how this tool, which seems to be seen as such a powerful force across the board, can be used for mutual gain between the USA and Brazil.

Many, such as Roberto de Rezende Barbosa, pointed out how far the industry has come in the last 30 years in developing better techniques for agriculture; according to him productivity has pretty much doubled in the last 30 years. While in the 1970s Brazilians looked to the USA to lead the way, now Brazil is looked at as a reference for ethanol produced in a tropical climate. He admits that the US has a much more advanced culture in research and development, with many different research institutions and universities. Brazil's culture is newer and much more concentrated to a few institutions such as CTC and Unicamp.

Most seem to agree that the US may have something to offer Brazil in way of technological advancement for the development of ethanol. The US is known for its

innovative society in many areas. Many see the advantage for Brazil if the US were to focus on developing new ways to improve the sugar ethanol industry or if it could concentrate on developing the process of distilling and fermenting for both first and second-generation ethanol.

Chris Somerville pointed out some of the ways in which he feels American technology could impact the Brazilian ethanol industry. He gave some examples of a possible technology transfer for crop modeling to predict the crop and logistical software used to access the impacts of climactic variation, which according to him are very underdeveloped in Brazil. He believes that a technology transfer would help Brazilian cellulosic fuels become more productive, produced from the inedible parts of plants, wood, or grasses.

Tadeu Andrade sees the benefit of the US providing technology to the Brazilian sugarcane industry. He believes that by providing technology to the Brazilian sugarcane industry the US is able to obtain ethanol that does not directly compete with feedstock, therefore not raising the price of food worldwide. By supporting the Brazilian ethanol industry the US is also helping to boost the world's supply of ethanol, therefore keeping prices down. This way the US gains through developing sugar ethanol. Mr. Andrade also pointed out the potential for development of second-generation ethanol; both the USA and Brazil are working on second-generation ethanol and are leaders in pursuing best ways to harness the energy out of inedible raw materials. A partnership between the two countries could lead to bigger investments in R&D and more cross pollination of knowledge, which would boost the industry.

Albert Fishlow stated that the US can certainly provide Brazil with advanced technology, however he thought this technology would be best used to find ways of increasing the world's food supply by finding alternative food sources. According to Mr. Fishlow, ethanol is in a precarious position due to the focus that the USA and Brazil has on its new oil deposits. As the world is currently hungry for commodities right now, with certain commodities being more attractive right now, the price of sugar makes it more attractive for sugar to be produced instead of ethanol. Mr. Fishlow suggests that Brazil and the USA focus more on finding these alternative food sources which will have a readily available market and ease some of our more pressing global issues.

Thomas Trebat also pointed out a different dimension of innovation needed for the ethanol industry, aside from working with the raw materials or biological component. As he states,

"I see it more of a technical matter…ethanol is bedeviled by a lot of issues, it's hard to

transport, it's hard to store, you can't build pipelines because it corrodes them, there aren't distribution networks globally, so I would go back to what I sort of said in the answer to the first question. I think there is a tremendous amount of innovation that needs to occur before this ethanol industry really starts to make a lot sense, before it really is something that is a significant competitor to fossil fuels, it's just too expensive right now, and there's something to this argument that it contributes to food scarcity."

According to Prof. Trebat, right now there does not seem to be the right infrastructure in place to support a substantially larger ethanol industry. Innovation in way of pipelines and transportation methods certainly would be a step in the right direction. Also, creating distribution networks and manufacturing more flex fuel cars abroad, not just in Brazil, would help to spread the industry globally. In order to do this, there would need to be a greater market and greater supply, so all these factors are precariously intertwined.

Another difficulty of technology is the attitude of fierce protection of intellectual property, once the technology is developed. As Tadeu Andrade points, this can be a serious pitfall when trying to progress the ethanol industry as a whole. As he states, *"One side always knows a little bit more that the other side. So intellectual property in general is a halt to political alignment."* Mr. Andrade also pointed out the dangers of a dominating attitude that comes with having certain technologies. *"Yes it's very tough because whoever has this technology thinks that they are the king of the world, the king of the world can do anything he wants."* Although a technology transfer seems to be best thing for the industry as a whole, it is tough to fathom one relinquishing this kind of innovation to a country that has been historically regarded as your competitor in an industry.

As Luis Roberto Pogetti stated, he believes that it isn't smart to quibble about the rights to technology; the important thing is that technology is used to speed up the development of ethanol and electric energy. Throughout the interview process it was pointed out that electric energy and ethanol are not competitors because electric cars need source of electricity, which are powered by fuels. Mr. Pogetti is reflecting the interest of the industry in general and not the interests of one party. The implication is that improving the industry is good for everyone.

While speaking to Tadeu Andrade, he brought up the fact that other regions in the world are looking to learn how to produce ethanol. He gave the example of China buying up lands in Africa and also Chinese companies coming to Brazil to learn how to produce ethanol. Africa is the only other region that has an abundance of available lands that have a climate

that is accommodating to sugarcane. Although as Luis Roberto Pogetti points out, it does not have the infrastructure, markets, or stability at the moment to quickly expand the markets. However the Chinese are looking to develop their knowledge of the process based on what they know of grain based ethanol and expands to sugarcane. Brazil has been experiencing a boom of exports to China because of their demand for commodities, so it may make sense that Brazil could look to strengthen their economic ties to China in other ways. However the Brazilian economy also faces the threat of the Chinese manufacturing industry flooding Brazil with its products (*Brazilian Manufacturing in the Face of Chinese Competition*, 2011).

Tadeu Andrade pointed out that while Brazil has been experiencing increased trade with China due to their interest in commodities, a partnership with the US in ethanol makes more sense because corn and sugar can ethanol are much more similar that sugar and grain ethanol. The US and Brazil, having long been the number one and two producers of ethanol, have spent more time researching second-generation ethanol. As the technologies are more adaptable to the other's raw material, it makes more sense to engage in technology transfers with each other and invest in research and development together.

Albert Fishlow points out that such bilateral partnerships in technology are hard to contain. The way that technology moves today, the minute that you have something that is successful it will easily spread. However others, such as Luis Roberto Pogetti and Thomas Trebat, do not seem to see the object of creating technology to limit its use to Brazil and the USA. The object of technology is more to expand the ethanol market globally and expand markets and increase supply.

Others do not see such a similarity between the technologies for corn and sugar ethanol. As Luis Roberto Pogetti puts it, sugarcane is much more complex than its competitors such as corn and beets with seven times the number of chromosomes, making research difficult as isolating variables is a much lengthier process. Sugarcane ethanol research is also much more expensive as well as time consuming. At the same time, as Mr. Pogetti puts it, corn occupies 10 times more area for planting than sugarcane does, so it attracts more investment in research than sugarcane as it is cheaper and has a wider audience. Mr. Pogetti states that Brazil had to develop research centers of its own, like CTC, to meet the growing demand for sugarcane ethanol research in Brazil. However international interest was slim until 2007, when the growth of sugarcane brought renewed interest to developing ethanol from sugarcane and Pogetti notes that Europe, The United States, as well as Brazil are investing in research for second-generation ethanol.

Roberto de Rezende Barbosa does not see the feasibility on a technology transfer of

first-generation ethanol, but sees the differences of the two raw materials as a positive force to the ethanol industry. The two raw materials are quite different and are exposed to very different climactic variables. They are also genetically quite different so to crudely apply the same technological advances to both would not be effective. What both Mr. Rezende Barbosa and Mr. Luis Roberto Pogetti agree on is that these two major producers can act as a natural hedge to guarantee a semi-constant supply of ethanol to the world. As the ethanol industry is more vulnerable to climactic variables that are unpredictable, as was the case in the recent drought affecting the North American corn, having two major producers that are separated by hemispheres makes the industry more secure, as the climactic variables that influence one crop are unlikely to be the exact same variables that influence the other. In this way risk is more distributed. As Thomas Trebat points out, it is beneficial to spread this technology to other areas of the world. This would create more consumers, and as Chris Somerville points out, make the industry more secure.

6.3 Second-generation Ethanol

Although collaboration on first-generation ethanol seemed to be more polemic, collaboration on second-generation ethanol is an area where many believe that the USA and Brazil can create a more mutually beneficial partnership by jointly investing in research and development. It is the newest frontier of renewable energy and provides a solution to the dilemma of using raw materials that compete with feedstock for ethanol. However, as this is a relatively new area, researchers are still trying to discover the best ways to extract the energy from these nonfood materials.

Unlike first-generation ethanol, second-generation ethanol is made up of raw materials that are typically present when the edible materials are extracted. A lot of the left over parts of food materials, such as wheat stock, are being explored as raw materials for fuel, principally for small vehicles. These materials are agricultural residues, what may have been considered to be waste, that have the potential to be used as a renewable energy. This area provides quite a bit of hope for those looking for a renewable energy source that truly would not negatively impact the world's food supply and drive up food prices. First-generation biofuels are made from such edible materials as sugar, starch, vegetable oil, animal fat, and corn. The technology to produce first-generation ethanol is already well developed, and many believe that the technology is very specific to each raw material and not easily transferred to others (*Biofuel Technologies*, 2011).

For quite some time first-generation ethanol has been under the microscope for its impacts to the global environments and economy. First-generation ethanol has been linked to creating competition not only for food and fiber production but for land and water use as well. With the possible exception of first-generation ethanol made from sugarcane, first-generation ethanol made from grains, sugar beets, corn, or oil seeds, have been criticized for their limited ability to achieve targets for *"...oil- products substitution, climate change migration, and economic growth"*(Sims, Taylor, Saddler, and Mabee, 2008, page 5).

Due to these concerns over the shortcomings of first-generation ethanol many have looked for solutions in non-edible raw materials. Second-generation ethanol is made from ligno-cellulosic materials which include cereal straw, forest residues, woodchips, grasses, and bagasse. Producing ethanol from these materials could potentially eliminate some of the shortcomings found in traditional ethanol and potentially offer a reduction of costs in the future (Sims, Taylor, Saddler, and Mabee, 2008).

However there are still challenges facing the development of second-generation ethanol. For example, Researchers are still finding ways to break down the cellulosic material into sugar. As there are still many technical barriers, the industry is not as developed as the industry for first-generation ethanol (*Biofuel Technologies*, 2011).

Albert Fishlow brought up various aspects of first-generation ethanol, particularly corn ethanol, which would lead researchers to look for substitutes. He mentioned the research being done on woodchips and vines, alluding to second-generation ethanol research. Although he is pretty certain that petroleum reserves will occupy the attention of government, he also mentioned the search for other renewable energy sources other than first-generation ethanol.

Both the USA and Brazil are interested in producing ethanol from second-generation. During the interview process many expressed a positive attitude or hopefulness about the potential for the USA in Brazil to combine their technical know-how and develop more efficient ways to extract the energy from second-generation ethanol materials. As opposed to the division on whether technology developed for first-generation ethanol could be successfully adapted to other raw materials, the technologies for second-generation ethanol is perceived to be sufficiently similar for partnership and collaboration to make sense.

When speaking to Tadeu Andrade, he expressed the need to develop ethanol production from biomass or second-generation ethanol. Although research is underway for second-generation ethanol, he still believes there is further large-scale development needed to expand the biomass ethanol industry. As he stated, *"…so I think that a good investment is research and development in second-generation ethanol based on sugar and not on corn, so*

as not to impact the natural movement of and inflate food prices." Although the US and Brazil have gotten the ball rolling in second-generation ethanol research it is commonly acknowledged that second-generation ethanol is still a frontier territory and would greatly benefit from investment in the industry and division of how the industry could look in the future.

When speaking to Roberto de Rezende Barbosa, he brought up the similarities in the fermentation process of second-generation ethanol. He spoke of the energy that can be found in the lining of sugarcane and how it can be turned into vapor energy in much the same way that the lining of corn crops can be turned into energy. Mr. Rezende Barbosa elaborated by discussing how second-generation ethanol is a huge field of study that has a wide range of research, in the United States and various regions of the world. He mentioned that there are other regions of the world that study second-generation ethanol but the main countries are the United States and Brazil. He believes that the technology will be available in the next 10 years because researching is a very lengthy process. As he pointed out the technology can be available but the structure to use it also needs to be in place. There have to be means to support the technology for it to be viable. Mr. Rezende Barbosa also spoke of the centers of research excellence that exist in the United States for this purpose. Mr. Rezende Barbosa believes that in the tasks of envisioning structures to support the future the second-generation ethanol market as well as the development of a method for more efficient extraction of second-generation ethanol, the USA and Brazil have a good opportunity for collaboration.

The themes of volume and hedging risk showed up quite frequently throughout the interview process. Many brought up the fact that developing multiple and various energy sources in different regions were away of not putting all your eggs in one energy basket. Having alternative fuel producers in different climactic environment was one hedge, and Mr. Pogetti brought up the idea of an energy portfolio for each country. Developing multiple sources of energy such as fossil fuels and first in second-generation ethanol are away of diversifying your portfolio and consequently being more secure in your energy stance. According to Mr. Pogetti, the USA and Brazil should look at their respective energy matrixes and learn how to administer their energy sources domestically.

6.4 Co-opetition

Aspects of co-opetion showed up throughout the interview process. Most brought up the potential for the USA and Brazil to increase and expand the ethanol market. Some more

directly pointed out that the ethanol market had to be expanded to other nations in order for it to have more of a viable future.

Co-opetition incorporates game theory which deals heavily in the perceptions of the participants of the game. Brandenburger and Nalebuff explain this in their 1996 book, *"Different people view the world differently. Just as the players added values and the tools are important elements of the game, so are the players' perceptions. The way people perceive the game influences the moves they make"* (Brandenburger and Nalebuff, 1996, page 52). They also went on to give an example of the Texas shootout as an important example of how perception is used to create win-win situations in business. This is when two partners that the business and specify what they should do if one partner wants to end the relationship. In the Texas shootout the dissatisfied partner must offer a price. The other partner must either buy the dissatisfied partner's share or sell their share for that price. By incorporating the other's perception on what the business is actually worth, a more successful agreement can be reached. Most win-win situations require an analysis of perceptions, as opposed to win-lose situations. A goal of the interview process was also to bring to light perceptions on the same issues, showing how they overlapped or differed. Clearly there are many aspects of ethanol and each game participant might have its own perception of each aspect of the game, so the perceptions may be voluminous and complex, as well as interrelated. As game theory requires one participant to put himself in the other participant's shoes and incorporate a different perception, it is useful to have an idea of the other participants lens on looking at the same issue (Brandenburger and Nalebuff, 1996).

One of the strongest advocates of a co-opetitive strategy was Thomas Trebat. He cited the Bush-Lula biofuels agreement as a great step in the right direction, which unfortunately had little follow-through. This agreement was meant to advocate further research and development in biofuels as well as create third markets in other parts of the world. This was done because as President Bush said during a joint press conference following the agreement, *"If you're dependent on oil from overseas, you have a national security issue…"* (Ferrand, 2007). The initiative called for the US to diversify energy sources and reduce domestic consumption of gasoline by 20% by 2017, this also made a lot of economic sense at the time given the rising prices of oil due to growing demand in emerging markets such as China and India. The agreement also aimed at bolstering a global market for biofuels, with the objective of creating structure in the form of rules and regulations. Lula also encouraged the development of the biofuels market in countries like Peru, Colombia, Guatemala, and other nations in the Caribbean in order to create a Persian Gulf equivalent of ethanol in the Western

Hemisphere (Ferrand, 2007).

This type of expansion in the global market is part of a co-opetitive strategy. Instead of looking at bringing in new competitors to the ethanol market, the United States and Brazil were looking at the bigger picture of making the pie larger. Making the ethanol market larger involves bringing in new competitors that improve the product, which will in turn bring new consumers. By expanding the ethanol market, you are increasing supply worldwide and exposure to this alternative fuel. After the pie is increased then all the individual countries can compete to see who can sell the most, but because there is an increase in consumers everybody wins. Prof. Trebat cited this agreement as an example of what he envisions for a successful ethanol market. However he said that he doesn't know much ever came of that agreement. He mentioned that students have written papers for him about it and most of them say that it was a good idea; however no one seems to give examples of any conclusive results that were derived from the agreement. One thing to note about the agreement is that at the time oil prices were raising and the USA and Brazil were possibly more concerned with developing alternative fuel sources, especially with the consumption of emerging markets. However, as has been mentioned previously, many are not as concerned with fuel prices in the future due to new reserves of oil being found in the US and Brazil.

Prof. Trebat highlighted the importance of bringing the ethanol to third markets. He gave examples of bringing ethanol to countries like Haiti, Cuba, and the poor countries of the Caribbean. These are countries that are desperate for job creation and need to diversify their energy matrixes. However these third parties lack the technology to make ethanol and adequate supplies at affordable prices, as well as the adaptive technologies to use ethanol. By expanding ethanol to these markets, Brazil and the USA would help create a more thriving ethanol market and also boost the economy of the Western Hemisphere, especially the southern part of the Western sphere. As Prof. Trebat puts it,

"… but I think the real challenge for Brazil and the United States for that to be more than a somewhat limited commercial relationship between Brazil and the US in regards to biofuels, somehow the two have to solve these very thorny problems on how to create biofuels outside the USA and Brazil. And then I think they can either collaborate or cooperate that people gain. Until they can both gain or until there is a substantial market beyond these two large markets, which are the biggest suppliers, the gains from collaboration on ethanol, not so much biofuels but ethanol, are likely to be fairly marginal."

Professor Trebat later concluded that he almost would rather see the USA and Brazil competing in the ethanol market as this would drive producers to create a better product. He did advocate cooperation in the upstream portion of the relationship however, which is a characteristic of co-opetion.

Aside from bringing ethanol to new markets, others spoke of sharing research and development, which would create volume to the market, this expansion of the pie also being part of the co-opetitive strategy. Prof. Trebat pointed out that Brazil has a culture of study in agronomy that is more advanced than the US, as well as a more advanced domestic ethanol industry than the US. He stated that the US can learn a lot from Brazil in this regards. This would essentially expand the ethanol market, especially in the US, then Brazil and the USA, as well as any other countries that were producing ethanol, could compete for the new consumers. Chris Somerville also highlighted how an increase in consumers is security for the ethanol market, and advocated research and development to do so. Others highlighted the fact that a cooperation can bring volume to the industry which is an important aspect expanding the market.

6.5 The Influence of Policy

Throughout the interview process many interviewees spoke of the importance of politics, domestic and international, to the development of ethanol. Some believe that industry would be the impetus to create policy that promoted ethanol. Some believe that business and government need to act simultaneously in order to have successful long-term growth. Some interviews showed a desire for one country to learn from the other. All agreed that politics had the power to either greatly promotes or severely damage the ethanol industry.

Politics is such a broad topic but when using it to analyze the ethanol industry it is useful to separate domestic from international. For instance, developing the ethanol market could bring different political gains for the US or Brazil, both in the domestic and international arenas. Also it is important to realize that at times international success is contingent upon certain domestic political factors.

One of the important arguments for the US to build up the ethanol industry is to have leverage against certain major oil producers in the world with which it has historically conflicts with. As Prof. Trebat explained, most of the US conflicts are related to oil. He elaborated that our preoccupation with Iraq, Iran, and the Arab Spring are largely linked to our dependence on oil. Many have pointed to this dependence as a major threat to the USA,

and as previously noted, the petroleum reserves in the US haven't been accurately measured. Luis Roberto Pogetti also emphasized the importance of being less dependent on Arab countries, and developing an ethanol market in the Western Hemisphere.

Another gain for the US in the international arena in the promotion of ethanol would be boosting its relations with other Latin American countries. Prof. Trebat stated that by spreading the ethanol market to other countries in Latin America that face unemployment and issues of poverty, the US would be strengthening its ties to the Hemisphere and gaining by boosting the economy of the Hemisphere, principally the southern portion of it. He expressed his opinion that the real way to better relations is to help grow the economies and not necessarily just having goodwill trips to the nation.

Prof. Thomas Trebat spoke briefly about possible international trade agreements, emphasizing that the agreement should be more inclusive than exclusive. In line with his previous arguments that creating third markets and ethanol was the best way to boost the industry, he saw the possibility of creating multilateral trade agreements and not just bilateral agreements. In this way you can bring more potential producers of the table.

Albert Fishlow predicted that politics would be a wrench for the ethanol industry. According to his argument of focus on petroleum reserves, there would be competitive policy advocating petroleum versus policy advocating ethanol and in the end petroleum would win. He brought to attention the contradiction of Brazil promoting ethanol while Petrobras is ardently seeking government support for the extraction of pre-salt. Mr. Fishlow also brought up the case with Chevron in Brazil as an example of stumbling block to partnership.

Chris Somerville and Thomas Trebat brought up the fact that the USA should be interested in partnering with Brazil because it is growing a lot faster in comparison to the USA. Chris Somerville pointed out that while Brazil is growing the US is flat or declining, so it is a good idea to want to tie itself closer to Brazil. This could happen in the form of technical exchange or building a market.

Tadeu Andrade brought up a very important environmental issue and the support from important environmental groups that the development of the ethanol industry would bring. Mr. Andrade emphasized the political sway that certain environmental groups such as Greenpeace have in the political arena. By promoting and ethanol industry, governments would gain the political supports of such groups that have power in the constructivist sense.

Luis Roberto Pogetti brought up the benefit for Brazil to get more international exposure by creating bilateral agreements with the USA. He stated that there are few examples of successful bilateral agreements with Brazil. It has historically been very closed,

both politically and in business. He also mentioned that Brazil is still new to international politics, bringing to attention what he felt were relations with certain countries that may hurt other more important international relations. He gave the example of Brazil's relationship with Hugo Chavez and how that might be damaging to other international relations.

Tadeu Andrade brought up the prospects of developing the ethanol industry so that it could not be as deleterious to the world food supply. As he pointed out, a partnership that focused on sugarcane and ethanol from biomass would not be as harmful to the food supply. The partnership that created this impact to food prices would be a boost for international relations.

Roberto de Rezende Barbosa brought up the fact that Brazil is now the reference for producing sugarcane ethanol in a tropical environment and this would be beneficial politically if the ethanol market spreads globally. According to Mr. Rezende Barbosa, the technology for producing sugarcane ethanol in Brazil has dramatically improved in the last 30 years, so much so that Brazil it is now the vanguard for sugarcane ethanol production. By spreading the sugarcane ethanol industry to other parts of the world, Brazil would be looked on as a much-needed leader in the field.

On the domestic front, the support that the US gives to green issues is in large part determined by which political party is currently in power. As Thomas Trebat noted, ethanol support will depend on whether we have a Democrat in office. As Obama was reelected for a second term, it is more likely that green programs will get more government support than if we had a Republican president. However, as previously noted, new oil deposits can excite both parties to the point of lowering ethanol as a priority. In fact, as Prof. Trebat pointed out, the US has experienced a good deal of lobbying against the ethanol market, less opposition than Brazil has. He points out that the US can learn a great deal from Brazil in this industry.

Domestically in the US the corn farmer is supremely politically important. The Iowa caucus heavily determines the election of the US president, and because of this fact Iowan farmers have a lot of power. As Prof. Trebat points out, the main issue is the farmer. Chris Somerville discussed how corn farmers fear the low price of ethanol. However, as Prof Trebat stated, the farmer is not heavily concerned on whether his corn is made into ethanol or sold as food, as long as he has a market for what he grows. So for this reason the demand for corn should not hurt farmers. And as the tariffs and subsidies were lifted in late 2011, there is less of a financial burden on the American taxpayer to support the delicate corn ethanol industry.

Long-term security for ethanol producers in the form of domestic Brazilian ethanol policy was the theme that came up frequently in the interview process. Luis Roberto Pogetti

and Roberto de Rezende Barbosa brought up the fact that ethanol is a capital-intensive industry where the assets need to be depreciated on a long-term basis. Because of this high cost of entry there needs to be domestic policy that removes some of the risk of getting into the industry. Luis Roberto Pogetti brought up the fact that the US has more long-term policy on ethanol blending than Brazil does, because of this producers have no security. Producers do not know what will be the percentage of ethanol that is required to be blended into gasoline in the medium term to distant future. For this reason he believes that ethanol needs to be more clearly defined in its role in Brazil's energy matrix. He believes that businesses and government need to work together in order to build the industry.

Although he is not a big advocate of subsidies, Mr. Pogetti did point out that ethanol is not paid for the positive externalities that it brings to society. These benefits come to society in the form of public health and a cleaner environment. In order for ethanol to have a competitive advantage it must be paid back for these. By avoiding the use of ethanol, consumers will have to pay for better public health and a cleaner environment in the form of tax dollars. Mr. Pogetti suggests a more preventative measure by paying ethanol producers instead, either by the government or the individual. This is not a subsidy, this is paying for public benefit. Mr. Pogetti points out that programs are ethanol need government support until they gain scale. He stated that Brazil won't be able to engage in successful bilateral relations with the US until they fix these domestic issues.

Roberto de Rezende Barbosa emphasized that politics can either be a blessing for the ethanol industry or mortally damaging. He cites the main issue is harmful interference of governments with the free market movements in commodities. He gave the example of how the lowering of gas prices in Brazil has been severely damaging to ethanol. He explained that ethanol producers are prepared to compete with the fluctuations in the price of gasoline and have become accustomed to climactic changes that are an unpredictable factor in the production of ethanol. However ethanol producers cannot compete with government policy that deals a blow to its industry, such as making the price of gas artificially low. Mr. Rezende Barbosa is not an advocate of subsidies in general in Brazil, as opposed to the US where there is more agility in reacting to political and economic pressures, things in Brazil move a bit slower in government.

Tadeu Andrade and Mr. Rezende Barbosa agree that the ethanol provides a great deal of jobs for Brazilians. By expanding the industry Brazil would create many more jobs at home. The expansion of jobs and consequently the boost to the economies of more impoverished areas as a result would be a great gain. With this expansion of the ethanol

industry, there should be policy that specifies quality and standards of ethanol.

7 Applying Co-opetition to Second-Generation Ethanol

Upon applying the Action Research Methodology to this research, the issue of where to focus Research & Development and Innovation for the best mutual win for Brazil and the US arose. Research and Development is a key part of creating mutual wins in co-opetition. The power of technology and the hope that all stakeholders expressed in its ability to improve the ethanol and energy markets was very strong. Through using Action Research, different solutions were considered.

1. ***Diagnosing: Defining a problem***

How to focus the power of innovation to improve the global ethanol market?

2. ***Action Planning: Consider alternative (better) courses of action***

Plan A) The US and Brazil jointly investment in R&D for corn and sugarcane ethanol to expand the first-generation ethanol market.

Plan B) The US and Brazil jointly invest in sugarcane ethanol since it has a greater energy output.

Plan C) The US and Brazil jointly invest in cellulosic ethanol to help create and expand markets for second-generation ethanol.

3. ***Taking Action: Selecting a course of action***

Plan C is the best decision because the breakdown processes as well as the fermentation and distillation processes of second-generation ethanol are similar enough to apply technology transfer. It is more difficult to jointly invest in first generation ethanol because corn and sugarcane are too genetically different to apply the same innovations to either raw material. Although certain American companies may invest in developing sugarcane ethanol, it may be more likely that American companies will be willing to invest in developing second-generation ethanol as there is an abundance of raw materials found in the US in the form of wood, grasses, etc.

4. ***Evaluation: Analyze and evaluate the effects of the plan of action***

In this research, this course of action was evaluated by discussing it with the different

stakeholders interviewed. The plan received a positive response. All stakeholders were optimistic about second-generation ethanol. Stakeholders who discussed successful joint investment in technology for ethanol produced in both Brazil and the United States said that second-generation ethanol would present the better option as the fermentation and distillation processes were similar and second-generation ethanol did not compete with the world's food supply.

5. ***Draw Conclusions: Solidify findings of the action***

The best means of growing the pie for second-generation ethanol is to produce it more efficiently, make it cost competitive with other biofuels in as little time as possible, and being able to deliver when demand increases, especially the secure demand that is present in the USA due to policy. The way that companies can do this in the USA and Brazil is jointly investing in innovations in efficiency in technology. The only way that the cellulosic fuels won't be consumed in the USA is if there isn't supply. It is up to producers to meet the future standards that haven't been met historically. (Danko, 2013)

During the research, it became apparent that the co-opetion model could be best applied to the development of the worldwide second-generation ethanol market. In this case you could think of American companies and Brazilian companies working together in a game with the players in their Value Nets. The model applies to the second-generation ethanol because it is an industry that has a come a good way developing technology to break down the inedible raw materials of cellulosic ethanol, yet will greatly improve with development in this area as well as the fermentation and distillation processes. Although other regions of the world have shown interest in cellulosic ethanol development, it is the US and Brazil that have the most plants as of now, and are the current world leaders in ethanol. To better illustrate the co-opetition strategies between the US and Brazil, it is useful to draw the Value Net for either a Brazilian or American ethanol company. For this exercise, a hypothetical American cellulosic ethanol company is used to demonstrate co-opetitive relationships, but the inverse could easily be done with and Brazilian cellulosic ethanol plant.

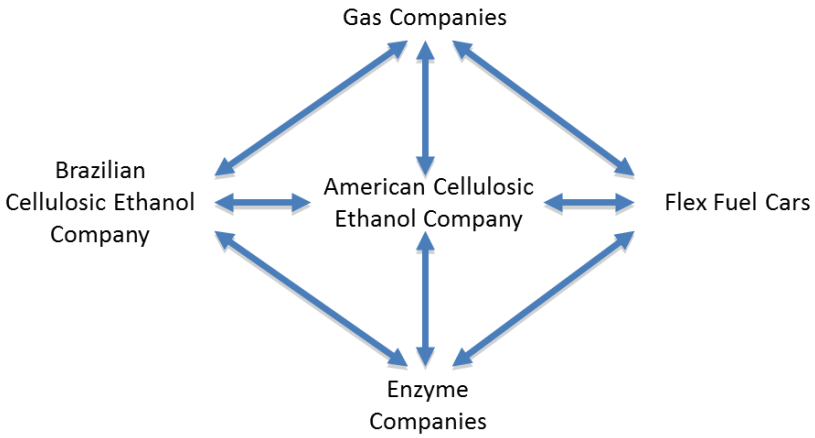

Figure 5 - Example of the Value Net (Brandenburger and Nalebuff, 1996)

The figure above shows some of the players in the Value Net for a typical American cellulosic ethanol company. However as Brandenburger and Nalebuff indicate, the more complete the Value Net the more useful the exercise will be. So to expand on the figure above, here are some additional players.

Competitors

- Other American cellulosic ethanol plants
- First-generation ethanol
- Brazilian and other foreign cellulosic ethanol plants
- Fossil fuel companies
- Solar Energy, Electric Energy (for cars mostly), Wind Energy, and other Green Energy Sources

Complementors

- Fossil Fuel Companies
- Flex-Fuel Car Companies
- Larger Vehicle (Planes, Buses, etc.) Companies
- Electric Energy (for cars mostly, Obama policy, lobby for the connection!!!)

Suppliers

- Biomass Producers
- Enzyme Manufacturers
- Research Institutions
- Employees
- Manufacturers of various essential Capital components
- Transportation Companies

Customers

- Gasoline Companies
- Biofuel Companies

Figure 6 - The Expanded Value Net (Brandenburger and Nalebuff, 1996)

Now that an extended Value Net has been drawn up, we can analyze how to play a better game by using the different Elements of PARTS. Brandenburger and Nalebuff devised a series of questions that companies can ask themselves in relation to the different components of the game in order to have better wins. Below are answers to these questions based on the

Value Net of our hypothetical American cellulosic ethanol plant. These answers are a springboard to apply co-opetition in the international cellulosic ethanol market.

1. Player Questions:

What are the opportunities for cooperation and competition in your relationship with customers and suppliers, competitors, and complementors?

A) With competitors, both Brazilian and American, an American cellulosic ethanol company can partner up to jointly invest into research institutions and Universities that can provide innovation that will more rapidly make cellulosic ethanol production more cost competitive with first-generation biofuels. The handful of cellulosic fuel plants in the USA and Brazil can partner up to bring innovation to and kick-start the market. Although this may attract new entrants, the existing cellulosic ethanol plants will have a chance to create loyalty, agreements, and relationships with their customers.

B) As gas companies also want to meet cellulosic ethanol blending requirements in the future given the US policies in place, certain gas companies may have vested interest in investing in cellulosic ethanol research with cellulosic ethanol producers. As an incentive, the gas companies that invest may be given a right to purchase a certain quantity of the cellulosic fuel produced at a discount, to give them an edge over their competition for blended gasoline.

C) Enzymes used in second-generation ethanol production have been one of the most costly elements for the industry. Producing enzymes in larger quantities for more players in specific orders can possibly reduce the price of enzymes.

D) Although cars powered by electric energy may be considered competitive to cars powered by renewable energy, the push by Obama to get the USA off oil and using more electric cars may be an excellent opportunity for the cellulosic ethanol industry as well, both Brazilian and American. In this case, cellulosic ethanol companies in the USA should support these green initiatives by Obama but also promote policy that ties renewable fuel to electric energy. Electricity needs to be generated by plants that have been, in many cases, powered by fossil fuels. In order to create a more sustainable industry, electricity for electric cars should ultimately be powered by cellulosic ethanol. One caveat is that cellulosic ethanol companies should be careful to still maintain the support of cars solely powered by second-generation ethanol in the

future.

E) Another important building block for the second-generation ethanol market will be public awareness. The energy consuming public, especially small vehicle operators, should know the environmental benefits of second-generation ethanol as a means of promoting the market. This awareness can be achieved by launching international marketing campaigns.

Would you like to change the cast of players? In particular, what new players would you like to bring into the game?

A) The American and Brazilian Governments in particular could be introduced as customers. The production of second-generation ethanol, in comparison to fossil fuels provides positive externalities to the environment and American and Brazilian people in particular. One way of helping the industry become more competitive would be to pay for these positive externalities directly to the cellulosic ethanol companies. If cellulosic ethanol is not developed than tax payers will have to pay for the damages to the environment and higher food prices down the road, and repairing damages can be more costly than avoiding them.

B) Universities, especially in the US, should offer more training to students in agronomy and other areas that would supply cellulosic ethanol plants with the right employees or research centers with the right trained staff to more efficiently develop cellulosic ethanol. As Thomas Trebat pointed out, Brazil has more of a culture of university study in these areas and can teach the US to develop this field in universities.

2. Added Value Questions:

What is your added value?

In a game this large it may be difficult to precisely access any one company's added value to the whole pie, however it is easier to quantify added value in smaller subsets of the game. For instance, if a Brazilian cellulosic company strikes a deal with an American gas company to provide a certain level of cellulosic ethanol to meet their blended gas target outputs, the added value really is the value of the entire blended gas, not just the value of the ethanol to make the blended gas. The definition of added value is the size of pie when you are a player minus the size of the pie when you are out. Without the cellulosic ethanol there is no blended gas.

How can you increase your added value?

The added value of cellulosic ethanol really comes from its ability to meet government mandates of cellulosic ethanol blends in gas. In order to increase added value, it is important to support these mandates in the USA and lobby for secure long term blending requirements in Brazil.

What are the added values of the other players in the game? Is it in your interest to limit their added values?

Since the second-generation ethanol industry is relatively new and a market of consumers still needs to be established and target industry outputs have not been met historically, it may be too early to start limiting added value. In being overly competitive any one cellulosic ethanol plant may shoot itself in the foot. Also supplier prices may shoot up.

3. Rules Questions

Which rules are helping you which rules are hurting you?

A) Blending requirements, both in the US and Brazil, for cellulosic ethanol in gasoline are helping. Long-term requirements are better than requirements that are subject to change at any time, like the requirements in Brazil.

B) Any policy that favors fossil fuels and lowers their prices artificially can be very damaging to the ethanol industry.

What new rules would you like to have? In particular, what contracts would you like to have with your customers and suppliers?

A) Long-term cellulosic blending policies in Brazil would benefit both the American and Brazilian cellulosic industries as there would be a higher guaranteed global demand.

B) Gas companies also have a vested interest in production of sufficient cellulosic ethanol to meet blending requirement in the USA. As is the case, striking R&D contracts with customers may be an option. For the gas companies that invest, there should be special incentives, like discounts on the cellulosic ethanol outputs.

C) As enzymes are a high variable cost, it may be a good idea to lower costs all around for the industry by placing larger orders with competitors. Certain long-term contracts would benefit the industry.

Do you have the power to make these rules? Does someone else have the power to overturn them?

Cellulosic ethanol plants, especially those in United States, do no have power to create policy in Brazil. However it would be in their interest if this policy were present and the Brazilians private sector has more ability to influence their policy makers.

4. Tactics Questions

How do other players perceive the game? How do these perceptions affect the play of the game?

Other players perceive the second-generation ethanol industry as one that is positively viewed by the general public but has been slow to deliver, mainly because of the complicated procedures involved in breaking down the tough inedible raw materials. Policy makers perceive the industry as one of over promising and under delivering as many targets for cellulosic ethanol that were set late last decade were not remotely met (Danko, 2013).

Which perceptions would you like to preserve? Which perceptions would you like to change?

Perceptions that the industry is unreliable are hurtful to expansion of cellulosic ethanol. The industry needs to come closer to meeting the targets it sets to create credibility and reliance. So ethanol companies in the US need to apply better methods of forecasting supply. If the forecasts are to be sufficiently accurate, then all cellulosic ethanol plants need to collaborate. The perception of high technical and capital investment may be worthwhile to maintain in order to inhibit ill-equipped new entrants.

Do you want the game to be transparent or opaque?

Most of the game should be transparent. Due to under delivering in the past, the industry already has some hurdles to overcome. The industry should be clear on how much of the Renewable Fuel Standard for cellulosic ethanol that it is prepared to meet. This way gas companies may be more willing to sign long-term supply contracts.

5. Scope Questions

What is the current scope of the game? Do you want to change it?

The game encompasses gas companies, first and second-generation ethanol plants, automobile producers, research institutions, fossil fuel companies, and enzyme producers, mostly in the USA and Brazil, but also with new investors and suppliers

from Europe. The game could be improved if new players were brought in from other Western Hemisphere countries. This way demand would increase, competition will increase, and the product will be improved.

Do you want to link the current game to other games?

In the future it may be worthwhile to link the cellulosic ethanol game to the auto insurance game. (Brandenburger and Nalebuff, 1996)

8 Conclusion

There are many factors that must be considered in order to create a successful strategy for expanding the ethanol market through a partnership between the USA and Brazil. Most stakeholders believe that with the right conditions in place a successful partnership between the USA and Brazil in ethanol is possible. The hope lies more in sugarcane ethanol. Some expressed doubts on first-generation ethanol entirely, mostly in reference to corn ethanol, but saw more promise in second-generation ethanol. Some of the critical success factors included developing technology for second-generation ethanol, support from the research community, supported government policy, bringing ethanol to third parties, demonstrating the benefit to stakeholders from each country, and developing partnerships between the USA and Brazil in the manufacturing sector. Some of the main hurdles include government policies that go against the interests of ethanol producers, concerns over sharing intellectual property, and being distracted by the possibility of new petroleum reserves. It is important for both American and Brazilian stakeholders to try and understand each other's perceptions of the same industry in order to make their viewpoint of ethanol more flexible as it is an incredibly dynamic industry, where one sees a problem another sees a solution. By analyzing the viewpoints of different stakeholders there is more of a chance of reaching a more productive collaboration.

The research showed that while first-generation ethanol is a much more mature and developed market, it does not provide as many obvious opportunities for collaboration between corn ethanol and sugar ethanol as second-generation ethanol does. Stakeholders interviewed spoke about the research being done to make renewable energy from inedible raw materials as being what was on the cutting edge of ethanol development. It sparks optimism across the board because of the fact that second-generation ethanol does not threaten the world's food supply or drive up the prices of food. First-generation ethanol uses corn in the US, which is widely criticized for its inefficiencies in energy input for production and output in its use. The qualitative research also showed that not all stakeholders believed that technology transfer in first-generation ethanol would be applicable between countries. These conditions make for daunting obstacles inherent in a possible partnership in first-generation ethanol. The second-generation market still requires a lot more research and development, it is a source of hope and renewed excitement in biofuels, however it does not have the years and structures in place that first-generation ethanol has. The research showed that stakeholders believed that there would be a significant return on technology advancement for

second-generation ethanol and that the USA and Brazil have more opportunities for technology transfer in this area as the processing of these raw materials have much more in common than first-generation ethanol raw materials. By analyzing these interviews, it is evident that there is an opportunity for collaboration but not necessarily a plan of action or strategy for this opportunity.

The research showed that co-opetition model could be applied to developing a more productive partnership between the USA and Brazil. While historically ethanol has been looked at as a competitive industry between the USA and Brazil, as key stakeholders pointed out, the ethanol market is in need of expansion and innovation for it to be a viable industry. Because of the unique qualities of the market and the potential for its development through research and development, especially in second-generation ethanol, the models of co-opetition can be applied to a joint expansion of the second-generation ethanol market. Here the strategy of jointly investing in Research and Development to "expand the pie", then competing to divide it up would be more effective. By joint research and development of this market and promoting interest in second-generation ethanol, possibly by marketing it as a more sustainable fuel, the industry has the possibility to become much more successful. This research showed that stakeholders in ethanol believed that growing the ethanol market outside the US and Brazil would attract more consumers, so there does not need to be any kind of paranoia between leakage in the technology transfer between the US and Brazil. It is important to note that secure long-term government policy on ethanol-gas mixing should be in place to guarantee that there is adequate investment in Research and Development in second-generation ethanol. As many stakeholders pointed out, the industry already has enough uncertainties and harmful government policy would be detrimental. Policy that secures the need for ethanol in gasoline blends would provide the right incentive to invest in research for the betterment of this renewable energy.

One more notable observation from this research is some stakeholders had the different perspectives on the same issue and sharing differing perspectives can serve to provide solutions where some may see obstacles. Not every stakeholder believed in the possibility of technology transfer for first-generation ethanol, which highlighted that there was no polemics about technology transfer for second-generation ethanol. Also, perspectives differed on ethanol's relationship to petroleum. While some saw a competitive relationship others brought up a complimentary relationship. Instead of aiming to displace petroleum, ethanol's role should be different; by blending into gasoline it makes it less pollutant and provides an ideal fuel for small-sized vehicles with a good combination of mileage and

power.

The research showed that a co-opetitive relationship between the US and Brazil is made more possible by the state of current relations between the US and Brazil. Recent meeting between US and Brazilian world leaders indicate that relations are good and leaders are looking for opportunities for mutual wins. Although the US would especially like to boost its domestic economy, increased trade relations may mean unwanted competition in the Brazilian domestic market. While trade seems to be at a standstill, meeting between Rousseff and Obama have showed a mutual interest for the development of renewable energy. So the international stage and relations are set to move forward and create a deeper and more productive partnership in renewable energy, especially in second-generation ethanol.

8.1 Suggestions

A partnership between the US and Brazil to promote ethanol as a commodity has support from the top leaders in government from each country, for it to viably grow the partnership would probably flourish under certain premises. It does not look like ethanol will be a complete substitute for gasoline any time soon because the structures are not in place to support the industry, the world is hooked on oil, and there has been widespread excitement in the finding of new deposits of energy. What seems more feasible is a campaign of complimentary usage between the two fuels, showing how small vehicles run better on blended fuel and blending is better for the environment. In this way the energy matrix of each country is more diversified and secure. For this to be practical for the consumer, ethanol can't compete with a heavily subsidized petroleum industry.

In order for ethanol to be invested in there needs to be long term government blending policies that ensure there will be a market. This can be done by private pressure on the government, especially the Brazilian government, to more clearly define in the long term what will be ethanol's role in the energy matrix. Obama especially has demonstrated his interest in renewable energy, and the movement towards more tangible demonstrations of how the government supports clean energy would be the next logical step. The need is for concrete percentages for ethanol blends in the future, not necessarily ranges that can still fluctuate, so that ethanol producers can create long-term projections on how they will meet a secure demand. This is the foundation for investment in a growing and sustainable ethanol international market.

Once the policy is in place that creates the needed security for investments, research

centers can be mobilized in both the USA and Brazil to go to work on developing second-generation ethanol. These can include Universities as well as research institutions such as CTC and EBI. The idea of this research would be to develop the global ethanol market, not just increase production in the USA and Brazil. Increasing consumers and producers would bring new competitors to the ethanol market and in turn better the product, creating a beneficial cycle for the market.

Second-generation ethanol also seems to show more promise for a potential collaborations between the USA and Brazil. The pros for partnership are that the fermentation and distillation processes for each country's raw materials for second-generation ethanol is similar enough to have a productive technology exchange. First-generation ethanol uses raw materials that are debatably too distant for foreign technology to be applied for the development of the industry. Second-generation ethanol is also less of a threat to the world's food supply so it makes more sense in the long run to look for technologies that will more efficiently extract energy from second-generation ethanol to make it more worthwhile to consumers.

Motivation to use and develop ethanol should not come from spreading fear that other more commonly used fuel sources will be depleted but that ethanol development diversifies the energy portfolio of each country and is better for the environment. Diversifying their energy matrices means that countries are hedging their energy sources, making them less dependent on single sources of energy and consequently the countries or regions that produce these fuels. While the US may have found new deposits of petroleum there is a lot of uncertainty surrounding the quantity, quality, and cost of extraction of these energy deposits, so more dependence on petroleum could still make the US more vulnerable to oil producing regions of the world. The other advantages, that fewer tend to concretely qualify, are the environmental benefits. It is becoming easier every day to see the effects of damaging our environment, whether it is the melting polar ice caps, less stable global temperatures, etc. As this phenomenon continues, it is more likely that social pressures and moral obligations to actively seek ways to be less damaging to the environment will increase. These attitudes will be beneficial for the promotion of the development of ethanol.

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