International Baccalaureate

Sample B

Extended essay cover

Candidates must complete this page and then give this cover and their final version of the extended essay to their supervisor.

Candidate session number	0	0							

Candidate name	

School number	0	0				

School name	

Examination session (May or November)	MAY	Year	2009

Diploma Programme subject in which this extended essay is registered: ENVIRONMENTAL SYSTEMS AND SOCIETIES

(For an extended essay in the area of languages, state the language and whether it is group 1 or group 2.)

Title of the extended essay: Ethanol fuel: a beneficial replacement of convential gasoline toward the energy, economy, and environment of the United States

Candidate's declaration

If this declaration is not signed by the candidate the extended essay will not be assessed.

The extended essay I am submitting is my own work (apart from guidance allowed by the International Baccalaureate).

I have acknowledged each use of the words, graphics or ideas of another person, whether written, oral or visual.

I am aware that the word limit for all extended essays is 4000 words and that examiners are not required to read beyond this limit.

This is the final version of my extended essay.

Candidate's signature:

Date: 1/30/09

IB Cardiff use only: **A:** **B:**

Supervisor's report

The supervisor must complete the report below and then give the final version of the extended essay, with this cover attached, to the Diploma Programme coordinator. The supervisor must sign this report; otherwise the extended essay will not be assessed and may be returned to the school.

Name of supervisor (CAPITAL letters)

Comments

Please comment, as appropriate, on the candidate's performance, the context in which the candidate undertook the research for the extended essay, any difficulties encountered and how these were overcome (see page 13 of the extended essay guide). The concluding interview (viva voce) may provide useful information. These comments can help the examiner award a level for criterion K (holistic judgment). Do not comment on any adverse personal circumstances that may have affected the candidate. If the amount of time spent with the candidate was zero, you must explain this, in particular how it was then possible to authenticate the essay as the candidate's own work. You may attach an additional sheet if there is insufficient space here.

Student had a difficult time with this subject + research question. The biggest challenge (that she did not seem to overcome) was that the essay was very narrative.

I have read the final version of the extended essay that will be submitted to the examiner.

To the best of my knowledge, the extended essay is the authentic work of the candidate.

I spent [10] hours with the candidate discussing the progress of the extended essay.

Supervisor's signature:

Date: 2/5/09

Ethanol fuel: a beneficial replacement of conventional gasoline toward the energy, economy, and environment of the United States

IB Extended Essay: Environmental Systems & Societies

Candidate Number:

Word Count: 3991

Abstract

The continuing reliance of gasoline fuel poses a serious risk to the United States. Gasoline, formed from petroleum imports, emits harmful pollutants such as carbon monoxide. One type of renewable energy that appears to be promising in the present and in the future is biofuels. The most widely-used of these is ethanol fuel. How is ethanol a beneficial replacement of conventional gasoline toward the environment and energy security of the United States? RQ stated (reworded)

To answer and support this, sufficient data and evidence must be collected to effectively support ethanol and its benefits. Ethanol fuel strengthens energy security, reduces dependency of petroleum imports, improves air pollution, reduces greenhouse gases, and boosts the economy. brief scope conclusion The domestic production of ethanol allows the United States to rely on itself instead of foreign oil reserves. This increases the energy security by securing energy sources in the nation. As a result, the United States' dependency on crude oil and petroleum imports decreases. Ethanol improves the air quality by reducing greenhouse gas emissions that raise the global temperatures to a dangerous level. The main result of the reduction of the country's greenhouse gas emissions is the reduction of the nation's contribution to global climate change and its potential effects on the United States' economy, energy security, and public health.

As awareness of the countless benefits of ethanol reaches consumers, this viable alternative develops into becoming the future of many oil-reliant nations like the U.S. Since ethanol fuel is easy to manufacture and process and is made from very common material, ethanol fuel has progressed to becoming a promising and more efficient alternative to gasoline throughout much of the world. Through analyzing experiments, diagrams, facts, and data, ethanol concludes to be an effective replacement to gasoline with many positive impacts environmentally and socially that should be a national priority. scope again

Words: 300

J = 02/02

Table of Contents

Ethanol fuel: a beneficial replacement of conventional gasoline toward the energy security, economy, and environment of the United States

RQ stated. but likely to be narrative and rather broad. A 01/02

Petroleum sources are dwindling… Gas prices are sky-rocketing! What alternative fuel sources are worth pursuing? With the diminishment of the beloved sources of gasoline, the consumers must quickly find alternatives to their accustomed gasoline fuel. Humans have been depleting natural petroleum resources rapidly ever since automobiles became common in every household. Driving automobiles creates auto exhaust, the fumes from an automobile, which basically poison the air. Auto exhaust greatly contributes to global warming, acid rain, and air pollution. Global warming is "the result of a buildup of carbon dioxide (CO_2) and other gases in the atmosphere that entrap heat, leading to a long term warming of the earth's climate" (Rock 25). Americans should prevent this gradual transformation because global warming could threaten crops and melt polar ice caps which in turn produces mass famine and drowns coastal areas, respectively. Acid rain, precipitation containing nitric and sulfuric acids formed from burning of fossil fuels like gasoline, adds to the air pollution of the United States. Meanwhile, machines naturally extract petroleum resources from deep down in the environment, much faster than they can be restored. As the situation worsens, scientists research and strive to discover or upgrade alternatives for the limited supply of gasoline fuel. One type of renewable energy that appears to be promising in the present and in the future is ethanol fuel, providing a replacement of conventional gasoline to benefit the environment and energy security of the United States.

reasons for topic clearly stated. B = 02/02

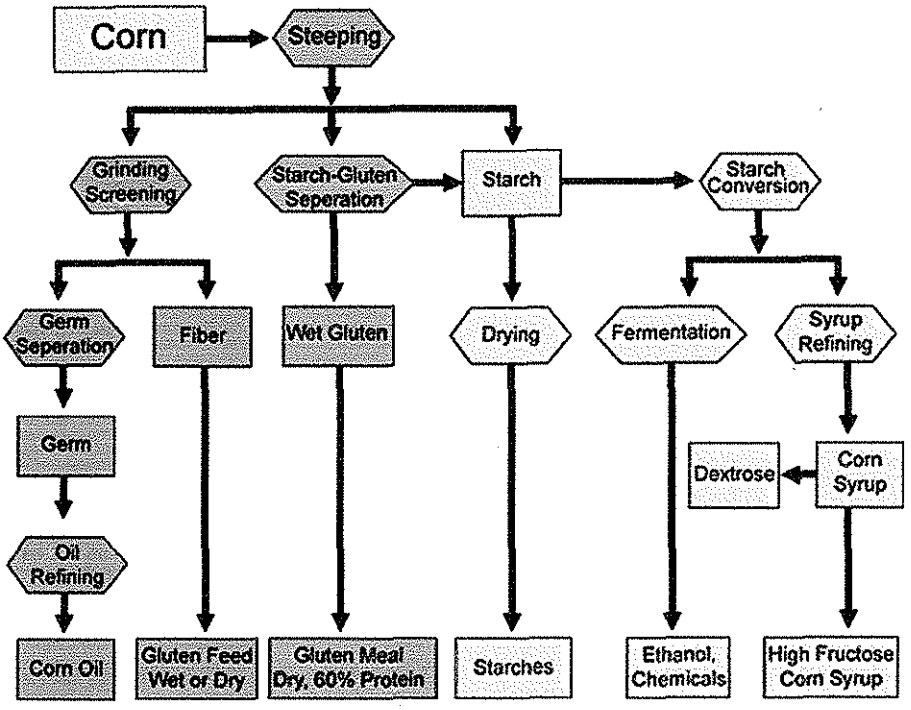
Ethanol fuel is the most widely-used of biofuels in the world (Biofuels, 2007). Biofuel can be broadly defined as solid, liquid, or gas fuel produced from renewable resources.

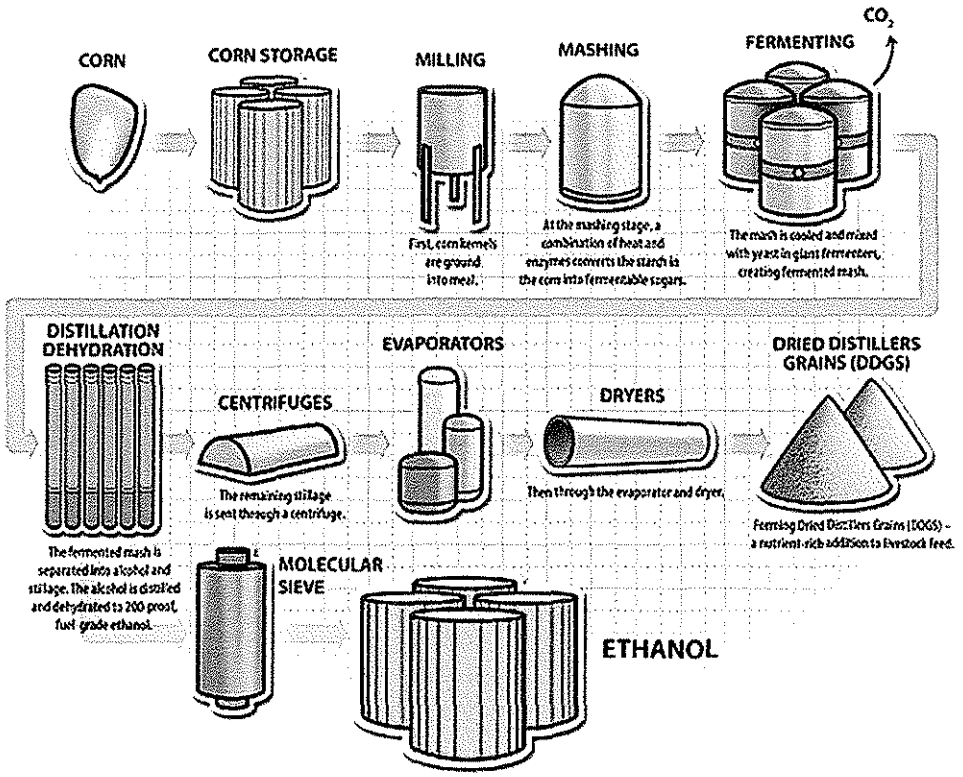
Examples of biofuels include plant biomass, material derived from recently living plants, and treated municipal and industrial waste. These biofuels contrast to fossil fuels, resultants from long dead biological material. Increasingly common, the action of microorganisms through fermentation create biologically produced alcohols also known as bioalcohols. Basically, they are alcohol fuels obtained from biological sources. The first four aliphatic alcohols (methanol, ethanol, propanol, and butanol) are of interest as fuels because they can be synthesized biologically, or naturally, which poses less harm to the environment than unnatural fuels that is, fossil fuels. The characteristics of bioalcohols like ethanol are similar to that of gasoline which allow them to be used in current automobile engines.

Since ethanol fuel is easy to manufacture and process and can be made from very common material, ethanol fuel has progressed to becoming a promising alternative to gasoline throughout much of the world. While the basic steps of ethanol production remain the same, the efficiency of the process has been considerably improved throughout time. The production methods depend on what is transformed. For corn, there are two production processes: dry milling and wet milling. The initial treatment of the grain serves as the main difference between the two processes. The following diagrams demonstrate the different processes where the wet milling process, first diagram, soaks the grain first while the dry milling process, second diagram, mills the grain initially.

- figure should be numbered + source

Corn Wet Milling Process





reference?

Ethanol plants in the United States use dry milling more frequently because wet milling is more complicated; in wet milling, the starch, fiber, gluten and germ are individually separated from corn with the starch converted to ethanol. On the same note, dry milling is preferred since "Wet milling achieves smaller reductions than dry milling" (M. Wang). The following diagrams illustrate the two processes both of which result in ethanol. "Dry mill ethanol facilities produce between 2.6 and 2.8 gallons of ethanol per bushel of corn (depending upon cornstarch content and process efficiency)" (Argonne). In addition, though dry milling releases CO_2 during fermentation, the CO_2 is captured and sold for use in carbonating soft drinks and beverages and the manufacture of dry ice (RFA). The corn milling processes require significant energy input for heat which is often natural gas fossil fuel. Although this is true, the resultant energy is much higher than that of the input; depending on the factors, there can be up to a 70% energy gain. (Ethanol Fact Book).

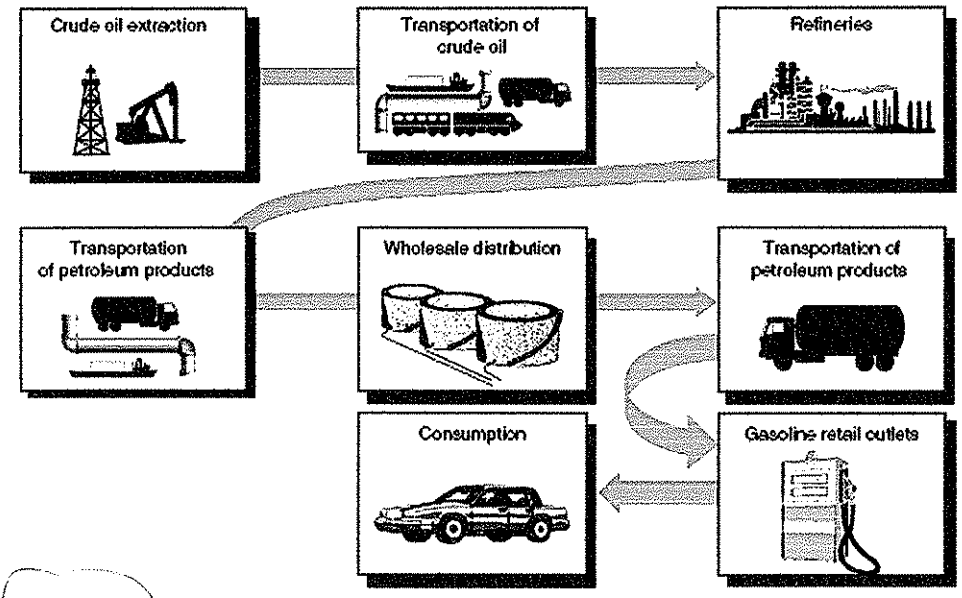
Moreover, ethanol can be mass-produced by fermentation of sugar or by hydration of ethylene from petroleum and other sources. Ethanol fermentation is the biological process by which sugars such as glucose, fructose, and sucrose, convert into cellular energy. Ethanol fuel can be made from the starch or sugar in a wide variety of crops; being a few of these: corn, sugar cane, switchgrass, wheat, sugar beets, and molasses. In general, any sugar or starch that alcoholic beverages can be made from, like potato and fruit waste can form ethanol. Another biofuel ingredient, cellulosic ethanol, is made from straw, crop waste, switchgrass, and certain wood products. These different crops form ethanol that varies in terms of energy and greenhouse gas emissions during production and use. Crops with higher yields of energy, such as switchgrass and sugar cane, more effectively produce ethanol than corn. Although this is true, the main feedstock for the US production of ethanol is currently corn. "All of the

ethanol currently used in this country as an additive to gasoline comes from corn" (Energy Alternatives). Throughout this essay, the term ethanol refers to corn ethanol unless specified otherwise.

Ethanol can be mixed with gasoline in any concentration up to pure ethanol (E100). Although pure, 100% ethanol is generally not used as a motor fuel, a percentage of ethanol is combined with unleaded gasoline. Any amount of ethanol can be combined with gasoline, but the most common blends are E10 (10% ethanol) and E85 (85% ethanol, 15% gasoline). The mixtures benefit the American consumers because the ethanol decreases the fuel's cost, increases the fuel's octane rating, and decreases gasoline's harmful emissions. The blends also allow a gradual conversion of using harmful gasoline to using clean-burning fuel. In the U.S., ethanol capabilities vary widely and most spark-ignited gasoline style engines will operate well with E10. Yet, newer models of automobiles with flex-fuel engines that run on both ethanol or gasoline fuel are more frequent. More and more common in the United States, mainly in the Midwest where corn is the major crop, ethanol and its impacts reaches awareness of the consumers.

As a replacement, ethanol (E85) takes only one-half of the volume more to drive the same distance as gasoline. (Energy Alternatives). Despite the decrease in the extent of the fuel, the use ethanol fuel introduces numerous benefits. One such benefit is the reduction of crude oil and petroleum imports. Crude oil is the natural form of fossil fuel which is refined to form petroleum products. The process of producing gasoline for U.S. consumers is pictured in the following diagram.

- Figure 4 ?



Not in bibliography

Source: GAO.

some flow charts used.

Crude oil extraction for gasoline a lot is expensive and sometimes environmentally damaging. When environments are explored and extracted, animal life and their habitats are often disturbed and the environmental system of the animal cycle is disrupted. The relationship of costly petroleum imports and ethanol fuel is that if the former decreases, then the latter increases. Thus if this relationship occurs, the United States relies less on foreign nations and improves energy security of the nation. The U.S. progresses to do exactly that, "Between 2001 and 2007, U.S. fuel ethanol production capacity grew 220% from 1.9 billion to 6.1 billion gallons" (RFA). Energy security rests on two principles: use of less energy to provide needed services and access to technologies that provide a diverse supply of reliable, affordable, and environmentally sound energy. With this in mind, by use of ethanol blends, Americans can secure energy and use more beneficial fuels.

systems

reasoning

Since the use of ethanol poses as a current issue in the US society, numerous ongoing debates struggle over whether ethanol makes a good, green substitute for gasoline. A major

topic that applies to the substitution of ethanol is the energy balance of the atmosphere and the effect of ethanol. Some researchers believe that ethanol has a positive net energy balance while others say that the energy used to make ethanol is not worth the energy run by an automobile. One claim is that it takes more energy to produce ethanol than the actual product of burning ethanol. On the other hand, the positive view of ethanol feels that ethanol made from corn is better than gasoline in terms of greenhouse gas production. In 2006, Dan Kammen and Alex Farrell of the Energy and Resources Group at UC Berkeley, with their students Rich Plevin, Brian Turner and Andy Jones along with Michael O'Hare, a professor in the Goldman School of Public Policy "deconstructed six separate high-profile studies of ethanol… correcting errors, inconsistencies and outdated information regarding the amount of energy used to grow corn and make ethanol, and the energy output in the form of fuel and corn byproducts… each (study) yielded the same conclusion about energy: producing ethanol from corn uses much less petroleum than producing gasoline" (Sanders). Ultimately, Kammen says, "ethanol made from corn is a little better - maybe better by 10 to 15%" (Sanders).

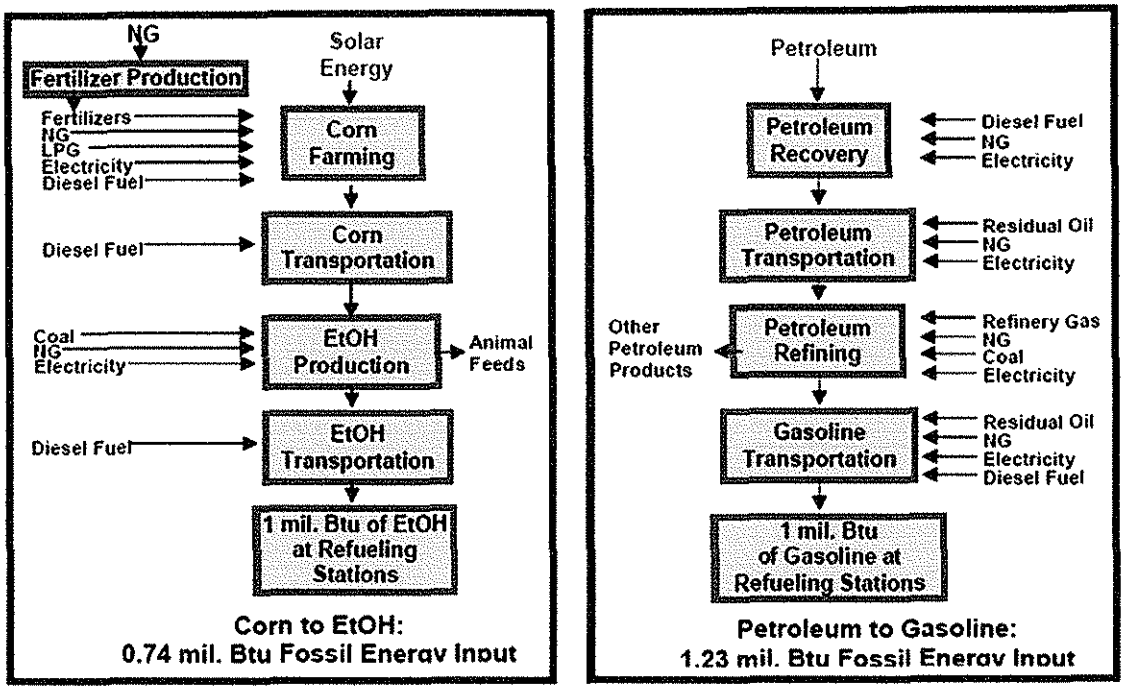
Furthermore, the energy balance depends solely on the circumstances of the ethanol production. For example, if corn was raised by the least energy efficient farmers, those who use continuous corn planting and irrigation, being processed by ethanol plants that do not use cogeneration, where normally wasted heat energy produced by a power plant or industrial process is utilized to generate electricity (Dictionary.com), and other energy efficient processes, then ethanol product could have a negative energy balance of about 0.7:1 (Argonne). Based on industry averages, far less energy is used to grow corn and make ethanol than is contained in the ethanol. However, this is based on only the average, which arouses uncertainty and invalidity. In another study to estimate the net energy balance of corn

ethanol, the experiment concluded an "energy ratio of 1.24, that is, for every Btu dedicated to producing ethanol, there is a 24-percent energy gain" (Duffield, Shapouri and Graboski). A Btu or BTU, short for British Thermal Unit, is a basic unit of energy which is gradually being replaced by the SI unit of energy, the joule. Thus, producing ethanol from domestic corn stocks achieves a net gain in a more desirable form of energy. Ethanol production utilizes abundant domestic energy supplies of coal and natural gas to convert corn into a premium liquid fuel that "can replace petroleum imports by a factor of 7 to 1" (Duffield, Shapouri and Graboski).

Americans desperately need and depend on petroleum in the form of gasoline to support their daily transportation. Reliance on petroleum and fossil fuel in general must end due to the fact that oil is a finite source, meaning its supply is limited. For the long-term future, it is important to start planning of what and how Americans shall fuel their cars with when these finite supplies are exhausted. The use of ethanol fuel provides a partial solution to this deficit as it will most likely lead to a reduced use of gasoline. A reduced use of gasoline means the United States will trade less petroleum and in time, result in less transfer of the nation's wealth to foreign nations. With fewer deficits, the U.S. would rely less on foreign nations for their oil and grow into a more independent nation by producing ethanol fuel.

In relation to gasoline, the average process of producing ethanol exceeds the energy-efficiency that that of producing gasoline. The diagram below illustrates the energy inputs used to produce and deliver a million British Thermal Units (BTU) of ethanol (EtOH) and petroleum gasoline to a refueling station (Office of Energy Efficiency and Renewable Energy). The diagram clearly shows that petroleum uses more oil to make fuel than that of corn.

figure #



✓ good.

put reference here too

Therefore, based on the comparative diagram, the fossil energy input per unit of ethanol is lower in fossil energy consumed for ethanol production compared to fossil energy consumed for each million BTU of gasoline delivered.

In today's society, ethanol plants are more efficient than a decade ago since our state-of-the-art technology and techniques moves forward so quickly. In 1980, for example, ethanol plants used 2.5 to 4.0 kilowatt-hours (kWh) of electricity per gallon of ethanol produced; the standard unit of electricity or consumption equal to 1000 watts over one hour, the kWh, is equivalent to 3412 Btu's (BusinnessDictionary.com). Today ethanol plants use as little as 0.6 kWh (Passero, Energy Alternatives). The majority of ethanol producers still purchase electricity from outside sources, but newer facilities generate electricity from process steam within the plant. Nevertheless, it does appear that growing numbers of farmers are reducing

their farm inputs and that this trend will continue.

Ethanol brings about economic benefits in the United States: creation of jobs, lower trade deficit, and trade balance. The production of ethanol in the United States generates domestic jobs and wealth by processing domestic resources into clean burning fuel. Replacing foreign oil with American-made fuel, ethanol, virtually stimulates all major sectors of the economy of the United States. More importantly, the production of increased crops for ethanol leads to new jobs for Americans; thus, stimulating the economy. According to a study by Northwestern University's Kellogg School of Management, "in 1993, U.S. ethanol production led to the creation of almost 200,000 jobs per year" (The Ethanol Fact Book). In contrast, the petroleum import dependence of the United States deprives its economy of "of 828,400 jobs. With the increased cost of imports, this figure has also grown, now estimated at a loss of 2,241,000 jobs" (Copulos, The Hidden Cost of Oil). Therefore, by producing ethanol instead of importing petroleum, the Americans can enjoy more job opportunities. Another economic benefit from the reduced use of gasoline, less trade deficit calls for less transfer of U.S. wealth to foreign countries since the U.S. will trade less gasoline. Evidence of this correlation: "In 1997, ethanol production improved the U.S. trade balance approximately $2 billion" (Ethanol Fact Book). The use of ethanol beckons a reduced use of gasoline which provides all these benefits toward the nation's economy and the people.

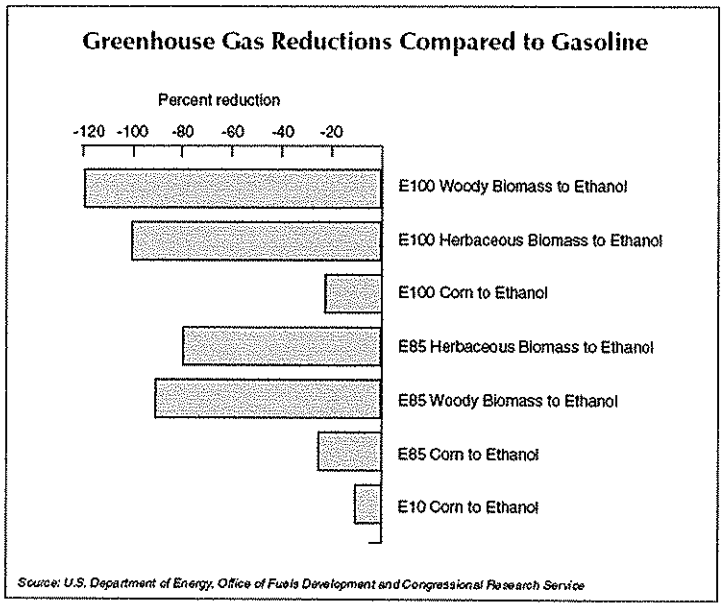
Since ethanol is made from a crop that Americans eat everyday, they fear the increase of the price of corn. Nevertheless, they should not worry for there is enough land to plant corn and other crops such as sugar and wheat on; the producers do not have to compete for land and do not have to compete in prices of crops. Evidence of this production: "In 2006, U.S. corn farmers produced a near record 10.74 billion bushels of corn. Of that, 1.8 billion bushels

went to the production of ethanol and co-products—so there is plenty of room to expand ethanol production without limiting the availability of corn" (Ethanol Fact Book). To put things in retrospect, a bushel of corn used in the fuel ethanol process produces... 2.5 gallons of ethanol" (Ethanol Fact Book). Americans should also not fear the dearth of corn since its supply continues to increase and new raw materials continue to develop including "cornstalks, switch grass, vegetable matter, waste from paper/pulp production, and other 'cellulosic' sources" (The Ethanol Fact Book). Also, the corn used to make ethanol is field corn, which is primarily fed to livestock, not humans. Thus the production of ethanol will not have a dramatic impact on amount of corn eaten by people or the price of corn. (Ethanol Across America). Furthermore, the effect of the expansion of ethanol production is structural; therefore, it is difficult to predict what the ultimate impact will be.

bias in this source?

Equally important, the environmental impact of ethanol plays a chief role in supporting its production and use in the United States. Through the use of ethanol, the production of gasoline will most likely decrease and result in the decrease of fossil fuel burning i.e., gasoline. Americans look negatively at the burning of fossil fuels due to the fact that it contributes to greenhouse gases. Example of these gases, carbon dioxide and methane, trap infrared radiation in the earth's atmosphere, which result in higher temperature on the earth's surface. These gases also reduce the loss of heat into space and thus, cause global temperature to increase; this is called the greenhouse effect. Although greenhouse gases are essential in maintaining a habitable place for inhabitants to live, an excess of these gases can raise the global temperature to a dangerous level. Relative to these gases, in a study of "Well-to-Wheels" life cycle analysis of energy use and greenhouse gas emissions in 2002, the General Motors Corporation compared 15 propulsion technologies and 75 different fuel

pathways in the United States. The results show that "ethanol as E-85 reduces greenhouse gas emissions more than any other alternative fuel" (Clean Fuels Inc), supporting ethanol's positive impacts on the earth's atmosphere. Another study, according to the models developed by Dr. Michael Wang of the Argonne National Laboratory, says "ten percent ethanol blends reduce greenhouse gases (GHG) by nearly 30 %" (Clean Fuels Inc). Furthermore, the following chart from The Ethanol Fact Book presents the reduction of greenhouse gas with different blends of ethanol and gasoline.



The chart presents a sure reduction of harmful greenhouse gases with any ethanol blend. In any case, ethanol fosters the reduction of greenhouse gases compared to gasoline. The significance of using ethanol is immense, "Ethanol-enriched fuels reduced greenhouse gas emisions by 7.8 million tons, which is comparable to removing 118 million cars from the nation's roads each year" (Argonne's GREET 1.6 Model). The main result of the reduction of the country's greenhouse gas emissions is the reduction of the nation's contribution to global climate change and its potential effects on the U.S. economy, security, and public

health. Similarly, by the reduction of greenhouse gases, the emissions of air pollutants decrease too.

Link back to RQ good.

Ethanol helps reduce the harmful pollutants from the air rather than contribute to them like gasoline. Since ethanol is inherently cleaner than gasoline, it emits less hydrocarbons, nitrogen oxides, carbon monoxide, and hydrogen. "As a result, it is used to meet environmental and alternative fuel requirements set forth in the Alternative Motor Fuels Act of 1988, the Clean Air Act Amendments of 1990, the Energy Policy Act of 1992, and the Energy Tax Act. These public laws represent the bipartisan efforts to reduce the environmental and economic impacts of gasoline consumption on the society" (The Ethanol Fact Book). The Renewable Fuel Standard (RFS), a provision of the Energy Security Act of 2005, ensures that America's use of clean-burning renewable fuels would doubly by 2012. In effect January 1, 2006, this policy plays a major positive role in the ethanol market and continue to support the use of ethanol and the blends. Ethanol fuel rather than gasoline supports these laws that aim to improve the environment.

Along with laws supporting a better environment through ethanol, programs advocate the amelioration of the environment in the United States such as the Federal Clean gasoline programs. Another example, the Federal Oxy-Fuel CO Reduction program calls for a reduction of carbon monoxide in the atmosphere, which can be achieved by replacing gasoline with ethanol. In addition to the benefits of public health, ethanol reduces smog instead of contributing like gasoline does: "A growing number of studies show that E10 reduces soot particulate pollution... E10 reduced soot pollution by 36% from newer vehicles and more in older, more polluting vehicles" (Coleman). Soot, or the smoke from vehicle exhaust pipes,

contains fine particles which are particulate matter (PM), a mixture of solid particles and liquid droplets (Alternative Fuels). Fossil fuel has such negative impacts on the air since "the particles enter our nose and mouth and become embedded in the deepest recesses of the lungs. Numerous scientific studies have connected particulate matter with health dangers: premature death, cancer, acute respiratory illnesses, shortness of breath, heart disease, and lung damage" (Alternative Fuels). To prevent the deterioration of American life, the U.S. should immediately reduce the use of gasoline fuel by switching it with ethanol. This evidence further supports the numerous benefits of switching from gasoline to ethanol blends toward the atmosphere. Likewise, "Oxygenates like ethanol help fuels burn more completely, thereby reducing emissions of carbon monoxide, volatile organic compounds and toxic air emssions" (American Lung Association).

When handling both gasoline and ethanol, spills can occur that causes concern to consumers of water. Gasoline spills can leak into the environment and pollute the water thanks to the oxygenate. An oxygenate is a gasoline additive to reduce carbon monoxide that is created during the burning of fuel. MTBE (methyl tert-butyl ether), an oxgenate that has been banned in many states, contaminates groundwater, mostly through leaks in underground gasoline storage. Due to contamination of water, MTBE was generally replaced. Indeed, the State of New York replaced MTBE blends with E10 on January 1, 2004. "In the two years since the switch to E10, New York has averaged 5.5 exceedance days per year, a 68% reduction" (Clearing the air with Ethanol). In other words, the replacement of ethanol in New York reduced the number of smog days. Thus, Americans can simultaneously enjoy better air quality and obtain fuel for transportation. Ethanol biodegrades rapidly in the environment thus posing a significantly less risk to water resources than MTBE (American Coalition for

Ethanol). Although this is true, environmental transport properties may not be as beneficial because ethanol, when present in a gasoline spill, can delay the degrading of other, more toxic components in gas. Then again, "under acute exposure conditions, ethanol is 3.7 times less toxic to aquatic life than MTBE" (NEIWPPC & NESCAUM). More negative to the environment, oil spills at sea can spread for hundreds of nautical miles, covering beaches with a thin coating of oil and killing organisms that it coats.

Conclusion:

Ethanol fuel proves to be a great and promising alternative to conventional gasoline through its benefits towards the energy security, economy, and environment of the United States. What is more, since the United States knows how to produce and distribute it, and Americans already possess cars that can use it, the use of ethanol can only increase. The technology to form ethanol is here. If the United States has the technology to produce ethanol, why not make the most out of it? Americans should seize the opportunity by showing their interest in using and advancing ethanol fuel. The production and use of ethanol fuel secures the nation's energy security by reducing reliance on foreign petroleum imports. By decreasing fossil fuel use of the U.S., the economy and environment can also improve greatly with the use of ethanol. Economically, America's continuing reliance on imported oil and refined petroleum products poses an enormous financial burden on the nation's economy. This burden also threatens the nation's economic security. The U.S. can secure energy sources which it can control by replacing petroleum imports with ethanol production. In addition, ethanol production increasingly becomes efficient with each and every adjustment due to new evidence.

Environmentally, ethanol fuel reduces greenhouse gases rather than contribute to them as gasoline fuel does. Although cellulosic ethanol is still not ready for Americans to use as a

C 03/04 ✓

problems given to ✓

D 02/04

more systems needed ✓

E = 04/04

A good pros/cons of each. ✓

P 02/04

more by self using data obtained + evaluate sources more.

* Should try to use SI units

fuel, it will most definitely be a significant alternative fuel in the future. As global warming poses a greater threat, Americans are more conscious of their actions and consequences to the environment. They will demand ethanol and in effect, the availability of ethanol will increase. In turn, the gasoline demand will decrease, resulting in the reduction of burning fossil fuels. With less air pollution, Americans can enjoy a better environment to live in without excessive greehouse gases and fine particles of smog or soot. With the reduction of soot from use of ethanol, Americans will hopefully enjoy better health and obtain less smog-induced diseases. Ethanol fuel has the power to change the future of the environment, energy, and economy of the United States. "Even the cautious Department of Energy predicts that ethanol could put a 30% dent in America's gasoline consumption by 2030" (Adam Lashinsky and Nathan D. Schwartz, Fortune, January 24, 2006). Therefore, enforcing the use of ethanol as a replacement to conventional gasoline must be an urgent national priority.

Ok. based on information presented + ideas given
A+ 02/02

Although it has a RQ that could be narrative & broad the work presented is clear, logical, often has both views presented with an overall conclusion based on these.
More on linking topic to ESS is needed.
Student does make an effort & link back to RQ asked often.
More pulling of data into own graphs would be nice.

G 03/04 good - some pieces not clear

I 02/04 issue of references on diagrams

K 04/04 interest is obvious and lots of research.

I-2 - correct (except figure)

K-3 not very creative / lack intellectual initiative

Good set sources both sides

Bibliography

"Alternative Fuels." NYC.gov. 2001. 31 May 2008.
<http://www.nyc.gov/html/dot/downloads/pdf/alternativefuel.pdf>.

American Coalition for Ethanol. 2008. American Coalition for Ethanol. 24 May 2008.
<http://ethanol.org/>.

Armstrong, Sarah R. "Ethanol: Brief Report on its Use in Gasoline." 1 Mar 1999. ethanol.org. 7 Sep 2008.
<http://ethanol.org/pdf/contentmgmt/Ethanol_Health_Impacts_Cambridge_Environmental_Inc.pdf>.

"Biofuels in the US Transportation Sector." EIA. Feb 2007. 10 May 2008.
<http://www.eia.doe.gov/oiaf/analysispaper/biomass.html>.

Clean Fuels Development Coalition. "Ethanol Fact Book." 2003. 8 Dec 2007
<http://www.cleanfuelsdc.org/pubs/documents/2003EthanolFactBook.pdf>.

Clean Fuels Development Coalition, Inc. The Ethanol Fact Book. Bethesda MD, 2007.

"cogeneration." *Dictionary.com Unabridged (v 1.1).* Random House, Inc. 10 Sep 2008.
<Dictionary.com http://dictionary.reference.com/browse/cogeneration>.

Coleman, Brett Hulsey and Brooke. Mar 2006. Clearing the Air with Ethanol. 14 Sep 2008
<http://ethanol.org/pdf/contentmgmt/Clearing_the_Air_with_Ethanol_2006.pdf>.

Copulos, Milton R. "The Hidden Cost of Oil." 8 Jan 2007. National Defense Council Federation. 23 Sep 2008.
<http://ndcf.dyndns.org/ndcf/energy/NDCF_Hidden_Cost_2006_summary_paper.pdf>.

Duffield, James A., Hosein Shapouri and Michael S. Graboski. "Estimating the Net Energy Balance of Corn Ethanol." July 1995. Governors' Ethanol Coalition. 23 Sep 2008.

<http://www.ethanol-gec.org>.

Farrell, Alexander E., et al. "Ethanol Can Contribute to Energy and Environment Goals." www.sciencemag.org. Jan 27 2006. Sep 10 2008. <http://ethanol.org/pdf/contentmgmt/Science_Journal_January_2006.pdf>.

Haugen, David M., et al. Global Resources. Farmington Hills: The Gale Group, 2008.

"Kilowatt-hour (kWh)." *BusinessDictionary.com*. WebFinance, Inc. 10 Sep 2008. <http://www.businessdictionary.com/definition/Kilowatt-Hour-kWh.html>

Office of Energy Efficiency and Renewable Energy. "Argonne National Laboratory Ethanol Study: Key Points." 2008. National Corn Growers Association. 26 May 2008 <http://ncga.com/ethanol/pdfs/Wang2005.pdf#search=%22Argonne%20National%20Laboratory%20ethanol%22>.

Passero, Barbara, et al. Energy Alternatives. Farmington Hills: Thomson Gale, 2006.

Plagiarism.org. 2008. 31 May 2008 <http://www.plagiarism.org/index.html>.

The Purdue OWL. 26 Aug. 2008. The Writing Lab and OWL at Purdue and Purdue University. 23 April 2008 <http://owl.english.purdue.edu>.

Renewable Energy Directory. Renewable Energy. 28 Dec 2008. <http://www.energyplanet.info/Ethanol/>.

RFA-Renewable Fuels Association. 2008. Renewable Fuels Association. 27 April 2008. <http://www.ethanolrfa.org/>.

Sanders, Robert. "Ethanol can replace gasoline with significant energy savings, comparable impact on greenhouse gases ." 26 Jan 2006. UC Berkeley News. 20 May 2008.

Sundyne.com. "Corn Wet Milling." 2000. 31 May 2008. <http://www.sundyne.com/> Path: Search; Corn wet milling.

Wang, M, et al. "Effects of Fuel Ethanol Use on Fuel-Cycle Energy and Greenhouse Gas Emissions." Ethanol.org. Jan 1999. 10 Sep 2008. <http://ethanol.org/pdf/contentmgmt/Argonne_Ethanol_and_GHG_Emissions.pdf>

"What is bioethanol." Russian Biofuels Association. 2007. 10 Jan 2008. <http://www.biofuels.ru/bioethanol/What_bioethanol/>.

Whitten, Gary Z. "Air Quality and Ethanol in Gasoline." 2008. Renewable Fuels Association. 19 May 2008 <http://www.ethanolrfa.org/objects/documents/69/nec_whitten.pdf>.

Assessment form (for examiner use only)

Candidate session number	0	0							

		Achievement level		
		First examiner	maximum	Second examiner
Assessment criteria	**A** research question	1	2	1
	B introduction	2	2	2
	C investigation	3	4	3
	D knowledge and understanding	2	4	2
	E reasoned argument	4	4	4
	F analysis and evaluation	2	4	2
	G use of subject language	3	4	3
	H conclusion	2	2	2
	I formal presentation	2	4	3
	J abstract	2	2	2
	K holistic judgment	4	4	3
	Total out of 36	27		26

Name of first examiner:
(CAPITAL letters)

Examiner number: _____

Name of second examiner:
(CAPITAL letters)

Examiner number: _____