Ethanol

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Ethanol fuel From Wikipedia, the free encyclopedia.(Redirected from Gasohol)Jump to: navigation, search

The use of ethanol as a fuel for internal combustion engines, either alone or in combination with other fuels, has been given much attention mostly because of its possible environmental and long-term economical advantages over fossil fuel.

Both ethanol and methanol have been considered for this purpose. While both can be obtained from petroleum or natural gas, ethanol may be the most interesting because many believe it to be a renewable resource, easily obtained from sugar or starch in crops and other agricultural produce such as grain, sugarcane or even lactose. Since ethanol occurs in nature whenever yeast happens to find a sugar solution such as overripe fruit, most organisms have evolved some tolerance to ethanol, whereas methanol is toxic. When 10% alcohol fuel is mixed into gasoline, the result is known as gasohol. When 85% alcohol fuel is mixed into gasoline, the result is known as E85. Other experiments involve butanol, which can also be produced by fermentation of plants.

Alcohol is also increasingly used as an oxygenate for gasoline, as a replacement for MTBE.Contents

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Ethanol fuels

Proposals to use alcohol as a fuel are generally concerned with its use in transportation, chiefly as a total or partial replacement for gasoline in cars and other road vehicles. However, other less conventional approaches have been advanced, such as the use of alcohol in fuel cells, either directly or as a feedstock for hydrogen production.

To have a net energy gain, it is critical that detailed energy and input stock analyses be performed. Although a topic of some debate, some studies suggest a net energy loss in the production of Alcohol Fuel versus equivalent oil products. This line of reasoning suggests that a "negative net energy balance" results if one considers the aggregate energy input in producing pesticides and fertilizers necessary for crops production, as well as the fuel required to operate farm machinery and to ferment and distill the feed stock.

However, studies that supposedly confirm this idea of a negative energy balance have often come under fire for using old data - whereas old distillation plants used to have negative energy balances, nowadays plants can have positive energy balances of up to 34%, whereas oil (petrol, diesel, etc.) apparently has a negative energy balance. <--This may also be outdated. Can someone check this?--> However, a positive energy balance of 200% or above will be required before mass-production of ethanol by fermentation becomes economically- and technologically-feasible.

Fuel ethanol can be produced from a variety of crops, such as sugarcane, sugar beets, maize (corn), switchgrass, barley, hemp, kenaf, potatoes, cassava, sunflower, etc.

Three countries have developed significant bio-ethanol programs: Brazil and Colombia (from sugarcane), and the United States (from corn). Ethanol for industrial use is often made synthetically from petroleum feedstock, typically by the catalytic hydration of ethylene with sulfuric acid as the catalyst. This process is cheaper than the production by fermentation. It can also be obtained via ethene or acetylene, from calcium carbide, coal, oil gas, and other sources.

Agricultural alcohol for fuel requires substantial amounts of cultivable land with fertile soils and water. It is hardly an option for densely occupied and industrialized regions like Western Europe. For example, even if Germany were to be entirely covered with sugarcane plantations, it would get only half of its present energy needs (including fuel and electricity), and even that only if we assume that sugarcane would grow in Germany at all. However, if the fuel alcohol is made of the stalks, wastes, clippings, straw, corn cobs, and other crop field trash, then no additional land is needed. However using these sources for this purpose would require additional replacement animal feedstock, fertilizers and electric power plant fuels.[edit]

Production and Distribution

Ethanol can be derived from corn, wheat, potato wastes, cheese whey, rice straw, sawdust, urban wastes, paper mill wastes, yard clippings, molasses, sugar cane, seaweed, surplus food crops, and other cellulose waste. Petroleum is also used to make industrial ethanol.

Ethanol, which is the same chemical as the alcohol in alcoholic beverages, can reach 96% purity by volume by distillation, and is as clear as water. This is enough for straight-ethanol combustion. For blending with gasoline, purities of 99.5 to 99.9% are required, depending on temperature, to avoid separation. These purities are produced using additional industrial processes. Ethanol in water is an azeotropic mixture which cannot be purified beyond 96% by distillation. Today, the most widely used purification method is a physical adsorption process using molecular sieves. Ethanol is flammable and pure ethanol burns more cleanly than many other fuels. Assuming it is derived from biomass, the combustion of ethanol produces no net carbon dioxide. When fully combusted, its combustion products are only carbon dioxide and water which are also the by-products of regular cellulose waste decomposition. For this reason, it is favoured for environmentally conscious transport schemes and has been used to fuel public buses. However, pure ethanol reacts with or dissolves certain rubber and plastic materials and cannot be used in unmodified engines. Additionally, pure ethanol has a much higher octane rating has 113, than ordinary gasoline, requiring changes to the compression ratio or spark timing to obtain maximum benefit.[1] To change a gasoline-fueled car into an pure-ethanol-fueled car, larger carburetor jets (about 30-40% larger by area) are needed. (Methanol requires an even larger increase in area, to roughly 50% larger.) A cold starting system is also needed to ensure sufficient vaporization for temperatures below 15 °C (59 °F) to maximize combustion and minimize uncombusted nonvaporized ethanol. If 10 to 30% ethanol is mixed with gasoline, no engine modification is typically needed. Many modern cars can run on the mixture very reliably.

A mixture containing gasoline with approximately 10% ethanol is known as gasohol. It was introduced nationwide in Denmark, and in 1989, Brazil produced 12 billion litres of fuel ethanol from sugar cane, which was used to power 9.2 million cars. It is also commonly available in the Midwest of the United States and is the only type of gasoline allowed to be sold in the state of Minnesota. The most common gasohol variant is "E10", containing 10% ethanol and 90% gasoline. Other blends include E5 and E7. These concentrations are generally safe for recent, unmodified automobile engines, and some regions and municipalities mandate that the locally-sold fuels contain limited amounts of ethanol. One way to measure alternative fuels in the US is the "gasoline-equivalent gallons" (GEG). In 2002, the U.S. used as fuel an amount of ethanol equal to 137 petajoules (PJ), the energy of 1.13 billion US gallons (4,280,000 m^3) of gasoline. This was less than 1% of the total fuel used that year.[2]

The term "E85" is used for a mixture of 15% (by volume) gasoline and 85% ethanol. This mixture has an octane rating of about 105. This is down significantly from pure ethanol but still much higher than normal gasoline. The addition of a small amount of gasoline helps the engine under cold start conditions. E85 does not always contain exactly 85% ethanol. In winter, especially in colder climates, additional gasoline is added (to facilitate cold start). E85 has traditionally been similar in cost to gasoline, but with the large oil prices seen during 2005 it has become common to see E85 sold for as much as $0.70 less per gallon than gasoline, making it highly attractive to the small but growing number of motorists with cars capable of burning it. With no real hope of large long-term reductions in oil prices, the long term cost-competitiveness (even without tax subsidies) of E85 seems assured.

Beginning with the model year 1999, an increasing number of vehicles in the world are manufactured with engines which can run on any gasoline from 0% ethanol up to 85% ethanol without modification. Many light trucks (a class containing minivans, SUVs and pickup trucks) are designed to be dual fuel or flexible fuel vehicles, since they can automatically detect the type of fuel and change the engine's behavior, principally air-to-fuel ratio and ignition timing to compensate for the different octane levels of the fuel in the engine cylinders.

In the past, when farmers distilled their own ethanol, they sometimes used radiators as part of the still. The radiators often contained lead, which would get into the ethanol. Lead entered the air during the burning of contaminated fuel, possibly leading to neural damage. However this was a minor source of lead since tetraethyl lead was used as a gasoline additive. Today, ethanol for fuel use is produced almost exclusively from purpose built plants eliminating any use of lead.

In Brazil and the United States, the use of ethanol from sugar cane and grain as car fuel has been promoted by government programs. Some individual U.S. states in the corn belt began subsidizing ethanol from corn (maize) after the Arab oil embargo of 1973. The Energy Tax Act of 1978 authorized an excise tax exemption for biofuels, chiefly gasohol. The excise tax exemption alone has been estimated as worth US$1.4 billion per year. Another U.S. federal program guaranteed loans for the construction of ethanol plants, and in 1986 the U.S. even gave ethanol producers free corn.

In August 2005, President Bush signed a comprehensive energy bill which included a requirement to increase the production of ethanol and biodiesel from 4 to 7.5 billion US gallons (15,000,000 to 28,000,000 m³) within the next ten years. It is expected that in the short term the majority of this increase will come from ethanol produced from corn.[edit]

Other alcoholsSee also Methanol fuel

Although not as common as ethanol, other fuel alcohols have been considered, notably methanol, butanol, and propanol. These alcohols are toxic, although the latter two are considerably less toxic than methanol, and considerably less volatile. In particular, butanol has a high flashpoint of 35 °C, which is a benefit for fire safety, but a difficulty for starting engines, particularly in cold weather. (In comparison, ethanol has a flashpoint of 13 °C; methanol has a flashpoint of 11 °C; and propanol has a flashpoint of 15 °C.)

The fermentation processes to produce butanol and propanol from cellulose are fairly tricky to execute, and the Weizmann organism (Clostridium acetobutylicum) used to perform these conversions produces an extremely bad smell that must be considered when designing and locating a fermentation plant. This organsim also dies when the butanol content of whatever it is fermenting hits 7%. For comparison, yeast dies when the ethanol content of its feedstock hits 14%!

One advantage shared by all four alcohols is octane rating. Butanol has the additional attraction that its energy per kilogram is closer to gasoline than the other alcohols (while still retaining over 25% higher octane rating).

As of 2005, production of all four alcohols from petroleum is cheaper than fermentation and extraction from biomass, but this is expected to change as fermentation and extraction processes become more efficient while petroleum becomes more expensive.[edit]

Ethanol and hydrogen

A view is emerging that current consumers of fossil fuels should move to using hydrogen as a fuel, creating a new so-called hydrogen economy. However, hydrogen is not a fuel source in and of itself. Rather, it is merely an intermediate energy storage medium existing between an energy source (be it solar power, biofuels, and nuclear power) and the place where the energy will be used. Because hydrogen in its gaseous state takes up a very large volume when compared to other fuels, logistics becomes a very difficult problem. One possible solution is to use ethanol to transport the hydrogen, then liberate the hydrogen from its associated carbon in a hydrogen reformer and feed the hydrogen into a fuel cell. Alternatively, some fuel cells can be directly fed by ethanol or methanol. As of 2005, fuel cells are able to process methanol more efficiently than ethanol.

In early 2004, researchers at the University of Minnesota announced that they had invented a simple ethanol reactor that would take ethanol, feed it through a stack of catalysts, and output hydrogen suitable for a fuel cell. The device uses a rhodium-cerium catalyst for the initial reaction, which occurs at a temperature of about 700 °C. This initial reaction mixes ethanol, water vapor, and oxygen and produces good quantities of hydrogen. Unfortunately, it also results in the formation of carbon monoxide, a substance that "chokes" most fuel cells and must be passed through another catalyst to be converted into carbon dioxide. (The odorless, colorless, and tasteless carbon monoxide is also a significant toxic hazard if it escapes through the fuel cell into the exhaust, or if the conduits between the catalytic sections leak.) The ultimate products of the simple device are roughly 50% hydrogen gas and 30% nitrogen, with the remaining 20% mostly composed of carbon dioxide. Both the nitrogen and carbon dioxide are fairly inert when the mixture is pumped into an appropriate fuel cell. Once the carbon dioxide is released back into the atmosphere, where it can be reabsorbed by plant life. No net carbon dioxide is released, though it could be argued that while it is in the atmosphere, it does act as a greenhouse gas.

EEI has developed a new method for producing butanol from biomass. This process involves the use of two separate micro-organisms in sequence to minimize production of acetone and ethanol byproducts. Interestingly, this process produces significant amounts of hydrogen as well as butanol. [3][4][edit]

Alternate sources

Sugar cane grows in the extreme southern United States, but not in the cooler climates where corn is dominant. However, many regions that currently grow corn are also appropriate areas for growing other crops that can be used for energy production. These crops include corn stover, sugar beets, wheat straw, hybrid poplars, and dedicated herbaceous biomass feedstocks such as switchgrass or bermudagrass. Some studies indicate that using these sugar beets would be a much more efficient method for making ethanol in the U.S. than using corn. United States Department of Energy reports have shown that a minimum farmgate price, hybrid poplars and switchgrass would be economically advantageous over conventional crops in certain regions of the U.S.

In the 1980s, Brazil seriously considered producing ethanol from cassava, a major food crop with massive starchy roots. However yields were lower than sugarcane, and the processing of cassava was considerably more complex, as it would require cooking the root to turn the starch into fermentable sugar. The babaçu plant was also investigated as a possible source of alcohol.

There is also growing interest in the use of waste biomass as a source for alcohol other types of fuel. New technologies such as cellulose to ethanol production could provide much higher positive energy ratios of 2 to 3 times more energy in ethanol produced than input. Cellulose to ethanol production could also run on any cellulose and hemicellulose source from farm waste, hay/grass, basically any plant matter including wood, cardboard and paper. Theoretically farms could produce fuel without sacrificing food production, because all that is needed is the left over plant matter after harvesting. Cellulose to ethanol production is still in development and has seen limited use in industrial ethanol production. However, a bioenergy corporation in Canada is producing 1 million gallons/year of cellulosic ethanol from their Ottawa facility. Using current technologies, 1 ton of biomass (such as switchgrass) would be able to produce 80 gallons of ethanol using a conventional enzymatic fermentation process. The biggest challenges in using cellulose as a feedstock is the treatment and disposal of process waste and the conversion of C5 sugars (hemicellulose). Lignin, a part of the cell wall that provides plant structure, does not readily break down to simple sugars but has a energy equivalent of soft coal. Lignin would be incinerated to produce energy for the ethanol plant and surrounding areas or gasified to produce a syngas (hydrogen and carbon dioxide). Unlike grain based processes which produce a by-product known as distillers grain with minimal waste treatment needs, cellulosic processes are typically effluent and waste treatment intensive.

Distiller grain is a protein enriched animal feed with much higher nutritional value than natural grain and is typically priced at less than half that of natural grain. It therefore tends to be a desirable product for animal feeders. Approximately one-third of grain usage in the production of ethanol in modern plants is recovered as distillers grain.[5] [6] [7]

At this time, most of the different processes for converting biomass into ethanol and other fuels are very complicated and not particularly efficient. A few processes have seen increasing buzz, including thermal depolymerization (though that process produces what is described as light crude oil).

It is possible to decompose cellulose into sugar in strong or weak solutions of sulphuric acid, but this process also decomposes and wastes perhaps half the potential sugar content and creates large amounts of acidic waste, so scientists are searching for more efficient and less polluting enzymatic and microbial processes for breaking down cellulose into sugar.

Another approach under development is to gasify biomass by heating it in an oxygen-poor environment. This yields hydrogen, methane and carbon monoxide as well as noncombustible carbon dioxide and nitrogen compounds. Bacterial cultures have been isolated that can convert the reactive gasses into ethanol, which is then distilled out of the liquid medium.[edit]

Net fuel energy balance

To be viable, an alcohol-based fuel economy should have positive net fuel energy balance. Namely, the total fuel energy expended in producing the alcohol — including fertilizing, farming, harvesting, transport, fermentation, distillation, and distribution, as well as the fuel used in building the farm and fuel plant equipment — should not exceed the energy contents of the product.

This is a controversial subject charged with potential bias. Much of it depends on what is included and what is excluded from the calculation, particularly when compared with the energy balance of the production of gasoline itself. Analyses are greatly complicated by various methods of accounting for the energy value coproducts and consideration of alternate uses of the feedstock. Not surprisingly, this debate has been at best inconclusive to date.

Switching to a system with negative fuel energy balance would only increase the consumption of non-alcohol fuels. Such a system would only be worth considering as a way of exploiting non-alcohol fuels that may not be suitable for transportation use, such as coal, natural gas, or biofuel from crop residues. (Indeed, many U.S. proposals assume the use of natural gas for distillation.) However, many of the expected environmental and sustainability advantages of alcohol fuels would not be realized in a system with negative fuel balance.

Even a positive but small energy balance would be problematic: if the net fuel energy balance is 50%, then, in order to eliminate the use of non-alcohol fuels, it would be necessary to produce two units of alcohol for each unit of alcohol delivered to the consumer.

In this regard, geography is the decisive factor. In tropical regions with abundant water and land resources, such as Brazil, the viability of production of ethanol from sugarcane is no longer in question; in fact, the burning of sugarcane residues (bagasse) generates far more energy than needed to operate the ethanol plants, and many of them are now selling electric energy to the utilities. Also, in countries with abundant hydroelectric power, the net fuel energy balance of the cycle could be improved to some extent by using electricity in the production, e.g. for milling and distillation.

The picture is quite different for other regions, such as most of the United States, where the climate is too cool for sugarcane. In the U.S., agricultural ethanol is generally obtained from grain, chiefly corn.[edit]

Energy balance in the United States

One study has concluded that the use of corn ethanol for fuel would have a negative net energy balance. Namely, the total energy needed to produce ethanol from grain — including fermentation, fertilizing, fuel for farm tractors, harvesting and transporting the grain, building and operating an ethanol plant, and the natural gas used to distill corn sugars into alcohol — exceeds the energy content of ethanol. However, all subsequent studies have concluded that ethanol production yields more energy than it consumes (most agree on a ratio of 1.34:1 — [8] and see below).

Using old data greatly affects the outcome in these studies. According to the USDA, farms have become more energy efficient since 1978 due in large part to replacing gasoline powered equipment with more fuel-efficient diesel engines. Total farm energy use peaked in 1978 at 2,244 trillion Btu (2.368 EJ), but by 2000 had dropped to about 1,600 trillion Btu (1.7 EJ). In the meantime, corn production rose from an average of 110 bushels per acre (6.9 Mg/ha) in 1980 to 140 bushels per acre (8.8 Mg/ha) in 2000.

A study by Cornell University ecology professor David Pimentel found a negative energy balance. Pimentel's study was disputed by other specialists, forcing him to revise his figures. Still, in August 2003 (and again in March 2005), he stated in a Cornell bulletin that production of ethanol from corn takes 29% more energy than it produces, ethanol from switch grass requires 45% more energy and ethanol from wood biomass requires 57% more energy that it produces [9].

He concluded that the yield was 218 US gallons per acre (204 m^3/km^2) of gasoline equivalent, due to the energy in ethanol being only 66% that of gasoline. Pimentel also calculated that corn (maize) production requires about 115 US gallons per acre (108 m^3/km^2) of gasoline equivalent. Thus, he calculated a net energy production of 103 US gallons per acre (96 m^3/km^2), while his studies somehow all concluded a net energy loss in producing ethanol. Critics of Pimentel's study cite questionable deductions, for example; 1,000,000 Btu per acre (260 kJ/m^2) for labor, 5,656,000 Btu per acre (1474 kJ/m^2) for machinery, as well as additional deductions for steel and concrete production and construction of ethanol refineries, while not saying from where these numbers were derived. (Shapouri, Hosein, James A. Duffield, Michael Wang. The Energy Balance of Corn Ethanol: An Update. USDA: Office of the Chief Economist; Office of Energy Policy and New Uses. Washington, DC. July, 2002) Pimentel’s work has been largely criticized and discredited by subsequent studies.

It is only fair to hold gasoline to the same standard that ethanol is being put through. The focus of the USDA report, and others, was on ethanol and the energy balance equation, but according to a report by the Minnesota Department of Agriculture, when taking into account the energy needed to extract, transport and refine crude oil into gasoline, the final energy product of gasoline has an energy ratio of 0.805. That means ethanol production is 81% more energy efficient than gasoline. (Groschen [10])

Continuous refinements to ethanol production procedures have much improved the benefit/cost ratio, and most studies of modern systems indicate that they now have a positive net energy balance. Also, when ethanol is mixed with water vapor and converted into hydrogen, it does not need to be as pure as when it is used in a combustion engine, making the process more efficient. (see source below)

Many other studies of corn ethanol production have been conducted, with greatly varied net energy estimates. Most indicate that production requires energy equivalent to 1/2, 2/3, or more of the fuel produced to run the process. A 2002 report by the United States Department of Agriculture concluded that corn ethanol production in the U.S. has a net energy value of 1.34, meaning 34% more energy was produced than what went in. This means that 75% (1/1.34) of each unit produced is required to replace the energy used in production. The study also concluded that the energy used to produce and convert the ethanol was from abundant domestic sources, with only 17% of the energy used coming from liquid fuels, therefore, for every 1 unit of energy from of liquid fuel used, such as gasoline or diesel fuel, there was a gain of 6.34 units of energy. MSU Ethanol Energy Balance Study: Michigan State University, May 2002. This comprehensive, independent study funded by MSU shows that corn ethanol production has a net energy value of 1.56: it produces 56% more energy per unit volume of ethanol than it consumes. Nevertheless, as noted earlier, these relatively small energy gains are problematic, for they imply that between 2.79 (assuming net energy value 1.56) and 3.94 (assuming net energy value 1.34) units of ethanol must be produced for each unit of ethanol that can be sold to consumers. Actual net energy values might be improved by measures such as burning corn stalks (which are not fermentable using current technology) to run some parts of the corn ethanol production process that currently consume petroleum, gas, or ethanol (similarly to the way bagasse is currently burned to produce energy to run the ethanol production facilities in Brazil). As of 2005, ethanol production from corn requires a great rise in the cost of petroleum before it will become economically viable without government subsidies. Although for brief periods in the past year ethanol traded for less than gasoline and diesel before the subsidy was applied.[edit]

Arguments and criticisms

The use of alcohol as fuel is advocated with various arguments, mainly relating to its beneficial effects on the local and global environment, its independence from foreign oil, and its economic advantages. Critics generally dispute those arguments, claim that the switch would be expensive, and object to perceived need for increased government subsidies, taxes, and regulations.[edit]

Air pollution

There has long been widespread acknowledgement that ethanol is a cleaner-burning fuel than gasoline. Ethanol has far fewer standard regulated pollutants such as carbon monoxide and hydrocarbons, compared with plain gasoline in equivalent tests. See, for example, the air pollution and environmental studies listed at the Renewable Fuels Association website http://www.ethanolrfa.org/pubs.shtml

There has been concern about increased evaporative smog-forming hydrocarbon emissions. For example, the conservative organization RPPI claims that "adding ethanol to gasoline will at best have no effect on air quality and could even make it worse. Studies show ethanol could even increase emissions of nitrogen oxides and volatile organic compounds, which are major ingredients of smog." [11] Other critics have argued that the beneficial effects of ethanol can be achieved with other cheaper additives made from petroleum.

It is important to distinguish the issues. Ethanol in a blend with gasoline replaces tetra ethyl lead, benzene and MTBE -- all of which are additives that are meant to raise octane levels. Ethanol, with an octane rating of 110, far surpasses regular gasoline and precludes needs for other dangerous additives. However, ethanol can increase vapor pressure of gasoline causing increased evaporative emissions which, on balance, are far less serious than lead, benzene or MTBE.

Ethanol as a straight fuel is far cleaner than gasoline in its own right and this has been recognized from the dawn of the automotive age. See, for instance, Kovarik's "Fuel of the Future" http://www.radford.edu/~wkovarik/lead[edit]

Fire safety

Ethanol appears to be less of a fire hazard than gasoline; while methanol, being more volatile, is somewhat more prone to fire and explosions. However, since ethanol and methanol dissolve in water (rather than floating on it like gasoline) their fires can be extinguished with ordinary water hoses.

One of the problems with accidental combustion of pure ethanol is that it burns with a dim, blue flame, with invisible smoke. Methanol flames are dim enough to be considered invisible in daylight. Blending significant amounts of gasoline produces a highly visible flame; small quantities of dye can also produce this effect.[edit]

Greenhouse gases

A separate (and perhaps more important) benefit of switching to an ethanol fuel economy would be the decreased net output of the greenhouse gas carbon dioxide (CO2), since all the CO2 that would be liberated in the manufacture and consumption of ethanol would have to be absorbed by the plantations. In contrast, the burning of fossil fuels injects massive amounts of "new" CO2 into the atmosphere, without creating a corresponding sink.

Needless to say, this advantage will be accrued only with agricultural ethanol, not with ethanol derived from petroleum — which, due to its much smaller cost, presently accounts for most of the alcohol produced for industrial consumption. This point must be taken into account when estimating the cost of the switch.

However, this assumes processes such as distillation of ethanol and production of fertiliser which require large amounts of energy would be done without using fossil fuels.[edit]

Renewable resource

According to its proponents, another advantage of (agricultural) alcohol as a fuel is that it is a renewable energy source that will never be exhausted; whereas an economy based on fossil fuels will sooner or later collapse when the world runs out of oil.

However, David Pimentel disputes that "ethanol production from corn" is a renewable energy source. However, Pimentel's studies have been widely discredited, and also fails to compare other viable sources of ethanol such as Sugar beets and Sugarcane.[edit]

Dependency on foreign oil and international crime

A somewhat related (but more compelling) argument is that developed regions like the United States and Europe consume much more fossil fuels than they can extract from their territory, therefore becoming dependant upon foreign suppliers as a result. As such, this dependency has become a major cause of oil wars and coups d'etat initiated by Western powers, and attendant misery and human rights violations in certain oil-producing countries allied with the West. Even if the energy balance is negative, US production involves mostly domestic fuels such as natural gas and coal, so the impact on oil importation is still positive.[edit]

Statism

Some critics, mainly on ideological grounds, dislike the idea of an ethanol economy because they see it as leading to increased government subsidy for corn-growing agribusiness, and statism. The Archer Daniels Midland Corporation of Decatur, Illinois, better known as ADM, the world's largest grain processor, produces 40% of the ethanol used to make gasohol in the U.S. The company and its officers have been eloquent in their defense of ethanol and generous in contributing to both political parties.

One U.S. government study, Tax Incentives for ethanol and petroleum, examined subsidies historically given to the oil industry and to the ethanol industry and found that the amounts of those to the oil industry are far higher. At the same time, this study applies only to historical subsidies and doesn't investigate the question of what the case would be if petroleum fuels were substantially replaced by ethanol.[edit]

Cost

Some economists have argued that using bioalcohol as a petroleum substitute is economically infeasible because the energy required to grow the corn and other crops used as fuel is greater than the amount ultimately produced. They argue that government programs that mandate the use of bioalcohol are simply agricultural subsidies enacted to gain votes from heavily agricultural states, especially Iowa. However, this reflects a lack of understanding of the motor fuel industry; production of gasoline also requires more energy input than the fuel itself provides, but the trade-off is worthwhile because it converts less portable forms of energy (electricity for pumps, burning off crude oil for heat at refineries, etc.) into a high-value (portable, easily used) form of energy. As of 2005, ethanol production has actually become much more energy-efficient than gasoline production, with energy inputs as low as 70% of the energy value of the ethanol produced.[edit]

Ethanol fuel in Colombia

Colombia’s first sugarcane ethanol plant began production in 2005, with output of 300,000 liters a day in Cauca. The $20 million Ingenio del Cauca plant owned by businessman Carlos Ardila is the first of five plants with a total investment of $100 million which should begin operation over the next few months. The government aims to gradually convert the nation’s auto fuel supplies to a mixture of 10 percent ethanol and 90 percent gasoline. Ethanol plants are being encouraged by tax breaks.

Ethanol production should help to decrease Colombia’s dependency on gasoline at a time when its oil production is decreasing as well as reduce emissions of greenhouse gases. However, in the past year, many small amounts of petroleum deposits have been discovered throughout Colombia. It is estimated that Colombia is sitting on 5 billion barrels of petroleum.[edit]

Ethanol fuel in BrazilMain article: Ethanol fuel in Brazil

Today, Brazil is the largest producer and consumer of Ethanol fuel in the world. Since the 1980s, Brazil has developed an extensive domestic ethanol fuel industry upon sugarcane production and refining. In 2006, Brazil finaly met its oil auto-sufficiency thanks to its Ethanol program and recent discovery of new deep-water oil fields. Ethanol plants in Brazil maintain a positive (+34%) energy balance by burning the non-sugar waste from sugarcane.[edit]

Ethanol fuel in the United States[edit]

Ethanol fuel in the Midwest

The so-called corn-belt in the Midwestern United States produces large amounts of corn. Sugars from this corn can be and are used to make ethanol. Minnesota has pioneered the use of ethanol fuel mixes in the United States, and currently all gasoline mixes must have 10% ethanol (90% gasoline) by volume. There are almost 200 gas stations in Minnesota that serve E85, which is a fuel mix of 85% ethanol and 15% gasoline.[12] In the US, there is over a 4 billion gallon a year capacity for ethanol production. [13][edit]

U.S. National security

It is believed by some (including former CIA director James Woolsey and Frank Gaffney, President Reagan's undersecretary of defense [14]) that oil consumption in the U.S. contributes in a large way to the funding of terrorism. Oil is the primary source of revenue for many Mid-East countries. Many of these countries are thought to harbor and/or fund terrorist organizations. The use of alternative fuels would divert money away from these nations. Ideally, instead of funding terrorism, this money would then be used to fuel the U.S. economy.[edit]

See also
- List of energy topics
- biodiesel
- biofuel
- biomass
- butanol from Clostridium acetobutylicum
- sugarcane
- liquid fuels
- oil crisis
- Timeline of Alcohol Fuel
- Landless Movement (Movimento dos Sem-Terra) under Politics of Brazil [edit]

External links
- Ethanol Facts, provided by the National Corn Growers Association.
- U.S. Department of Energy: Biomass Program.
- U.S. Department of Energy: Clean Cities. Includes info on flexible fuel vehicles.
- Zen Alcohol Stoves. Includes info on alcohol fuels for stove use.
- Ethanol as Fuel - Documentation that Ethanol consumes more energy to make than is derived from its burning.
- American Coalition for Ethanol: http://www.ethanol.org/. Advocacy group.
- Methanol Institute: [15] Article about methanol in race cars.
- National Pollutant Inventory - Ethanol fact sheet
- How To Run Your Car On Alcohol Fuel - A 1982 book, now published online, with information on converting gasoline cars to use ethanol.
- Farm Industry News: Hydrogen Corn Economy. Article about converting ethanol to hydrogen.
- Making Alcohol Fuel - A website that covers the use and production of ethanol as a fuel.
- Renewable Fuel Association [16]
- National Ethanol Vehicle Coalition [17] Shows locations of E85 fuel pumps in the USA
- Clean Fuels Development Coalition [18]
- Pimentel: Ethanol - Inefficient Fuel
- Debunking Pimentel: Ethanol - Efficient Fuel
- Ethanol Fuel News and Discussion
- Henry Ford, Charles Kettering and the Fuel of the Future (history of ethanol) [19]

Sustainability and energy development   EditEnergy productionActive solar | Bioalcohol | Biodiesel | Biofuel | Biogas | Biomass | Deep lake water cooling | Distributed generation | Electricity generation | Ethanol fuel | Fuel cell | Fusion power | Geothermal power | Hydroelectricity | Methanol fuel | Ocean thermal energy conversion | Passive solar | Solar cell | Solar chimney | Solar panel | Solar power | Solar thermal energy | Solar Tower | Tidal power | Trombe wall | Water turbine | Wind turbineEnergy developmentEnvironmental concerns with electricity generation | Future energy development | Hydrogen economy | Hubbert peak | Renewable energy | Hypermodernity | Technological singularityEnergy and
sustainability statusEcosystem services | Kardashev scale | TPE | UN Human Development Index | Value of Earth | Intermediate technology | Infrastructural capitalSustainabilityEcoforestry | Ecological economics | Earth sheltering | Development economics | Environmental design | Exploitation of natural resources | Green building | Green gross domestic product | Natural building | Permaculture | Self-sufficiency | Straw-bale construction | Sustainability | Sustainable agriculture | Sustainable design | Sustainable development | Sustainable industries | Sustainable living | The Natural StepSustainability managementHuman development theory | Maldevelopment | Rio Declaration on Environment and Development | Rocky Mountain Institute | Sim Van der Ryn | Underdevelopment | World Business Council for Sustainable Development | World Summit on Sustainable Development | Precautionary principle | Intermediate Technology Development GroupEnergy and
conservationEnergy-efficient landscaping | Electric vehicle | Hydrogen car | Voluntary simplicity | Ecological footprint | Ecovillage | WasteRetrieved from "http://en.wikipedia.org/wiki/Ethanol_fuel"