

Oil, Automobiles, and Agriculture: Can a Modified Global Diet Alleviate the Strain on Our World's Oil Resources?

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In the late 1970's President Jimmy Carter made a bold statement: He declared that the world energy crisis is becoming a war of moral responsibility. He remembered OPEC's embargo on oil supplies in 1973 and encouraged a spirit of conservation in fear of another embargo. Springing from that sentiment was the steepest jump in oil prices the history of the United States. Between 1978 and 1982, the average price per gallon of gasoline skyrocketed from a modest \$ 0.66 to an unheard of \$1.32. Other countries experienced comparable increases. Japan, for example saw their price-per-gallon of gasoline rise from \$2.00 to \$2.60, and similarly the United Kingdom's gasoline went up from 1.22 to \$2.42 per gallon [DOE/IEA 1999]. That was the beginning of what would later be known as the World Energy Crisis. It is apparent now, in retrospect, that in times when US relations with the Middle East are less than profitable the ugly head of an oil scare reveals itself to the rest of the world in the form of elevated oil prices. Looking at the Gulf War, again, in every country around the world, oil prices jumped to a relative maximum. Whether this was due to the prospect of not being offered oil at a decent price due to poor negotiation, or even more critically, obliterated oil fields as casualties of war, the world began to realize that energy conservation was not simply a good idea, but imperative. Today, with Bush threatening war on Iraq, we are already beginning to see what could turn into the largest oil market shock the world has ever seen. According to a

report released by the revered US investment bank, Goldman Sachs, war could drive crude oil prices to \$41-\$46 per barrel, representing an increase of up to 15 dollars per barrel [Islam F, 2003]. We are now beginning to hear the faint cries of oil conservationists even if it's for the wrong reasons.

President George W. Bush, leader of the entity that consumes 25% of the world's oil, is even beginning to question the general trend of oil consumption. His motives for conservation may not be altogether altruistic and geared toward saving the world's oil supply, but at least his fear of dependence on the Middle East is better than not conserving at all. In his most recent State of the Union Address, he proposed a 1.5 Billion dollar initiative for research on methods for energy production from oil alternatives. The government is taking baby steps to ease the US into a state of conservation. For example, in October 2002, the US Department of Energy released its Vision for Bioenergy & biobased Products in the United States. The opening line reads, "The United States is approaching a biobased revolution that will fundamentally change the way we produce and consume energy and industrial products." Much insight in this document is dedicated to informing the public that there are ways to efficiently utilize domestic energy resources through the conversion of crops and agricultural waste to the molecular building blocks of the fuels that help us accomplish things such as "run[ning] our cars." Other countries are leading the US in this endeavor. Japan for example has already manufactured hybrid vehicles that can be bought in any state in the US and are available in Europe as well. The model Civic hybrid by Honda is estimated to attain upward toward 46 miles per gallon in city streets and on the highway 51 mpg. The Prius

of Toyota matches these numbers with a combined city/highway mpg rating of 48. The United States, in 1993, joined in this effort to develop hybrid technology for vehicles in what is known as the HEV Program. The projected vision of this program was to combine the efforts of the US Department of Energy and "The Big Three," Ford, General Motors, and Daimler-Chrysler in one-way street to developing a market-ready US made hybrid vehicle by the year 2003. This has not been the case. And even the Japanese hybrid cars that are available to US citizens are rarely seen on the streets. This may be a result of Americans trying to mend a wounded economy, or patriotism in times of war. But most likely, it is due to the fact that straight off the showroom floor, the Honda Civic hybrid runs \$19, 500. So, if we're so intent upon conserving oil, saving energy, and saving money, it's time to turn elsewhere with the same interests in mind.

The Clean Air Act Amendments of 1990 called for the sale of fuels with higher oxygenation level in areas of high atmospheric carbon monoxide concentration. This marked the beginning of the epoch for development of ethanol-blended gasoline. In addition to cleaner vehicle emissions, the use of ethanol allows us to have high-powered vehicles without high levels of gasoline consumption. Every major manufacturer of vehicles in the United States has approved of ethanol/gasoline blends as a feasible gasoline alternative that is compatible with the motors of all vehicles. In some areas of the United States, ethanol is already available in gas stations in the form of E10. This corresponds to a mixture that is 10% ethanol and 90% gasoline. In the US only 6 states, mostly residing in the Northeast region and Hawaii, do not have readily available ethanol/gasoline blends at pumps. The trend of including ethanol as an option at fueling

stations is slowly beginning to become a norm. This is because EG (ethanol-gasoline) blends are becoming accepted as a viable energy source. In 2002, Secretary of Agriculture, Ann M. Veneman publicized the findings of a USDA study that substantiates ethanol as energy efficient and as having a positive role in America's break from imported oil dependency [USDA News Release #322.02]. In this report, Veneman went on to state, "This new research shows that ethanol is a valuable energy source [which] supports President Bush's energy policy [that] calls for additional renewable sources of energy." So, a question arises regarding why we are not using ethanol as a primary source of fuel if it's so efficient. The answer to this question is deeply buried under years and years of trends that have already set the workings of the automobile industry in motion. So, it's more beneficial, then, to contemplate how ethanol can begin to become the primary source of energy in the US and in the world.

Ethanol is an organic molecule derived from the break down products of sugar that all living organisms use for energy. The chemical reaction involved in this process is simply:



There are currently more than 60 ethanol production facilities located in more than 20 states across the US. In fact, in June, Secretary Veneman announced that the USDA approved a \$12.5 million guaranteed loan for construction of another ethanol production facility in Iowa. The new ethanol production plant will produce 18 million gallons per year. These facilities take advantage of the fact that ethanol can be produced from many

potential feedstocks. These feedstocks include any byproduct of sugar processing, agricultural wastes, anything containing starch (corn, wheat, potatoes, etc.), paper, and wood waste. In light of this fact, Veneman announced “the approval of \$2.4 million value-added agricultural product market development grants that will assist in the development of alternative energy sources” [USDA]. In the USDA’s Annual Energy Outlook of October 2002, the estimated production of biobased ethanol for industrial use would be 1.75 million pounds. Of this amount, 147 Quadrillion Btu would account for ethanol blended into gasoline for the operation of automobiles. A Btu an abbreviation for a unit of energy called a British thermal unit.

The conversion process to ethanol from biomass is very interesting. It involves technology based on biochemically-engineered microorganisms. Conventional ethanol production relies on the fermentation processes of yeasts. The cost of production is very expensive, though, so ethanol use must often be subsidized. New and more efficient ways to achieve ethanol production are being researched and developed everyday. One method takes advantage of the metabolic machinery present in bacteria. One company, Agrol Technology Ltd. has designed and patented a “closed loop” ethanol fermentation process. This particular method uses bacteria that are taken from places of extremely high temperature such as hot springs and geysers. These bacteria are most suitable for the conversion because high temperatures are required for chemical processes to occur at a high rate. Any other bacteria or organism would die at these temperatures, or if they didn’t die, their molecular machinery (enzymes) would denature and wouldn’t work optimally. This procedure has been shown to work only at the laboratory scale, so there

are still many steps that must be taken in order for it to be applied to the industrial scale. The patent would have to be licensed to key ethanol producers and sugar refineries.

Another company, BC International Corporation (BCI) is already in the game. They are constructing a \$90 million dollar biomass-ethanol plant in Jennings, Louisiana. This company specializes in bio-ethanol production, again, focusing on microorganisms to do the work. This plant was the first bio-ethanol production facility the world ever saw, and already it is projecting to “produce 20 million gallons of ethanol a year” commercially available at a price competitive with fossil fuel [BCI]. The BCI plant works jointly with University of Florida scientists in an effort to maximize ethanol production. The bacterium of interest is called KO11 or “knockout 11.” This is a genetically engineered form of the common bacteria *E. coli*. This bacteria is capable of converting all types of sugar found in plant cell walls to ethanol. For the first time ever, it will be possible to use the waste byproducts from plants to sustain the production of ethanol that can be made available for the powering of automobiles. Now, its slowly becoming a question not of how we are going to ever be able to use ethanol for fuel but when. The technology is not only at our fingertips, but is in our hands. As soon as legislation is passed requiring the use of ethanol, it will become a societal norm. This will probably not be for years to come. Although if we were not able to depend on OPEC for fuel, the whole process would be expedited.

Beside the benefit of ethanol as a “clean” burning fuel, there is another major advantage to its incorporation into usable fuel for automobiles, provided the ethanol is

derived from plant matter. Every time we burn a molecule of gasoline from fossil fuel, carbon dioxide is ejected into the atmosphere as a reaction product of combustion. If fossil fuel is continuously burned, more and more CO₂ accumulates in the air. The final result is an atmosphere with a carbon dioxide concentration that is sky high. This is commonly known as the greenhouse effect. One implication of this phenomenon is elevated global temperature due to greenhouse gas insulation [EPA]. But, this could be counteracted if only the cycle could be closed. Using ethanol derived from plants is a perfect way to do this. Here's how it works. Plants use CO₂ from the atmosphere to photosynthesize sugar, using light from the sun. If then, the same plants are used to make ethanol for fuel to run our cars. The CO₂ in the atmosphere will be from the plants themselves. The cycle will then be closed, and there will be much less CO₂ accumulating in the atmosphere. So now, it is clear that the use of ethanol for fuel production is good for the atmosphere and useful in helping conserve the world's oil supply. Next, we will take a look at some facts about current ethanol powered vehicles, and then we will move on to ways in which plants can be made available to make ethanol accessible.

As mentioned previously, every major automobile manufacturer in the United States has approved of ethanol as an alternative source of fuel to power the engines of their vehicles. The most recent statistic, announced by the National Ethanol Vehicle Coalition, estimates that there are currently 2.3 million fuel flexible E85 vehicles on the road in the US. The unfortunate truth is that the owners of these vehicles probably do not even know that their vehicle can operate on alternative fuel. It's easy to take for granted the fact that gasoline is fuel for cars because it has been this way since the first

automobiles hit the road. This ignorance is a key operant in the fact that ethanol demand is so low. With more demand, prices will surely fall, and the domino effect will drive the rest of the battle until ethanol-gasoline blends are the only available fuel sources for automobiles. All it takes is for vehicle owners to look at the owner's manual under refueling, and determine if their particular automobile's engine is compatible with ethanol. The list of actual vehicles that can be powered on ethanol is astonishing. For example, the Ford Explorer SUV ('01-'03), Ford Ranger Pickups 3.0L V6 ('99-'03), Chevrolet S-10 pickups 2.4L V4 ('00-'02), the Chevrolet Suburban and Tahoe 5.3 L V8 SUV's ('02-'03), Dodge Caravan minivans 3.3L V6 ('98-'03) are all models of American made vehicles that can be powered using ethanol-gasoline blends for fuel. In order for the use of ethanol to become a norm in society, people must become aware that it is a viable energy source, and with a greater demand, ethanol must then be produced in greater amounts for a lesser price. In the 1990's the market for ethanol fell because of a shortage in production. Now, Brazil, the world's largest producer and exporter of ethanol is trying to come up with schemes to boost production. One way is to up government funding of up to 1 billion liters in ethanol ready for exportation. Eduardo Pereira Carvalho, head of State Union of Sugarcane Agroindustries (UNICA), estimates that this year, ethanol production will increase to 1 billion liters from 300 million liters last year. However, this can only be the case if the sale of ethanol consuming cars increases drastically all over the world. Otherwise, the demand for ethanol will continue to fall by 500 million liters a year as the current fleet of ethanol cars ages [Stewart, 2002].

If instead of relying on Brazil to produce a majority of the world's ethanol for powering vehicles, with the US being the chief consumer, the US switched to an ethanol-manufacturing machine, some drastic changes would have to be made. To gain an understanding of the exact scale of change, let's look at what biomass would be available for ethanol production if we switched to a no beef diet. According to the US Consensus of Agriculture in 1997, 42.5% of farmland use was dedicated to grazing pastures [USDA]. Another figure from the USDA estimated that roughly 725 million acres of farmland in the US in 1997. This corresponds to roughly 308 million acres of United States land used for grazing in 1997. Granted, this land was not all dedicated to cattle, but to simplify the analysis, let's assume so. It's important to note also that in 1997, 126.7 bushels of corn were harvested per acre of land. If we were to use only harvested corn for ethanol production, this would mean that, according to 1997 statistics, roughly 39 billion bushels of corn would be available for ethanol production. A North Dakota State University Extension Service calculation estimated that a bushel of corn weighs on average, 47.32 pounds. This correlates to 1.8 trillion pounds or 920 million tons of corn strictly for ethanol production. The calculations of David Pimentel of Cornell University estimate that 0.05 gallons of ethanol can be produced from 1 pound of corn. This means that in 1997, if all land for cattle grazing were dedicated to corn harvesting for the production of ethanol as a sustainable fuel for powering vehicles, 90 billion gallons of ethanol would be made available for powering US transportation. According to the US Department of Transportation in 2001, 134.2 billion gallons of gasoline were consumed in the US for transportation [USDOT]. If ethanol were to be in the ideal mixture ratio of E85, 85% of this total volume of gasoline would have to be ethanol. Eighty-five percent

of 134.2 billion is equal to 114 billion gallons of ethanol required to make E85 available for transportation. Remember from the previous calculation that only 90 billion gallons of ethanol would theoretically be available if all the farm grazing land for cattle in the US were dedicated to harvesting corn for the production for ethanol. This simply does not cover our needs. Where do we turn then?

Ethanol to power hybrids may put us closer to self-sufficiency. Let's assume that we switched to hybrids. This means, we take all vehicles and give them hybrid engines. As discussed earlier, current hybrids get roughly 50 miles per gallon of gasoline. Assuming the average vehicle pushes 14 miles per gallon, this represents a 72% decrease in gasoline usage by vehicles. Multiplying 134.2 billion by 28% leaves us with 37 billion gallons of total gasoline needed to operate hybrid vehicles. Assuming the same volume of E85 is necessary to run vehicles as gasoline, multiplying 37 billion by 85% leaves us with a necessity of 32 billion gallons of ethanol to run hybrids for 1 year. So there you have it. If we eliminate beef from our diets, take all the land cattle once grazed upon, dedicate it to harvesting corn to produce ethanol, and at the same time switch to hybrid vehicles that operate on E85, we will produce enough ethanol in 1 year to operate these vehicles for almost 3 years! Is this feasible? Ask the American people. It would be difficult to make such dramatic changes, and would take years to implement. With optimism, awareness, and research funding though, someday, this might be how things are.

It is necessary, then to push toward awareness of the fact that there is no simple answer to energy conservation. We can't just make one change and hope the

problem will be solved. As was demonstrated in this corn and cattle grazing-land analysis, even a change as drastic as giving up meat in our diet is not enough to provide ethanol to power US vehicles for one year. What about the rest of the world?

Minimizing consumption of seems cliché, but it remains the only way to conserve oil. As we push closer and closer to war, it is time to reconsider how we take our oil supply for granted. If we are not more conservative in how we use oil for the sake of preserving the world's reserves, it's better to at least do it for the possibility that it may not be offered to us at reasonable prices in the future, than to not conserve at all. So, for now, it is our responsibility drive less-and enjoy beef in our diets-as we push forth in an effort to minimize the use of oil in the world.

REFERENCES

Goldman Sach's Annual Report 2002.

Faisal Islam. Guardian Unlimited Observer. War Would Mean Biggest Oil Shock Ever.
February 2, 2003.

Stewart, Alistair. ODJ Brazil to Create Ethanol Stocks for Export and Local Markets.
Dow Jones and Company, Inc. 4 June, 2002.

WWW.toyota.com

www.Hondacars.com

www.ott.doe.gov

www.usda.gov

www.globaltechnoscan.com/7feb-13feb/ethanol.htm

www.bcintlcorp.com

www.epa.gov/globalwarming/kids/greenhouse.html

www.e85fuel.com

www.usda.gov

www.ext.nodak.edu/extpubs/ageng/machine/ae945w.htm

www.fhwa.dot.gov/ohim/hs01/mf33ga.htm#foot2

