Ethanol Subsidies on the Verge of Peak Oil: Green Effort or Pork Barrel?

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Introduction

Present levels of carbon dioxide (CO_2) -nearing 380 parts per million (ppm) in the earth's atmosphere- are higher than they have been at any time in the past 650,000 years[1] and could easily surpass 500 ppm by the year 2050 unless radical steps are taken.[2] One of the worst consequences of high levels of CO_2 is global warming. Evidence of rising average global temperatures and significant changes in climate conditions have become so clear in recent years that the voting public is more sensitive to environmental issues than they have ever been. This sensitivity provides an opportunity for policy makers to implement alternative agendas which were previously politically infeasible.

The major input contributing to carbon emissions is oil, which accounts for 45 percent of global emissions from fossil fuels. Today, nearly half of world oil consumption is used for transport.[3] Specifically in the U.S., transportation accounts for two-thirds of oil consumption[4] and is the predominant source of domestic urban air pollution. All future transportation forecasts include steeply increasing demand in developing countries, showing that both oil consumption and CO_2 emissions will continue to rise.[5] Transport will grow faster than any other end-use sector, and the growth in demand in non-OECD countries is expected to be three times higher

[1] IPCC (Intergovernmental Panel on Climate Change), *Climate Change 2007: The Physical Science Basis; Summary for Policymakers*, Contribution of Working Group I to the Fourth Assessment Report of the IPCC, Paris, (February 2007), p.2.
[2] Gary Stix, "A Climate Repair Manual", *Scientific American*,Vol.295, No:3, (September 2006), pp.46.
[3] IEA (International Energy Agency), *World Energy Outlook-2004*, Paris, (2004), p.84.
[4] EIA (Energy Information Administration) website. Available at http://www.eia.doe.gov/neic/infosheets/petroleumproducts.htm. Lastly accessed: March 02, 2007.
[5] For an example please see: EIA (Energy Information Administration), *International Energy Outlook 2006*, Washington, DC, (2006).

than in the OECD. Oil consumption in transportation has thus become a serious concern due to both increasing dependence on imports and escalating environmental impacts.

As the world's dependence on oil continues to grow, reliable oil supply capacity does not increase at the same pace. Moreover, supply security is at risk. Middle East countries produce a significant share of the world's crude oil and own most of its remaining reserves. Political instability in this region, the growing power of radical political currents, and an increasing tendency towards violence all create an overwhelming potential for immediate price spikes. Given both the current circumstances and the historical precedent of world oil crisis, oil is unlikely to be a reliable energy source for the future.

Because of the factors stated above, new and alternative fuel and vehicle technologies, which can reduce CO_2 emissions and oil dependency, have been explored for the last two decades. At present, none of these alternatives can be put into action due to a lack of political will and the absence of integrated strategies, and the inelastic response of the transport sector to energy price movements. Nevertheless, there is a growing consensus that the initial steps towards mitigating global warming must include taking measures in the transportation sector. In that context, contemporary alternative polices have been widely discussed and some technological breakthroughs have emerged to reduce oil consumption. Some examples of these policy and technology alternatives include electric cars, hybrid electric vehicles, vehicles using hydrogen-powered fuel cells, vehicle efficiency standards, carbon taxes for downstream users (individual car owners), tax incentives for electric and hybrid vehicles, tightening CAFE standards, and feebate schemes in which purchasers of gas-guzzlers are charged an additional fee. Without a doubt, the alternative that has generated the most contention has been that of ethanol as a so-called renewable fuel.

In this paper, first of all, the problem of oil supplies and price stability will be analyzed as

briefly as possible. This analysis leads to the conclusion that technology and policy innovations as well as resource diversification are necessary to ensure energy security. Given this conclusion, ethanol will then be discussed as a possible fuel alternative, and evaluated in terms of its technical feasibility, economic efficiency, and environmental impact. We can conclude that it is an open question whether or not increased use of ethanol will address the problems presented by the changing world energy structure. After discussing ethanol's potential as a substitute for oil, the Energy Policy Act (EPACT) of 2005 and its articles related to ethanol will be evaluated. While subsidies included in EPACT may give the impression of an environmentally friendly turn, they can just as easily be attributed to the powerful pressure of industry interests within the Bush administration and their pervasive influence over the legislative process.

I. Decreasing Oil Reserves and the Concept of "Peak Oil"

It is difficult to get a clear picture of world oil reserves and prospective supply capacity. Nevertheless, the following section will demonstrate that a broad range of analyses all point to the same conclusion: the world is headed for a supply crunch. This section defines the estimates of reserves and attempts to give a forecast of future levels of oil consumption. It also concludes that supply capacity, at best, will be problematic.

While there are no standard definitions for reserve concepts, which can vary between companies and countries, these definitions are generally, broadly similar. Reserves are mainly divided into two parts: *discovered reserves* and *undiscovered resources*. Undiscovered resources are geological extrapolations of potential crude oil supplies based on knowledge of geological formations outside existing fields.[6] Discovered reserves are an estimate of future cumulative

[6] Duane Chapman and Neha Khanna, *Global Oil Resources and Persian Gulf: Security and Democracy*, Working Paper, Cornell University, Ithaca, NY, (2003), p.16.

production from known fields. Discovered reserves are typically broken down into proved, probable, and possible reserves.

Proved reserves are known to a high degree of certainty (generally 95%) to exist and be exploitable. They include only "those that can be economically produced and marketed at the present time according to existing technologies and demand."[7] Probable reserves are those that are not yet proven and their certainty degree is assumed to be 50%. These are estimated to have a better than 50% chance of being technically and economically producible.[8] Possible reserves are those that have a significant probability of being commercially exploitable, but which can not be regarded as probable. These three concepts correspond to the minimum, average, and maximum estimates of a known reserve's capacity.

On the other hand, there is another concept used by some scholars and oil experts, *potential reserve expansion*, which defines identified reserves expected to be developed in existing fields.[9] In an existing field under production, remaining resources are given by the sum of proved reserves and potential reserve expansion.

One of the reserve estimates based on the U.S. geological surveys is given below in the first block of Table-1.[10] According to the EIA's most recent estimates (the second block of the Table-1), total remaining resources are slightly higher.[11] It is important emphasize that estimates of undiscovered resources are based on statistical models. As such, they are totally hypothetical and generally viewed as unreliable.

Table-1: Different Reserve Estimates

[7] Leonardo Maugeri, "Oil: Never Cry Wolf-Why the Petroleum Age Is Far from over?" *Science*, Vol.304, (May 21, 2004), p.1114.
[8] BP website: http://www.bp.com/sectiongenericarticle.do?categoryId=9011008&contentId=7021601. Last accessed: March 03, 2007.
[9] Chapman and Khanna, p.16.
[10] Chapman and Khanna, p.17.
[11] EIA, p.29.

Category	Known reserves	Potential reserve expansion	Undiscovered resources	Total remaining resources
Amount (billion barrel)	883	682	1,290	2,855

Category	Known reserves	Potential reserve expansion	Undiscovered resources	Total remaining resources
Amount (billion barrel)	1,292.5	730.2	938.9	2,961.6

One day in the not too distant future, world oil production will reach its *peak* (midpoint production).[12] We can describe this moment as the highest production volume of oil in the history of mankind. After this, oil production will start its structural decline. Estimates of the peaking date vary widely, a phenomenon that some authors attribute to a number of factors including problems with the quantity and quality of available data.[13]

The fact that OPEC members are allowed to export more oil when they report more reserves, may lead us to believe their estimates to be exaggerated. To see the clear picture of a country's oil situation, one has to know many details about the number of existing wells, past production rates, technology used in production, recovery rates, and so on.[14] Since national oil companies in the OPEC do not release detailed statistics for each field that could be used to verify the country's total reserves, the officially announced reserved values are seen highly suspect. Campbell and Laherrère speculate, "there is good reason to suspect that when, during the late 1980s, six of the 11 OPEC nations increased their reserve figures by colossal amounts, ranging from 42 to 197 percent; they did so only to boost their export quotas".[15] The same authors noted suspicious jumps between 1980 and 1995 in reserves reported by seven OPEC

[12] The term "peak oil production" was first used by K. M. Hubbert, "Nuclear energy and the fossil fuels," in *Drilling and Production Practice series*, American Petroleum Institute, Washington, DC, (1956).
[13] Rembrandt H.E.M. Koppelaar, *World Oil Production and Peaking Outlook*, Peak Oil Netherlands Foundation (PONL), Netherlands, (2005), p.7.
[14] Peter Maass, "The Breaking Point", *The New York Times*, (August 21, 2005).
[15] Colin J. Campbell and Jean H. Laherrère, "The End of Cheap Oil", *Scientific American*, Vol.278, Issue 3, (March 1998), p.79.

members whereby nearly 300 billion barrels of oil were added to official reserve tallies although no new major fields have been discovered.[16]

In a new study, Matthew R. Simmons, president of a specialized energy investment banking firm argues that Saudi Arabia's oil fields are now in decline, that the country will not be able to satisfy the world's thirst for oil in coming years, and that its capacity will not climb much higher than its current capacity of 10 million barrels per day.[17] Saudi Arabia was seen as "the central bank of oil" since its excess production capacity allowed it, when necessary, "to flood the market to drive prices down."[18] Many estimates of future supplies also depend on Saudi Arabia's ability to increase its production capacity.

There are other concerns about the reliability of official statistics. Although estimates in the U.S. are strictly reliable, regulators in most other countries may not enforce particular oil-reserve definitions. For example, the former Soviet countries have routinely released wildly optimistic figures in the past.

One of the difficulties of estimating the peaking date is the magnitude of undiscovered resources. Although some argue that there may be additional reserves in the undetected parts of the world, this is not very probable. Today, as Campbell and Laherrère underline, "only extremely deep water and polar regions remain to be fully tested, and even their prospects are now reasonably well understood."[19] The other serious concern is how much new technologies can increase the fraction of oil that can be recovered from fields in a basin. It is obvious that advanced technologies can increase the recovery factor, but there are some doubts about their significant contributions especially in draining the largest basins of oil.

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[16] Ibid.
[17] IAGS (Institute for the Analysis of Global Security), "New Study Raises Doubts about Saudi Oil Reserves", *Energy Security*, (March 31, 2004). Available at http://www.iags.org/n0331043.htm
[18] Maass.
[19] Campbell and Laherrère, p.80.

Because of the difficulties and confusions mentioned, estimates about world oil peaking time vary. A set of latest estimates for peaking projections are shown below[20]:

Table-2: Latest Estimates for Peak Oil

Source of Projection	Projected date	Source of Projection	Projected date
Individual Experts		**Governments**	
A. Bakthiari	2006-2007	Dutch Government (IEA HI copy)	After 2030
M. Simmons	2007-2009	French Government	2020-2030
C. Skrebowski	2007-2010		
K. Deffeyes	2005-2009	**Analyst firms**	
J. Laherrère	2010-2020	IHS Energy*	2011-2020
P. Odell	2060	Douglas Westwood	2010-2020
B. Pickens	2005-2007	Energy Files	2010-2020
M. Lynch	After 2030	PFC Energy	2014-2025
C. Campbell	2010		
S. Al-Husseini	2015	**Energy advisory organisations**	
J. Gilbert	2010	World Energy Council	After 2020
T. Petrie	Before 2010	Energy Research Center Netherlands	2010-2035
		CERA	After 2020
Oil Companies		ASPO	2010
CNOOC	2005-2010	IEA deferred investment scenario	Around 2020
Total	2020-2025	IEA high resource case	After 2030
Shell	After 2025		
BP	We cannot know	**Other Organizations**	
Exxon-Mobil	After 2030	Volvo	2010-2015
		Ford	2005-2010

As Table-2 makes clear, many of the estimates agree that the projected date for peak oil is not far away. According to many of the estimates, the danger is at the door and we are on the verge of an oil crisis. Our own calculations also reveal that all of today's proved reserves and potential reserve expansions will probably be depleted before 2050.[21] Even if new exploration

[20] Koppelaar, p.7.

[21] According to BP [*Statistical Review of World Energy*, Oil Statistics, (2006), p.7], the world total oil consumption equals to 82,459,000 (b/day)*365=30.09 (billion barrel/year). The total remaining resources excluding undiscovered resources are 2,023 billion barrels [EIA, (2006), p.29]. If existing consumption remains same, it takes nearly 67 years (2023/30.09 ≈ 67.22 years) to exploit all oil reserves. In addition, if we want to take into account the factor that oil consumption will continue to increase (i.e. not remaining at the same level), then we should look at oil consumption in the near past. According to BP, the average annual increase of world oil consumption from 2000 to 2005 is 1.704 percent. If we increase annual consumption by 1.704, the total consumption between 2007 and 2050 would be 2,076 billion barrels, which is greater than the sum of today's proved reserves and potential reserve expansions (1293+730=2,023). One more important thing is that EIA's consumption forecasts [EIA, (2006), p.29] are very near to our rough estimates. For example, EIA forecasts the world oil consumption in year 2020 as 37.96 billion barrels/year (104 million barrels per day) whereas we predicted this value as 38.77. Another important point is the possibility of more increased demand of highly emerging economies such as China. It is highly probable that their consumption would increase world total oil demand more than we expected. This effect was ignored in our calculations for simplicity.

and extraction techniques are available to find and exploit undiscovered resources in the future, all forecasts indicate that the price of generating oil will increase at a significant rate. The effects of increasing oil prices are discussed below.

II. Oil Prices and Supply Risk

Sustainability of oil is at risk not only because of the supply problem, but also due to price considerations. We can argue that oil prices continue to increase even as new reserves are discovered. The main reason for this is political rather than technical: political disorder and instability in the major oil exporting countries may be a permanent feature of the near future. To correctly understand the changes in price structures, it is necessary to evaluate the recent past.

The price range framework for oil, which was created in 1986, is called the "*target price zone*". This framework resulted in stable crude oil prices and reliable supply so that oil prices stayed in the range of $15-$20 between 1986 and 1997. Chapman and Khanna note that "all 12 years are within 75 cents of the first target range, except the 1990 price when Iraq invaded Kuwait."[22] During that period, while OPEC tried to maintain this target zone regime, the movement of oil prices was mainly manipulated by OPEC's substantial interventions.

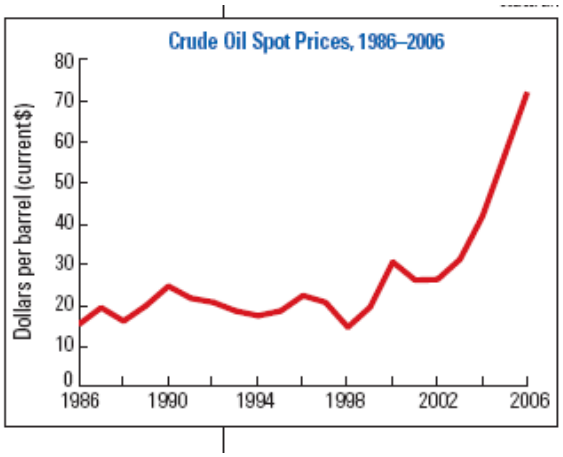
In 1998, a combination of factors caused a reduction in oil prices to nearly $12. Among these factors, Campbell enumerates unseasonably warm weather, Asian economic recession, the collapse of the rouble, misleading over-estimation of supply by the International Energy Agency (IEA), and turning of Iraq to contribute to oil supply.[23] The price collapse, however, was short-lived. In 2000, depletion pressures emerged again and oil prices skyrocketed. In this year,

[22] Chapman and Khanna, p.7.
[23] Campbell, Colin J., "Peak Oil". *Hubbert Center Newsletter*, #2001/2-1, M. King Hubbert Center for Petroleum Supply Studies, Colorado School of Mines, Golden, Colorado, (2001), p.2. Available at: http://hubbert.mines.edu/news/Campbell_01-2.pdf

according to BP statistics[24], the spot crude prices of Brent[25] increased from 17.97 to 28.50 $/bbl (barrel), and prices of Dubai oil increased from 17.25 to 26.20 $/bbl.

For the first time since the early 1980s, oil prices have stayed above OPEC's target price zone for an extended period. Consequently, OPEC arranged a "new price range of $23-$30 (...); [which was] equivalent to the old range adjusted for inflation."[26] In 2001, 2002 and 2003, crude oil prices stayed in this new range, but in 2004, prices once again passed over the ceiling of the range. In 2005, prices exceeded $50/barrel.[27] The following figure[28] summarizes how crude oil spot prices changed between 1986 and 2006 and how dramatic changes took place after 1998.

Figure-1: Oil Price Changes



Oil prices have increased dramatically since 2004 due to the rapidly growing energy demand of emerging economies, more money being spent on oil exploration, and other similar factors. Nevertheless, the primary reason that oil prices have increased is political rather than

[24] BP, 2006, p.12.
[25] Brent crude is one of the major classifications of oil consisting of Brent Crude, Brent Sweet Light Crude, Oseberg and Forties. Brent Crude is sourced from the North Sea. Oil production from Europe, Africa and the Middle East flowing West tends to be priced relative to this oil, i.e. it forms a benchmark. It is traded on the NYMEX which is a London exchange. For additional information please see: http://en.wikipedia.org/wiki/Brent_crude.
[26] Chapman and Khanna, p.7.
[27] BP, 2006, p.12.
[28] WI and CAP (Worldwatch Institute and Center for American Progress), *The Renewable Path to Energy Security*, Washington: Worldwatch Institute, (September 2006), p.9.

economic. This political influence is so forceful that one can readily assert that oil prices will continue to increase even if other major factors (transportation, supply, demand, taxes, refining capacity, etc.) remain unchanged.

What are these political factors affecting oil prices? The ongoing clashes in Iraq; ambitions of Iran to be a nuclear power; authoritarian and generally oppressive administrations of other countries in the region; severe income inequality and the deep influences of radical currents within the region; terrorist attacks on petroleum refineries, installations, and pipelines; the aggressive attitude of Israel and its discord with Arab countries; lasting tension in Lebanon and Palestine; and sectarian quarrels are all fundamental factors that increase the political instability in the Middle East, the world's most important oil exporting region.

The Middle East had a 30.8% share of crude oil production in 2005.[29] This region owns 76% of known oil reserves and 70% of additional reserves, obtainable by potential reserve expansions. As Bentley points out, "the sum of conventional oil production from all countries in the world, except the five main Middle-East suppliers, is near the maximum set by physical resource limits." [30] If they decide to lower supply, the difference between the supply capacity and demand cannot be met by other oil exporting countries.

On the other hand, the U.S. (the world's major oil consumer) is viewed by increasing numbers of the region's political moderates as one of the basic causes of the chaos in the Middle East. The U.S. imported 577 Mt (million tons) of crude oil in 2004 out of a global total of 2,235 Mt.[31] This means that the U.S. imported approximately one quarter of the tradeable crude oil in 2004. As President Bush said in his 2006 State of the Union address, the country is "addicted to

[29] IEA (International Energy Agency), *Key World Energy Statistics*, Paris, (2006), p.10.
[30] R. W. Bentley, "Global Oil and Gas Depletion: An Overview", *Energy Policy*, Vol.30, Issue:5, (February 2002), p.189.
[31] Ibid, p.11.

oil". If current trends continue, America will depend on imports for 70 percent of its oil by 2025.[32] This forces the U.S. to be active in the region, intervening regional politics and selling arms. Paying attention following sentences can help us to understand the complex equation in the region: "The world's largest arm exporters are also the largest oil importers, whereas the countries with the largest remaining and identified crude oil resources are the largest recipients of these arms."[33]

Briefly, these political factors will probably continue to change oil prices in the future. More importantly, global conventional oil supply will continue to be at risk due to the political instability in the major oil supplying region.

The picture we have drawn till now accounts for the studies for oil-alternatives. Remembering the huge share of transportation in oil consumption leads us to understand why so much effort has been exerted in this area. Without a doubt, one of the most widely discussed fuel alternatives is ethanol. In the next section, we will analyze the viability of ethanol.

III. Ethanol as an Alternative Fuel: Is it a Viable Option for New Transportation Policies?

Given the decline in world oil supply and the uncertainty in oil prices, we can argue that oil-dependent transportation policies are neither sustainable nor desirable. It is clear that the world, and especially the U.S., needs new, alternative technologies to reduce emissions and oil dependency. As a matter of fact, there have been some studies suggesting alternatives to eliminate, or at least to reduce oil dependency, but these are at best impractical.

Although many different choices have been discussed[34] for reducing oil dependency, we

[32] WI and CAP, p.7.
[33] Duane Chapman and Neha Khanna, "An Economic Analysis of Aspects of Petroleum and Military Security in the Persian Gulf", *Contemporary Economic Policy*, Vol.19, No.4, (October 2001), p.377.
[34] A rough list for these choices were mentioned at the second to last paragraph of "Introduction" part.

will just focus on renewable alternative fuels (biofuels). In terms of renewable alternative fuels[35], two sources are important: biodiesel, derived primarily from soybeans, and ethanol, distilled mostly from corn grain in the U.S. and sugar cane in Brazil. These fuels, so-called biofuels, are essentially a means of converting the sun's energy into liquid form through photosynthesis. They are referred to as renewable since growing plants each year is possible, i.e. after they are exploited once then they can be renewed next year.

It is obvious that biofuels have a potential to reduce some environmental problems related to transportation, but they can exacerbate others if they are not developed carefully. Depending on the feedstock used and how it is grown and processed, biofuels can negatively affect soil and water quality, local ecosystems, and consequently the global climate. For example, producing biofuels from low-yielding crops and therefore using heavy inputs of fossil fuel energy can result in as much greenhouse gas (GHG) emissions as oil or other petroleum fuels.[36]

One of the major concerns about biofuels is their net energy balance, which is given by the difference between the energy to produce one liter of biofuel and the energy obtained by burning one liter of this biofuel. Some scholars argue that ethanol's energy balance is either negative or slightly positive. We will return this controversy shortly.

Conventional biofuels are limited by their land requirements: producing half of the U.S. automotive fuel from corn-based ethanol, for example, would require 80 percent of the country's cropland. In addition to this basic limitation, as Connor and Minguez argue, there are some ethical concerns taking into consideration food supply and world population:[37]

"It requires production equivalent to 0.5 ton of grain to feed one person for one

[35] Gasoline alternatives such as CNG (compressed natural gas) and LPG (liquid petroleum gas) for energy efficient transportation have been widely used in the world; however, they are not renewable, rather, they are derivatives of petroleum. So, they have no potential to decrease oil-dependency.
[36] WI and CAP, p.23.
[37] David Connor and Inés Minguez, Letter to "Looking at Biofuels and Bioenergy", Discussion, *Science*. Vol.312, (June 23, 2006), p.1743.

> year, a value sufficiently large to allow some production to be used as seed for the next crop, some to be fed to animals, and some land to be diverted to fruit and vegetable crops. Compare this value with that for a car running 20,000 km/year at an efficient consumption of 7 liters/100 km. The required 1,400 liters of ethanol would be produced from 3.5 ton grain (2.48 kg grain/liter), requiring an agricultural production seven times the dietary requirement for one person."

In light of these considerations, we now discuss the efficiency and probable impacts of ethanol in terms of transportation and energy policies. Since biodiesel, the other major biofuel, is used on a far smaller scale and is not as popular as ethanol yet, it is not considered in what follows.

Ethanol is ethyl alcohol, a grain alcohol mixed with gasoline and sold in a blend called gasohol. Certain crops, such as corn and sugar cane, are fermented to make ethanol. Other feedstock includes sorghum, brewery wastes, and cheese whey. There are mainly two types of ethanol fuel used in transportation: E10 (10% ethanol and 90% unleaded gasoline) and E85 (85% ethanol and 15% unleaded gasoline). E10 is approved for use in any make or model of vehicle sold in the U.S. In 2005, about one-third of America's gasoline was blended with ethanol, most in this 10% variety.[38] E85 is an alternative fuel for use in flex-fuel vehicles (FFVs)[39].

There are currently nearly 5 million FFVs on America's roads today.[40] Most cars and SUVs on the road can run on blends of up to 10% ethanol, and motor vehicle manufacturers already produce vehicles designed to run on much higher ethanol blends. Ford, DaimlerChrysler, and GM are among the automobile companies that sell flexible-fuel cars, trucks, and minivans that can use gasoline and ethanol blends ranging from pure gasoline up to 85 percent ethanol

[38] RFA (Renewable Fuel Assocation), "Ethanol Industry Outlook 2006", p.3. Available at: http://www.ethanolrfa.org/objects/pdf/outlook/outlook_2006.pdf. Last accessed: February 27, 2007.
[39] FFV: Cars and trucks that can run on either gasoline or E85 ethanol.
[40] US Department of Energy (US DOE), Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Available at: http://www.eere.energy.gov/afdc/altfuel/eth_market.html. Last accessed: March 07, 2007.

(E85).[41] In 2005, about 2% of U.S. gasoline consumption (92,96 million barrels, approximately four billion gallons) was met by ethanol.[42]

Many see ethanol as a source that can help reduce GHG emissions, while some also believe that it can help reduce oil dependency. However, there are some serious counter arguments against the efficacy and efficiency of ethanol, and they can be summarized under three subtitles: (i) Sustainability, (ii) energy return, and (iii) GHGs reduction. In the following pages, we will discuss these arguments as well as a new scientific concept, cellulosic ethanol, and evaluate the future of the ethanol.

III.A. Sustainability

Using corn, a human food resource, for ethanol production, raises major ethical issues. According to the WHO, "freedom from hunger and malnutrition is a basic human right and their alleviation is a fundamental prerequisite for human and national development."[43] Today, there are billions of people in the world who are malnourished. The expanding world population will probably complicate the food security problem.

> "The current food shortages throughout the world call attention to the importance of continuing the U.S. exports of corn and other grains for human food. Cereal grains make up 80% of the food of the people worldwide. During the past 10 years, U.S. corn and other grain exports have nearly tripled."[44]

Using corn as an energy source rather than a source of nutrition may not be seen as very ethical under these circumstances. Moreover, if the entire corn production were devoted to generate ethanol, it would meet at most 20% of current fuel consumption. "The entire state of

[41] WI and CAP, p.14.
[42] EIA, Monthly Ethanol Production and Stocks, *819 Monthly Oxygenate Report*. Available at: http://tonto.eia.doe.gov/dnav/pet/pet_pnp_oxy_dc_nus_mbbl_a.htm. Last accessed: March 07, 2007.
[43] WHO (World Health Organization), "*Nutrition for Health and Development"*. Available at: http://www.who.int/nutrition/en. Last accessed: March 08, 2007.
[44] David Pimentel and Tad W. Patzek, "Ethanol Production Using Corn, Switch-grass, and Wood; Biodiesel Production Using Soybean and Sunflower", *Natural Resources Research*, Vol.14, No.1, (March 2005), p.70.

Iowa, if planted in corn, would yield approximately five days of gasoline alternative."[45] In 2005, about 12 percent of the U.S.'s corn crop (covering 11 million acres of farmland) was used to produce ethanol[46] and yielded ethanol was around just 2% of total fuel consumption.

Concerns about soil erosion and water pollution due to excessive use of fertilizers and herbicides are also important. A total of about 13 liters of wastewater must be removed for 1 liter of ethanol produced. Crops grown for biofuels generally, and corn specifically are the most land- and water-intensive of the renewable energy sources. According to Deluca, year-round corn crops cause long-term soil degradation, and this type of degradation cannot be repaired by fertilization.[47]

Pimentel and Patzek also argue that the environmental cost of corn growing is very high: [48]

> "U.S. corn production causes more total soil erosion that any other U.S. crop. In addition, corn production uses more herbicides and insecticides than any other crop produced in the U.S. thereby causing more water pollution than any other crop. Further, corn production uses more nitrogen fertilizer than any crop produced and therefore is a major contributor to groundwater and river water pollution."

All the factors stated above coerce us to think about the sustainability of ethanol, especially derived from corn. In today's world in which environmental degradation is widely diffused, finding sustainable solutions has great importance. Therefore, any policy option devised as an environmental friendly alternative should include ecologically sound activities. Besides, meeting transportation needs should never impede or endanger meeting nutritional needs, which is one of the basic human rights. In this regard, the doubts about the sustainability of ethanol can be perceived as reasonable.

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[45] Nathan Hagens, Robert Costanza, and Kenneth Mulder, Letter to "Energy Returns on Ethanol Production" Discussion, *Science*, Vol.312, (June 23, 2006), p.1746.
[46] WI and CAP, p.4.
[47] Thomas H. Deluca, Letter to "Looking at Biofuels and Bioenergy" Discussion, *Science*, Vol.312, (June 23, 2006), p.1743.
[48] Pimentel and Patzek, pp.68-9.

III.B. Energy Return

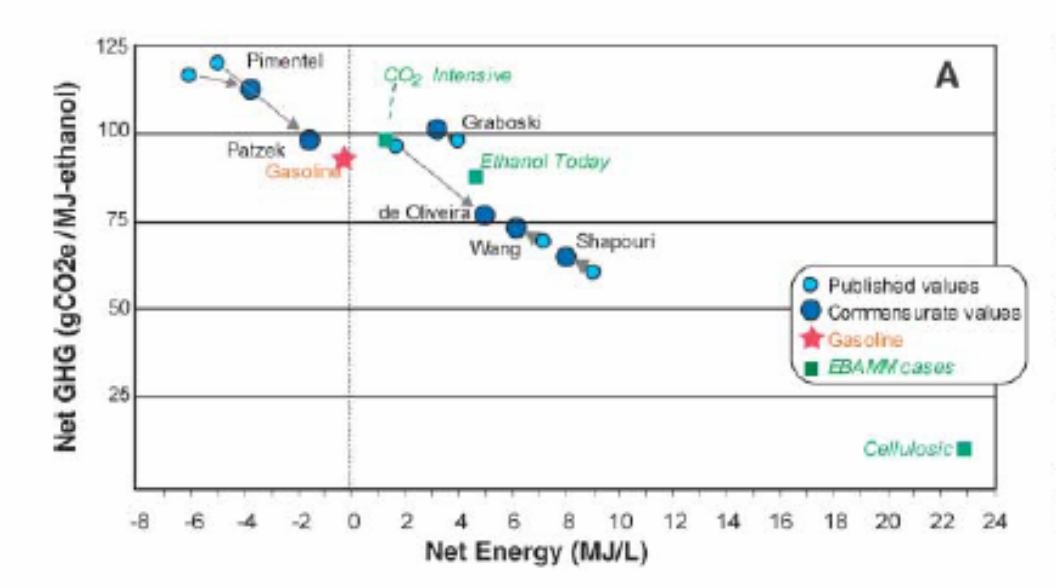
A serious debate is ongoing about ethanol's energy output/input ratio. Some scientists claim that the total energy input to produce ethanol is greater than the energy that can be obtained by burning ethanol whereas some believe the output/input ratio is greater than one.

The differences between scientific calculations are mainly caused by different assumptions and by the inclusion or exclusion of some factors. For example, scientists do not agree about how to credit coproducts (materials inevitably generated when ethanol is made, such as dried distiller grains with solubles, corn gluten feed, and corn oil) in calculations. Farrel and others[49] claim that increases in corn ethanol production will lead to more coproducts that displace whole corn and soybean meal in animal feed, and the energy thereby saved will partly offset the energy required for ethanol production. Shapouri and others' suggestion[50] is based on the fact that all natural gas and electricity inputs are ignored and only gasoline and diesel fuel inputs are assessed. Pimentel and Patzek incorporate even labor force into energy inputs.[51] Briefly, methods and approaches for calculating energy returns differ from each other significantly. As a result of this, numbers found for output/input ratio are also different.

The following figure summarizes different approaches about net energy returns:[52]

Figure-2: Energy Return Estimates for Ethanol

[49] A. R. Farrel, J. Plevin, B. T. Turner, A. D. Jones, M. O'hare, and D. M. Kammen, "Ethanol Can Contribute to Energy Environment Goals", *Science*, Vol.311, (27 January 2006), p.506.
[50] H. Shapouri, J. A. Duffield, and M. Wang, *The Energy Balance of Corn Ethanol: An Update*, US Department of Agriculture, Office of Energy Policy and New Uses, Agricultural Economics, Report No. 813, (2002), p.14.
[51] Pimentel and Patzek, p.66.
[52] Farrel et al, p.507.



It is apparent that some of the estimates are very optimistic and exaggerated. Critiques about these studies suggesting that they ignore some major inputs seem correct. On the other hand, pessimistic estimates generally ignore technology improvements in ethanol plants and efficiency increases in corn fields. Arguments about pessimistic studies, i.e. that they use old data in calculations of irrigation effects, neglecting coproducts, etc., also seem convincing. As a final evaluation, we can say with confidence that the energy return of ethanol is positive, but it is not a very stirring number. This makes ethanol a renewable source to some degree, but not a "very efficient" one. Particularly, if we take into account the 1.6:1 ratio ─the factor showing that we need 1.6 liter of ethanol to acquire same energy generated by 1 liter of gasoline ─, ethanol may lose its initial attractiveness.

III.C. GHGs Reduction

Similar disputes about GHGs reduction are prevalent. Differences in scientific approaches have led to confusion over the actual impacts of ethanol on GHGs reduction. One convincing

argument is mentioned by Moller:[53]

> "Although the use of lower ethanol blends leads to lower exhaust emissions of some volatile organic compounds (VOCs) and of carbon monoxide (CO), there are concerns that they lead to higher emissions of nitrogen oxides (NO_x) that also contribute to the formation of ozone. Some studies indicate that the benefits of lower VOCs and CO emissions do not offset the cost of higher levels of NO_x emissions."

Ethanol can contribute to reducing GHGs, but it greatly depends upon agricultural practices. According to Kammen, using ethanol reduces GHG emissions by 18%, but this result is subject to agricultural practices. The type of agricultural practice can affect the final result so much that emissions can increase by 29%.[54] So, we can assume that using ethanol reduces GHGs emissions only if the ethanol raw material is grown by environmentally-friendly methods.

One viable option is to move away from corn in favor of alternative feedstock. Sugar cane may be a relatively good alternative and has been extensively used in Brazil. However, climate conditions for growing sugar cane are not widely available in the U.S. Apparently, production of ethanol from cellulosic biomass promises to be more efficient and to lower GHG emissions.

III.D. Cellulosic Ethanol

As we will touch on later, the recent U.S. national energy policy act plans to double ethanol production from the current 2 percent of transportation fuel by 2012. But the fertilizer, water, natural gas, and electricity that are currently expended in ethanol production will need to be substantially decreased if such a change is to deliver expected environmental benefits. Because of this, much attention has been focused on cellulosic biomass, which can be identified

[53] Rosa Marie Moller, *A Brief on Ethanol, The Debate on Ethanol: Prospects and Challenges to California Producers*, Report for California Research Bureau, (November 2005), p.46. Available at: http://www.library.ca.gov/crb/05/09/05-009.pdf. Last accessed: March 08, 2007.
[54] Daniel M. Kammen, "The Rise of Renewable Energy", *Scientific American*, Vol.295, No.3, (September 2006), p.90.

as residues and wastes from plants not generally used as a food source, and cellulosic ethanol technologies, which use woody plants such as switch-grass and poplar. These technologies are likely to include a shift away from intensely farmed monocultures such as corn and positive effects on soil erosion, fertilizer runoff, and biodiversity.

Because cellulosic technologies can use a wide variety of feedstock, their flexibility may allow for more applications worldwide. Since cellulose-derived ethanol is made from the non-food portions of plants, "it greatly expands the potential scale while reducing competition with food supplies."[55]

Another advantage of cellulose processing is that "it also yields lignin that can be burned to provide energy to run the process and to generate electricity that can be sold."[56] In addition, the calculations for GHGs change substantially when the lignin (an unfermentable part of the organic material) is burned to heat the plant sugars. Kammen states that burning lignin does not add any GHGs to the atmosphere. According to him, the emissions are offset by the CO_2 absorbed during the growth of the plants, which are later used to produce ethanol. He adds that "substituting cellulosic ethanol for gasoline can slash GHG emissions by 90 percent or more."[57]

Because of its advantages briefly indicated above, ethanol derived from cellulosic biomass seems comparatively more appropriate as an alternative fuel.

III.E. Major Roadblocks for Ethanol

The success of the ethanol economy in the U.S. is contingent upon widespread consumer adoption of ethanol as a gasoline alternative. Currently, E85 ethanol makes up less than half of

[55] WI and CAP, p.14.
[56] Lester B. Lave, W. Michael Griffin, and Heather Maclean, "The Ethanol Answer to Carbon Emissions," *Issues in Science and Technology*, Vol.18, Issue:2, (Winter 2001/2002), p.75.
[57] Kammen, p.90.

one percent of the fuel used for transportation in the U.S. The outlook for ethanol is not as strong as some may have predicted.

The major roadblocks for adoption of sethanol include (i) high cost, (ii) lack of infrastructure, and (iii) price fluctuation. These roadblocks will be evaluated briefly below.

(i) Conventional gasoline powered vehicles cannot run on E85, because the ethanol corrodes critical system components that render a car unusable. After-market conversion kits are prohibitively expensive and are illegal in many states because the converted vehicles violate the state emission standards. The alternative is the FFV. However, while FFVs are generally priced similarly to their gasoline counterparts, most FFVs currently being produced are large SUVs and pick-ups that have terrible gas mileage and cost a lot to fill up even with E85.

(ii) Of the estimated 170,000 gasoline stations in the U.S., only about 800 sell E85 to the public and most are located in the Midwest near where E85 is produced. "Most of the E85 retail outlets are in the Midwest (MN, IL, NE, SD, and ND) and over 200 retail outlets in MN alone."[58]

Ethanol cannot be pumped through gasoline pipelines due to ethanol's solubility in water; therefore, it is currently shipped to its destination markets by transport truck, rail, or river barge. The lack of dedicated ethanol pipelines not only increases the final price but also creates supply availability problems. Naturally these factors limit the popularity of E85 outside the Midwest.

It is evident that "before automakers produce vehicles optimized for E85 and before customers would buy them, there would have to be a guarantee that there would be a substantial supply of this fuel universally available."[59] However, the possible costs for new infrastructures seem enormous and are the greatest impediment to transform the existing system into a new one.

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[58] American Petroleum Institute, Other Fuels, "Ethanol Fact Sheet", p.6. Available at : http://new.api.org/aboutoilgas/sectors/segments/upload/Ethanol_Fact_Sheet_Final.pdf. Last accessed: February 27, 2007.

[59] Lester et al, p.77.

(iii) The price of ethanol is constrained because of corn feedstock, which is closely tied to commodity prices for agricultural crops. For example, severe flooding of the Mississippi River in 1993 directly impacted the corn crop in the Mississippi basin, and this flooding resulted in a short-term increase in the regional ethanol fuel price.[60]

In conclusion, while E85 emits less smog-causing pollutants than gasoline, it provides fewer miles per gallon, costs more for the driver, and is hard to find outside the Midwest region. Even with the most optimistic estimates, ethanol on its own will probably never be able to provide Americans with energy independence in contrast to some claims, but it can be a part of a portfolio of choices inluding more efficient vehicles and other sustainable energy sources. The magnitude and timing of this contribution will depend on the development of better methods of producing ethanol than today's corn-based approach.

Although it is evident that ethanol cannot be a sound alternative or a substitute for oil whose supply is at risk, some important provisions about ethanol have been incorporated into the recent energy act. This inclusion deserves significant attention; therefore, we will analyze the recent energy legislation in the next section.

IV. Energy Policy Act (EPACT) of 2005 and Ethanol Subsidies

Nine days after his inauguration, President Bush launched the National Energy Policy Development Group, known as the energy task force, chaired by Dick Cheney. This group issued a report in May 2001, which became the basis for the first draft of the energy bill. The bill envisaged such giant subsidies for big energy industries, especially for the coal industry that it galvanized environmental groups to take action. At the time, Democrats controlled the Senate and

[60] IELE (Institute for Energy, Law & Enterprise), *Economics of the Energy Industries*, University of Houston Law Center, Report for "New Era for Oil, Gas and Power Value Creation" Program, (May 2002), p.27.

Senate Majority Leader Tom Daschle did not let the bill move. But at the beginning of 2003, Republicans took control of both houses of Congress, and three months later, in April 2003, a new version of Cheney's package came onto the agenda.[61] The final version (Domenici Bill) was ready to be voted on by the last week of November, 2003. Although the House passed the bill, enough votes never came in the Senate. This was a quite contentious process and many disputes took place in negatotiations.

In 2005, a new version of the energy bill was opened to discussion. In late July 2005, both the U.S. House and Senate passed the Energy Policy Act of 2005, which includes several important provisions. President George Bush signed this legislation into law on August 8, 2005 and the nearly five-year fight over the energy bill was over. But one question remained: Why did it take so long? The main reason was probably President Bush's past record on environmental issues. By reviewing his record, we may better understand the long and contentious debate over the EPACT. In addition, we may gain some insight into why even green provisions such as ethanol subsidies have not been perceived as genuine steps for mitigating oil addiction.

IV.A. President Bush's Past Environmental Record

To assess George W. Bush's performance on environmental issues while governor of Texas as lackluster would be generous to say the least. During his six-year reign as governor, from 1994 to 2000, Texas dropped to number 49 in spending on the environment.[62] Texas sent the most toxic chemicals and carcinogens into the air, had the highest emissions of CO_2, accounting for at least 10% of the national total, had the most chemical spills and Clean Air Act

[61] Robert F. Kennedy, Jr., *Crimes against Nature: How George W. Bush and His Corporate Pals are Plundering the Country and Hijacking Our Democracy*, New York: Harper-Collins Publishers Inc, (2005), pp.99-101, 143-145.
[62] Louis Dubose, "Running on Empty", *The Nation*, Vol.268, Issue 15, (April 26, 1999), p.14.

violations, and produced the largest volume of hazardous waste under his watch.[63] He protected the state's grandfathered plants, which were polluting much more than any other industries. As can be predicted easily, he was heavily supported by these plants and core energy industries during for the presidency campaign.[64]

When he came to national power, he chose a number of former CEOs for his cabinet, most of them from the energy and extractive sectors. Most of the important staff (members of his first cabinet, White House officials, high-level appointees, etc.) had extensive connections with the major players in the energy industry. Although past experiences of this team did not intrinsically necessiate a threat to the environmental agenda, the first actions achieved by them vindicated those who were profoundly sceptic.

The President's first step was to create the energy task force mentioned above. A few days after he created the energy task force, he went on CNN and blamed environmentalists for the energy crisis in California. California utility officials, however, denied that environmental regulations were responsible for the crisis.[65] In fact, since the crisis, it has been shown that California's energy shock was largely caused by market manipulation and regulatory breakdown, not by environmental regulations.[66]

Bush's next step was to declare a National Energy Policy (N.E.P.) published on May 16, 2001. The policy's defining notion was simple: environmental regulations have constrained America's domestic energy supply. As a matter of fact, this represented the attitude of Bush and his fellows towards the tradeoff between energy production and environmental concerns. Withdrawing from the Kyoto Protocol on global warming was one of the clearest signs of the

[63] Kennedy, p.13.
[64] Dubose, p.14.
[65] Bruce Barcott, "Changing All the Rules", *New York Times*, (April 04, 2004).
[66] "Enron Traders Caught on Tape," CBS Evening News, (June 1, 2004). Available at: http://www.cbsnews.com/stories/2004/06/01/eveningnews/main620626.shtml. Last accessed: May 11, 2007.

new American government's position.

In September 2002, while asserting that "the scientific work on global warming was still unsettled"[67], officials from the administration excluded a section devoted to global warming, which had normally been included in the EPA's annual report on air pollution.[68] With the stated belief that there was not enough scientific certainty to begin taking action to reduce global warming, Bush launched a 10-year, $100 million effort to "learn more about natural causes of climate change."[69] Apparently, his goal was to prove that global temperature changes have occurred naturally.

This and other similar attempts to dispute the scientific consensus on climate change drove the Union of Concerned Scientists, a nonprofit group devoted to the use of sound science in environmental policy, to issue a report in 2004, accusing the Bush administration of suppressing and distorting of research findings. Signed by renowned scientists, including 20 Nobel laureates, the report firmly criticized the Bush administration: "There is significant evidence that the scope and scale of the manipulation, suppression, and misrepresentation of science by the Bush administration are unprecedented."[70]

Bush and his appointed officials who came directly from the energy industry were so eager to relieve fossil fuel industries that they loosened all important clean-air regulations. For example, a series of rule changes effectively eliminated the regulation requiring a power plant's owner to install new pollution-control devices and others like it.

Bush also reversed several executive directives passed in the final days of the Clinton

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[67] Emma Brockes and Julian Borger, "Tiger Trap", *Guardian*, (July 26, 2001).
[68] Jeremy Symons, "How Bush and Co. Obscure the Science?", *Washington Post*, (July 13, 2003).
[69] Associated Press (AP), "New Climate Plan Draws Heat", (24 July 2004), viewed at: http://www.cbsnews.com/stories/2003/06/19/politics/main559380.shtml. Last accessed: March 09, 2007.
[70] Union of Concerned Scientists, *Scientific Integrity in Policymaking: An Investigation into the Bush Administration's Misuse of Science*, Cambridge: MA, (March 2004), p.4. Available at: http://www.ucsusa.org/assets/documents/scientific_integrity/RSI_final_fullreport_1.pdf

administration, which aimed to protect 58 million acres of federal land by restricting logging and road building; cancelled a looming deadline for automakers to develop prototypes for high-mileage cars; rolled back safeguards for storing nuclear waste; blocked a program to stem the discharge of raw sewage into America's waters; and reversed Clinton's decrees on clean-air standards for buses and big trucks.[71]

IV.B. Analysis of Some Provisions: Indicators of Intent

At first sight, the EPACT of 2005 seems a very promising law since it involves energy saving incentives for buildings, authorizes loan guarantees for innovative technologies that avoid GHGs, provides subsidies for wind energy and other alternative energy producers, provides tax breaks for those making energy conservation improvements to their homes, etc. However, meticulous eyes can see other provisions providing enormous subsidies to conventional energy industries. For example, according to Public Citizen, subsidies provided for oil and gas is $6 billion, for coal is $9 billion, for nuclear is $12 billion.[72]

Of the many provisions included in the Act, we will give two examples associated with oil-dependency issues and greening efforts. In this context, we will shortly touch on the tax credit of up to $3,400 for owners of hybrid vehicles and oil subsidies.

According to the Act, individuals and businesses that buy or lease a new hybrid gas-electric car or truck are eligible for, and can receive, an income tax credit of $250-$3,400– depending on the fuel economy and the weight of the vehicle. Hybrid vehicles that use less gasoline than the average vehicle of similar weight and that meet an emissions standard qualify

[71] Noreena Hertz, *The Silent Takeover: Global Capitalism and Death of Democracy*. New York: HarperCollins Publishers Inc, (2003), pp.111-112.

[72] Public Citizen "The Best Energy Bill Corporations Could Buy: Summary of Industry Giveaways in the 2005 Energy Bill", Energy Program. Available at: http://www.citizen.org/cmep/energy_enviro_nuclear/electricity/energybill/2005/articles.cfm?ID=13980. Last accessed: March 10, 2007.

for the credit. There is a similar credit for alternative-fuel vehicles and fuel-cell vehicles.[73]

The tax credit for hybrid vehicles can be seen as a good initial step for reducing oil dependency. However, it is a temporary and limited incentive. More importantly, it does not promote hybrid vehicles so much as to make them a serious alternative to oil-dominated transportation. A comprehensive analysis of the related provisions of the law reveals that tax credit rates will soon decrease. IRS provides detailed information about this:[74]

> "Since taxpayers may claim the full amount of the allowable credit only up to the end of the first calendar quarter after the quarter in which the manufacturer records its sale of the 60,000th hybrid and/or advanced lean-burn technology motor vehicle, consumers seeking the credit may want to buy early in the year. The phase-out period for a manufacturer begins with the second calendar quarter after the calendar quarter in which the manufacturer records its 60,000th sale. For the second and third calendar quarters after the quarter in which the 60,000th vehicle is sold, taxpayers may claim 50 percent of the credit. For the fourth and fifth calendar quarters, taxpayers may claim 25 percent of the credit. For quarters after that fifth quarter, taxpayers may not claim the credit."

The more important problem than the decreasing rate of incentives is the number of vehicle owners that can benefit from this incentive. In total, 300,000 vehicle owners can benefit from tax allowances during five years. At first sight it may look like a great number, but when we recall that the total number of vehicles is around 250 million in the U.S., we see that this is just a symbolic incentive. Moreover, by taking into account relatively high prices of hybrid vehicles, one can assert that these incentives will not be able to compensate the price difference between hybrids and conventional vehicles, especially after the third year.

As can be seen from this brief analysis, even in the most noteworthy scheme for clean transportation technologies there is not a promising benefit. In other words, these kind of provisions, which are supposedly in favor of oil-free policies, seem to being incorporated into the

[73] DOE (Department of Energy), The Energy Policy Act of 2005, "What the Energy Bill Means to You". Available at: http://www.energy.gov/taxbreaks.htm. Last accessed: March 08, 2007.
[74] IRS (International Revenue Service). Highlights of the Energy Policy Act of 2005 for Individuals. "Credit for Taxpayers Who Purchase or Lease Hybrid Vehicles or Other Alternative Motor Vehicles". Available at: http://www.irs.gov/newsroom/article/0,,id=153397,00.html. Last accessed: March 10, 2007.

Act just to relieve sensitive people. Another possibility is that they were designed to divert attention of the public away from bulky oil and nuclear power subsidies. Without this and similar gimmick clean subsidies, authorizing $2 billion direct support and various tax breaks for nuclear facilities would not have been so easy. The nuclear industry got subsidies for research, waste reprocessing, construction, operation and even decommission.

The Act exempts oil and gas industries from some clean-water laws, and streamlines permits for oil wells. But more interestingly, the petroleum industry got new incentives to drill in the Gulf of Mexico ─as if $60-a-barrel oil wasn't enough of an incentive. As everybody knows oil industry is one of the mature industries in the U.S, just like nuclear power industry. Both industries do not need any more incentives.

Provisions to subsidize major energy industries were included into the law whereas some important regulations, which were in the original bill, were excluded. Some of these discussed regulations are to increase vehicle efficiency standards by 1 mile per gallon for 5 years in a row, to require increased reliance on non-greenhouse gas-emitting energy sources similar to the Kyoto Protocol, to reduce U.S. oil consumption by 1 million barrels of oil per day by 2015.

IV.C. Evaluation of Ethanol Subsidies

The EPACT of 2005;

(i) Requires that Federal Fleet vehicles capable of operating on alternative fuels be operated on these fuels exclusively,

ii) Increases the amount of biofuels (usually ethanol) that must be mixed with gasoline sold in the United States to triple the current requirement (7.5 billion gallons by 2012),

(iii) Provides gasoline refiners and marketers blending ethanol into gasoline with a tax credit of 51 cents per gallon, and 10 cent per gallon tax credit to small agri-biodiesel producers,

(iv) Provides 30% tax credit for gas station owners who want to install alternative fuels infrastructure up to a maximum of $30,000.

In the future, the first provision will probably have no significant impact on consumption of alternative fuels when the consumption reaches a certain level. Currently, however, it has a significant impact. After the enactment of the bill, its unintended effects have emerged in the form of shortages of E85 in many parts of the country. The Act requires U.S. Federal Fleet FFVs to operate on alternative fuels 100% of the time. Formerly, such FFVs were required to be operated by the end of 2005 on alternative fuels only 51% (i.e., the majority of the time). This effectively means that the U.S. Government's use of E85 has doubled, with the unintended consequences of limiting public availability of E85 and increasing its price. Increased public sector consumption of E85 was also partially responsible for the increase in corn prices, which rose to $3.05 per bushel in January 2007[75], compared to $2.00 to $2.06 per bushel for the previous two market years.

The second provision mandates up to 7.5 billion gallons of "renewable fuel" to be used in gasoline by 2012. Related articles establish a Renewable Fuels Standard (RFS) that will double America's demand for ethanol by 2012. Projected consumption amounts can be seen below.

Table-3: Renewable Fuel Consumption

[75] US Department of Agriculture, National Agricultural Statistics Service (NASS), "Agricultural Prices", (February 28, 2007), p.15. Available at: http://usda.mannlib.cornell.edu/usda/current/AgriPric/AgriPric-02-28-2007.pdf. Last accessed: March 10, 2007.

Year	Renewable Fuels (billions of gallons)
2006	4.0
2007	4.7
2008	5.4
2009	6.1
2010	6.8
2011	7.4
2012	7.5

This provision also provides that a minimum of 250 million gallons of cellulosic derived ethanol will be included in the RFS by beginning in 2013. Despite its promising content, late beginning period of incentives for cellulosic ethanol can be perceived as a flaw. As we mentioned earlier, cellulosic ethanol is comparatively more appropriate and sustainable choice than ethanol derived from corn. If ethanol is considered as a serious complementary fuel to the oil, first of all the cellulosic ethanol would have to be subsidized.

The third provision may be the best one amongst the others. This credit will benefit small agri-biodiesel producers by giving them a 10 cent per gallon tax credit for up to 15 million gallons of agri-biodiesel produced. In addition, the limit on production capacity for small ethanol producers increased from 30 million to 60 million gallons. It not only encourages small farmers to deal with ethanol production, but also stimulates distribution networks by giving a 51 cents tax credit per gallon of ethanol used as motor fuel.

The fourth provision may be well-intended, but provides insufficient incentives. In this provision, fueling stations are eligible to claim a 30% credit for the cost of installing clean-fuel vehicle refueling equipment, e.g. E85 ethanol pumping stations. Under the provision, a clean fuel is any fuel that consists of at least 85% ethanol, natural gas, compressed natural gas (CNG), liquefied natural gas (LNG), liquefied petroleum gas (LPG), or hydrogen and any mixture of diesel fuel and biodiesel containing at least 20% biodiesel. This is effective through the end of

2010. One has to notice that this tax credit is not dedicated to promote only renewable alternative fuels, rather it includes fossil fuels such as CNG, LNG, and LPG.

While assessing this provision we can argue that amount of tax incentive is insufficient despite the reasonable end date for tax incentive. American Petroleum Institute estimates it will cost gas stations up to $200,000 to install pumps and tanks for E85.[76] Under these circumstances, many small gas station owners may be reluctant to install new pumps. Hence, it is still ambiguous whether this provison will help alternative fossil fuels such as LPG and CNG more or not.

The second and third provisions are direct and first and fourth provisions are indirect subsidies for ethanol. As we discussed earlier, subsidizing ethanol production based on corn growing is the least sustainable way among alternatives. Nearly four months before the enactment of that legislation, Pimentel and Patzek were warning about the cost of ethanol:

"If the production costs of producing a liter of ethanol were added to the tax subsidies, then the total cost for a liter of ethanol would be $1.24. Because of the relatively low energy content of ethanol, 1.6 l of ethanol has the energy equivalent of 1 l of gasoline. Thus, the cost of producing an equivalent amount of ethanol to equal a liter of gasoline is $1.88 ($7.12 per gallon of gasoline), while the current cost of producing a liter of gasoline is 33c."[77]

As a result of new legislation, the level of subsidies has increased considerably. State and agricultural subsidies as well as the EPACT of 2005 support the corn and ethanol industry. But some claim that ethanol production yields negligible benefits for farmers, rather, the farmer's profits are minimal. According to them, several big corporations are making huge profits from ethanol production. For example, Senator McCain, while criticizing draft energy bill, said in his

[76] American Petroleum Institute, Other Fuels, "Is E-85 a Viable Fuel With the Current Fuel Infrastructure and the Current Vehicle Fleet?", p.3. Available at : http://new.api.org/aboutoilgas/sectors/segments/upload/E_85_6_14_06.pdf. Last accessed: February 27, 2007.
[77] Pimentel and Patzek, p.68.

press release "it is now a very big business -tens of billions of dollars that have enriched a handful of corporate interests- primarily one big corporation, ADM. Ethanol does nothing to reduce fuel consumption, nothing to increase our energy independence, nothing to improve air quality."[78]

One of the environmentalists, Robert F. Kennedy, Jr., who participated in legislation process as the representative of National Resources Defense Center (NRDC), explains in a different way why ethanol subsidies were given. According to him, there was a strong resistance among senators, who believed that this bill was aiming to establish oil and gas development as the dominant use of federal lands, to subsidize the building of more nuclear power plants, and to exempt polluters from core provisions of America's clean air and water laws.[79] To break the resistance, according to him, some subsidies were provided: "Among the biggest subsidies were multi-bilion dollar packages for ethanol manufacturers, include to lure support from farm-state Democrats. The tactic prompted a series of demoralizing defections by Midwestern Democrats, including our former champion, Tam Daschle. Daschle had long promoted ethanol as a salve for South Dakota's economic woes. He was in a very tight race, and his in-state political advisers told him that if he didn't support the energy bill with its ethanol provisions, he was politically dead."[80]

Kennedy's claim makes perfect sense when it is considered together with two issues: (i) the EPACT's provisons concerning with coal, oil, and nuclear industries, and (ii) past environmental records of President Bush and his team.

[78] Senator John McCain, "Statement of Senator McCain on the Energy Bill", Press Release, (November 21, 2003). Available at: http://mccain.senate.gov/press_office/view_article.cfm?id=274
[79] Kennedy, pp.146-7.
[80] Ibid, p.148.

Briefly, the EPACT of 2005 did not aim to respond the needs of a sustainable energy policy. Its related parts to the transportation are unlikely to improve efficient energy use and contribute to reduce oil dependency. Although some provisions seem useful, they are mainly a yield of bribing policies to supporters of the law. Some Democrat senators were convinced to say "yes" to this bill by offered lucrative projects in their home districts. It was a so disputable process that Wall Street Journal condemned Republican senators for engaging in "months of plotting to buy enough votes with some $95 billion in tax breaks and pork-barrel spending."[81] Therefore, few provisions, which can be considered as a part of sustainable strategy, are in fact a coloring mechanism to hide the great victory of the core energy industry.

Conclusion

According to a broad range of estimates, the projected date for peak oil is not far away, and oil reserves may very quickly be running out. Moreover, rising instability in the world's major oil supplying region is likely to keep oil prices high and increasing. Since a considerable amount of oil is used for transportation purposes, this is the sector in which urgent measures must be taken if global energy security is to be assured.

Ethanol is widely considered to be the primary alternative to oil and has been significantly subsidized by the EPACT of 2005. However, as this study has shown, the ongoing debate about whether ethanol is a sustainable, efficient, and clean fuel, is far from over. Even if ethanol is assumed to be technologically viable and environmentally preferable, the structural changes mandated by the EPACT of 2005 fall dramatically short of those that would be required to make ethanol economically competitive.

[81] Wall Street Journal, "The Price of Governance", (November 24, 2004), p.sA14.

In order to protect the environment while ensuring the stability of the global energy supply, more than a forced shift to ethanol will be required. In fact, a fundamental paradigm shift is needed in order to maintain sustainability and ensure energy security. In the case of the U.S., this means a transition from heavy fossil fuel consumption to a concerted regimen of energy efficiency, and the development of new clean technologies. In this transition, the role of government can neither be ignored, nor overstated. Over the long haul, the public sector will be a pivotal player in encouraging consumers to make choices that fulfill their wants and needs today, without depriving posterity of their right to do same.