

Smell of Gigantic Hoax in Government Ethanol Promotion

by Laurence Hecht

The warning signs of a gigantic hoax in the promotion of ethanol as a substitute for gasoline came into sharp focus in mid-January, as *EIR* stepped up investigations of the claims by government agencies to the efficiency of biofuels. The evidence is not yet conclusive, but sufficiently suggestive to warrant prompt Congressional investigation into what might be one of the greatest and most costly hoaxes perpetrated by the Cheney-Bush Administration since the selling of the Iraq War.

The leading beneficiaries of this false promotion are the major grain cartels, the large hedge fund operators, who have moved in on the boondoggle, and at a higher level, those policy interests who would take us back to an agricultural society on the imperial model. The big losers will be the American public, including those farmers and farm-state businessmen who have been suckered into one of the greatest investment swindles since John Law's Mississippi land bubble.

The entry point for uncovering this hoax were the claims by officers of the U.S. Departments of Agriculture (USDA) and Energy (DOE) that production of ethanol from corn shows a positive net energy balance of 30,528 Btu per gallon,¹ or 67% more than the energy required to grow, transport, and distill it, and that cellulosic ethanol (derived from switchgrass or other inputs) could provide even higher net energy returns. But deeper investigation showed that while some independent analyses, most of them of recent vintage, show a slight positive energy balance, the figures promoted by government agencies—the USDA Office of the Chief Economist, in particular—appear wildly inflated. A huge energy giveback credit is allocated for the byproducts of ethanol production, the data appear selectively chosen to make the case, and the claims have been inflating over the years.

1. Hosein Shapouri, U.S. Department of Agriculture, Office of the Chief Economist; James Duffield, USDA/OCE; Andrew McAloon, USDA/Agricultural Research Service; and Michael Wang, U.S. Department of Energy Center for Transportation Research, Energy Systems Division, Argonne, National Laboratory, "The 2001 Net Energy Balance of Corn-Ethanol," (2004).

If, as the preliminary evidence suggests, the bottom line has been goosed up to make the case, the source of such probable corruption is not far to find. As one Federal official with experience in energy and pollution was quoted in the January 2007 *Scientific American*, referring to the 51-cent-per gallon tax break for ethanol, "Congress didn't do a life-cycle analysis; it did an ADM analysis." ADM is Archer Daniels Midland, the largest of the five grain cartel giants, which has been pushing corn ethanol for more than two decades, and whose influence over the USDA is no secret.

The hoax, however, goes much deeper than the debatable claims for a positive net energy balance for ethanol production. No competent evaluation of the efficacy of biofuels can be carried out apart from a consideration of the overall thermodynamic efficiency of the national economy. On this matter, deliberations by Congress and government agencies have been either non-existent or grossly lacking in competence. An observer from another Solar System, looking down on the past decades' transformations in industrial and land-use patterns of the United States, might well conclude that its inhabitants had been inhaling an excess of the vapors of that substance which the intelligent aliens would have identified in their molecular rotation spectroscopes as C_2H_5OH , or ethanol.

The expansion of the biofuels boondoggle to *cellulosics*, which is expected to be a leading feature of the President's 2007 State of the Union message, is now about to push us one step deeper into the "red ink" of negative net product of physical economic output. This latest bio-foolery has the added feature of driving us backward in time, toward that condition of agricultural and raw materials-based production which the American Revolution was intended to redress. We must warn the reader who would wish to simplify the issue, that the usual accountant's measures of net profitability have nothing to do with a competent analysis of the subject.

The outstanding weakness among the better-intentioned dupes of the biofuels mania has been an over-readiness to accept the narrowly defined premises of a problem, which, by its nature, cannot be solved without going beyond those self-imposed boundaries. For example, the ethanol question addresses a very limited part of the overall efficiency of our



USDA/Keith Weller

In a scene straight out of an H.G. Wells film, a microbiologist and technician add starter microorganisms to pilot-plant-size bioreactors in which ethanol is brewed from sugar mixtures derived from corn fiber. "The vision is of ethanol stills dotting the rural land area, drawing on the labor of hardworking peasants in a production radius of 25-30 miles for corn stover, and up to 60 miles for plants using switchgrass as a feedstock."

national economy—the production of a fuel for motor vehicle transportation. In a modern, nuclear energy-based economy, the best candidates for a portable motor vehicle fuel are electricity and hydrogen: the one to recharge the batteries of plug-in electric or hybrid electric-powered vehicles; the other to power fuel cells, or to feed the combustion chambers of high-temperature ceramic turbines capable of burning hydrogen at efficiencies twice or greater than that we can achieve with the best gasoline engines. As an interim measure, synthetically produced liquid hydrocarbons, including ethanol and methanol, may be generated by combining the nuclear-generated hydrogen (from electrolysis or catalytic cracking of water) with carbon from coal and other sources, even including a small amount of agricultural waste.

The cheapness and overall efficiency of the nuclear fuel cycle, not the energy input-output balance of the fuel produced, dictates the suitable replacement fuel for the gasoline which, by any calculation, will be in shortening supply over the next century. From a strictly thermodynamic standpoint, the energy cost of any synthetically produced fuel is always greater than the return. That goes for all the electricity that has been generated in the past hundred years, as well as for the nuclear-generated hydrogen which will make up an important part of our future fuel mix. The efficiency of electricity, which was the most important component of the advance of physical economic productivity in the 20th Century, lay in the new *qualities* of productive capability which it brought to farm, factory, and home. That paradox should help the reader to see the necessity of redefining the meaning of thermodynamic

efficiency in physical economic rather than purely mechanical terms.

Food and Scientific Principle

As a first step, let us view this matter from a standpoint often emphasized by physical economist Lyndon LaRouche, making use of the terminology of the great Ukrainian-Russian founder of biogeochemistry, Vladimir Vernadsky (1863-1945). Let us conceive the universe in which we live as consisting of three great domains: the non-living, encompassing all that which the chemist sometimes refers to as the inorganic; the living matter, including all life and its products (the Biosphere); and finally, that unique domain, relatively new on the scale of geologic time, of the products, both material and spiritual, of the human mind (the Nöosphere). Further, let us try to keep in our mind, a moving process conception of the interaction of these domains over time, from the period of the Earth's history when life existed as an unexpressed potentiality, to the development and rapid spreading of life over the whole envelope of the Biosphere, taking over the inorganic domain for its own purposes, to the emergence of the third and now dominating domain, cognitive humanity.

The negative energy balance findings for production of ethanol from corn are consistent with fundamental principles of science and physical economy, proceeding from this standpoint. For such principled reasons, even if ethanol, or some other biofuel, could be shown to exhibit a positive net energy balance from a strictly thermodynamic standpoint, it would

be foolhardy to convert large portions of our agricultural economy to biofuel production, as the interested beneficiaries of this great hoax propose. Much of the confusion on this matter stems from a failure to understand the fundamental distinction between *energy* and *power* (not *power* as defined in mechanics, as work divided by time, but in the Classical sense of transformative ability: *dynamis*).

The concept of energy, as used in thermodynamics, is based on the mechanical theory of heat, the presumption that a given quantity of heat may be equated to a definite quantity of motion. Its usefulness lies in the fact that the work of all types of machines—mechanical, electrical, chemical, and heat engines—may be compared. Thermodynamics fails, however, when it comes to evaluating systems of human or natural economy. Power, in the Classical sense of the term, such as that invoked by Plato in the *Theaetetus* dialogue, means something quite different. For example, which is more powerful: an atomic bomb, or the human mind? Which, or who, created which?

In evaluating so-called biofuels, it is thus necessary to distinguish between energy and *power*. The useful *power* contained in a kernel of corn is not to be measured by the number of kilocalories or Btu's of heat that can be generated by burning either the whole kernel, or its less-energetic ethanol derivative. Thus, we come to a second paradox: In terms of raw heat energy, there is several million times more available energy in a gram of slightly enriched uranium than in a kernel of corn. Yet the corn kernel contains more *power*, because it represents a far higher degree of organization of matter. Its power to support human or animal metabolism is not only greater, but immeasurably so. (Just imagine eating one or the other, and the point may be grasped immediately.)

Such a view helps us to fix our feet more firmly on the ground, that we may more readily grasp some basic principles which, until a few decades ago, were the common intellectual property of most of our fellow citizens: 1) The purpose of agricultural land, and its accompanying infrastructure, is to produce food. The living matter associated with the chlorophyll in the green part of plants permits the conversion of the extremely low-intensity energy flux of the Sun into this substance we cannot live without. The maintenance and improvement of this land area, its proper supply with water, power, transportation, and all the products of human invention, permit us to use this finite surface area to feed a human population of approximately 6.5 billion. 2) Modern industrial processes require the application of power at high levels of energy flux density, in such forms as electricity, light, and process heat. For the supply of this input, we turn to nonliving processes, particularly to the atomic and subatomic regions. Here, by harnessing the work of millions of particles of extremely low mass and high velocity (or, alternatively of tiny wave packets of extremely high frequency), we are able to produce work in the form of heat,

or directly as electricity, at densities millions of times greater than the received Solar energy.

The Cellulosic Fantasy

Domestic ethanol production jumped 50% in 2006 to approximately 5 billion gallons. Nonetheless, this made up less than 4% of the 140 billion gallons of gasoline consumed. Almost all of that ethanol came from corn. Already, at that level of production, the pressure is being felt on the price and supply of corn, which makes up a major part of poultry and livestock feed. In a world in which nearly 4 billion people are malnourished, the conversion of corn and cereal grain production capability to production of alcohol for burning in cars is thus clearly both immoral and insane. The amount of agricultural land is finite. According to a calculation by University of Connecticut emeritus physics professor Howard Hayden, replacing the entire U.S. motor vehicle fuel consumption with corn ethanol would require 51% of the land area of the United States.

The latest fantasy among the bio-fools, and the just plain fooled, is that cellulosic ethanol—ethanol distilled from non-food crops, such as switchgrass or southern pine, or from waste paper—can fill the gap. Detailed studies of such subjects as the collocation of corn ethanol and cellulosic feedstock production have been produced by the USDA and DOE.² In one study, the optimum collection distance for production of ethanol from corn stover and from switchgrass are compared.³ The vision is of ethanol stills dotting the rural land area, drawing on the labor of hardworking peasants in a production radius of 25-30 miles for corn stover, and up to 60 miles for plants using switchgrass as a feedstock. It is the primitive agricultural dream world of John Ruskin and his pre-Raphaelites. To see more clearly why it can only bring us closer to economic destruction, let us step back and take a quick overview of the production of ethanol from a biochemical standpoint.

Ethanol, or ethyl alcohol, the same substance found in beer, wine, and spirits, is produced by the fermentation of simple sugars under the action of tiny yeast organisms. In the production of wine or apple cider, the fruit sugars are acted

2. Robert Wallace, Kelly Ibsen (National Renewable Energy Laboratory, National Bioenergy Center); Andrew McAloon, Winnie Yee (U.S. Department of Agriculture, Eastern Regional Research Center Agricultural Research Service), "Feasibility Study for Co-Locating and Integrating Ethanol Production Plants from Corn Starch and Lignocellulosic Feedstocks," A Joint Study Sponsored by: U.S. Department of Agriculture and U.S. Department of Energy, NREL/TP-510-37092, USDA-ARS 1935-41000-055-00D (revised January 2005).

3. Robert Wooley, Mark Ruth, John Sheehan, Kelly Ibsen (National Renewable Energy Laboratory); Henry Majdeski, Adrian Galvez (Delta-T Corporation), "Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis Current and Futuristic Scenarios," NREL/TP-580-26157 (July 1999).

on by yeasts found in the air or introduced by the vintner. To ferment corn or grain requires first breaking down the vegetable starch, known as amylose, which makes up most of the nutritional value of the grains, into the simple sugars of which they are composed. A starch is a type of complex molecule known as a polymer, a straight or partially branched chain of sugar molecules numbering in the hundreds or even thousands. In the human digestive system, the starch contained in cereal grains and other foods is acted on by two slightly different enzymes, generically known as amylase, present in the saliva and in intestinal fluids. By acting on the chemical bonds which join the molecules of the starch together, the enzymes break the polymer down into its simpler component sugars, which can then be metabolized. Amylase, first purified from malt in 1835 by Anselme Payen and Jean Persoz, has long been used in the industrial fermentation of grains. The two types of amylase employed in producing ethanol from corn add about 4 to 5 cents per gallon to the cost.

Cellulose, which makes up most of the fibrous, structural part of plants and trees, is very similar in its components to starch, and shares the same empirical formula, $(C_6H_{10}O_5)_n$. Cellulose is the most abundant organic compound in the biosphere, containing more than half of all the organic carbon. But breaking down the cellulose into its component sugars, which can then be fermented into ethanol, is not such an easy matter. Only a few mammals, the ruminants and the beavers among them, can digest cellulose, and they do so not by their own devices, but by hosting bacteria which can do the digesting. In nature, the job of breaking down the great mass of cellulose fiber so the carbon within it may be reused, is given to certain bacteria, and especially to fungi.

Like starch, cellulose is classified as a polysaccharide, meaning a collection of many simple sugars. However, it is put together quite differently. The structural units are two linked sugars and they link together in chains of hundreds of sugars. Links between the hydrogen atoms of separate chains give the cellulose structure a crystal-like quality. Thousands of polymer strands might be put together in this way. To compound the problem of getting at the sugars, the cellulose is wrapped in a sheath of hemicellulose, another polysaccharide, and lignin. The hemicellulose is a bit easier to break down but more difficult to ferment than the cellulose. All in all, the cellulose is doing the job nature intended it for: to keep plants standing rigidly and resistant to outside attack. It is worth considering that, pound for pound, wood is stronger than steel as a structural member. Its strength comes from the ingeniously designed cellulose/lignin structure. Organic molecules are built around the incredible versatility of tetrahedrally bonding carbon atoms in joining up, in chains, rings, spirals, and the more complex topologies of living structures. What life builds up, man's ingenuity can break down. But at what cost, and for what good purpose?

Corn ethanol gets by with its 51-cents-per-gallon Federal

subsidy. To qualify cellulosic ethanol production for this level of welfare subsidy, still requires solving a lot of problems. Heat and acid pre-treatment are required to remove the lignin from the cellulose. Once freed, the cellulose must then be treated with strong acid and higher temperatures. The dream of the cellulosic ethanol proponents is that new ways of producing cellulase enzymes might be developed. So far, it remains only a dream. Several years ago, the DOE's National Renewable Energy Laboratory subcontracted the two largest enzyme companies to try to bring down the cost of producing cellulase. In the first phase, a cost reduction of about 10- to 12-fold was achieved. But this left the price of the enzyme, optimistically calculated, in the range of 30 to 40 cents per gallon. The goal has been to bring that price down to 10 cents or less; but that has proved much more difficult. According to Matthew Wald, writing in the January 2007 *Scientific American*, "at a seminar at the House of Representatives last September, companies complained that they could not convince a design firm to guarantee to a bank that the finished [cellulosic] plant would work."

Leading candidates for the feedstock of choice in cellulosic ethanol production include switchgrass (the native species of the North American tall grass prairies), Miscanthus, a tall grass of Asian origin which has gone through many trials in Europe, and fast-growing trees, such as the southern pine. Proponents argue that these species will not compete with food crops, as corn ethanol does. However, the land, infrastructure, and labor requirements for growing and harvesting don't go away. On the R-Squared Energy blog, Robert Rapier, who studied cellulosic ethanol production at Texas A&M University, calculates that a mid-sized cellulosic ethanol facility of 50 million gallons-per-year capacity would require 860,585 Douglas firs *per year* to stay in operation. At the best possible yields of switchgrass, he calculates that the replacement of 50% of our current annual gasoline consumption, would require 13% of the land area of the United States. This is assuming that a cellulosic ethanol production plant could ever be made remotely efficient. His figure is in the same general ballpark as the one cited earlier in the article for corn ethanol. But such quantities of arable and accessible land are simply not available.

The Net Energy Debate

For more than 25 years, competent scientific studies had shown that, when all the inputs were taken into account, it takes considerably more energy to produce a gallon of ethanol than can be derived from it. In 1980 and 1981, two panel studies by the U.S. DOE reported a negative energy return from corn ethanol production.⁴ These reports were reviewed

4. Gasohol: Report of the Energy Research Advisory Board, U.S. Department of Energy, Washington, D.C., 1980; Biomass Energy: Report of the Energy Research Advisory Board Panel on Biomass, November 1981.

How the USDA Gooses Its Data

Production Process	Without Give-Back	With Give-Back
(Btu per Gallon)		
Corn production	18,713	12,350
Corn transport	2,120	1,399
Ethanol conversion	49,733	30,586
Ethanol distribution	1,487	1,467
Total energy used	72,052	45,802
Net energy value	4,278	30,528
Energy ratio	1.06	1.67

Note: Figures are weighted average of dry and wet milling process. Energy value of ethanol is taken as 76,330 Btu per gallon.

Source: Hosein Shapouri, James Duffield, and Andrew McAloon (USDA); Michael Wang (DOE), "The 2001 Net Energy Balance of Corn Ethanol" (2004).

Energy use and net energy value per gallon of corn ethanol, before and after "coproduct energy credit" give-back.

by 26 independent scientific experts. The findings that the net energy balance from conversion of corn into ethanol was negative, were unanimously approved. Numerous investigations in the intervening decades have confirmed those results. In the most extensive study carried out recently by Dr. David Pimentel of Cornell University's College of Agriculture and Life Sciences, corn ethanol showed a negative net energy balance of -29%.⁵

However, according to Hosein Shapouri, the leading economist promoting ethanol at the USDA, those earlier studies "are useless, because we didn't know how to make ethanol then." It took 100,000 Btu's per gallon just to process it in the inefficient plants of that time, Shapouri recently told *EIR*.

But, Shapouri's leading opponents in the great debate over net energy balance, Pimentel and Prof. Tad Patzek of Berkeley's Department of Environmental Engineering, do not use the 1981 figures. When their estimates for the steam and electricity required to distill ethanol from corn are converted into units of Btu per gallon,⁶ their figure comes to 53,431. Shapouri gives a figure for the energy consumed in ethanol conversion of 52,349 for wet milling and 47,116 for the dry milling process, yielding a weighted average of

49,733 Btu per gallon. The difference is hardly enough to account for the enormous discrepancy between -29% and +67% in their respective estimates of the net energy balance. Pimentel and Patzek add in other small inputs, including the energy cost of the steel, stainless steel, and cement contained in the plant, which Shapouri has not used, and a small energy cost for treating sewage effluent. But Shapouri factors in a figure of 1,487 Btu per gallon for ethanol distribution. After all is said and done, Pimentel and Patzek have 56,436, and Shapouri 51,220 Btu per gallon for the energy cost attributable to the refining end of ethanol production. Again, the difference is minor.

A much larger discrepancy occurs respecting the energy cost attributed to corn production. Shapouri gives 18,713, while Pimentel and Patzek's data, after conversion of units, yields 37,884 Btu per gallon, more than double Shapouri's figure. The difference is 19,171 Btu, or 26.6% of the 72,052 Btu per gallon total energy needed for corn ethanol production, as calculated by Shapouri. Shapouri claims that his data are the best available from years of USDA calculations, and that Pimentel is not knowledgeable on many aspects of agricultural production. Pimentel is an entomologist, an insect specialist, Shapouri notes. But Pimentel says that Shapouri has shopped his data. He has taken the corn yields from the best-producing states, and looked for the lowest-value data for such items as the application rate of various fertilizers. Pimentel also says that Shapouri has omitted assigning an energy value for the farm labor. Shapouri concedes that point, but says that he sees no reasonable way to assign such a cost.

One of the largest energy inputs to corn growing is in the production of nitrogen fertilizer. Almost all nitrogen in fertilizer is derived from ammonia produced by the Haber-Bosch process which takes nitrogen from the atmosphere, using natural gas as a source for hydrogen and heat. Pimentel assigned a value of 11,452 Btu per gallon for the heat energy contained in the nitrogen fertilizer used for corn ethanol production in 2003; he may have lowered the estimate somewhat in subsequent years. Shapouri's figure from 2002 is 7,344 Btu per gallon. The difference of 4,108 accounts for 22% of the 18,713 Btu per gallon total energy cost which Shapouri assigns to corn production. Asked to explain his much lower figure, Shapouri says that the energy cost for nitrogen fertilizer has dropped considerably in recent years, owing in large part to the closing down of older, inefficient plants in the United States. Shapouri says that much of the ammonia and other nitrogen compounds are now imported from newer plants in such locations as Trinidad and Tobago, where natural gas is cheap. Patzek reports that improvements in the production process have reduced the energy cost of ammonia by about one-third over the past 60 years, but the figure Patzek gives (in 2004) for the specific energy consumption of nitrogen fertilizer is still about 26% higher

5. David Pimentel and Tad W. Patzek, "Ethanol Production Using Corn, Switchgrass, and Wood; Biodiesel Production Using Soybean and Sunflower," *Natural Resources Research*, March 2005.

6. A British Thermal Unit (Btu) is the quantity of heat required to raise the temperature of 1 pound of water by 1°F when the water is at its temperature of maximum density (39.1°F). A kilocalorie, the unit used in Pimentel's studies, is the quantity of heat required to raise the temperature of 1 kilogram of water by 1°C, at a temperature of 15°C. There are 3.97 kilocalories (the unit used to measure nutritional value of food, also known as the Calorie) in 1 Btu.

than that of Shapouri et al. in 2002. Shapouri also uses a somewhat lower figure than other authors for the application rate per hectare of the nitrogen.

The Great Give-Back

The really suspect part of the combined USDA and DOE analysis of the ethanol energy cost is yet to come, however. Even after all the differences noted so far, Shapouri's analysis results in what he calls an *energy ratio* of 1.06, that is a +6% net energy balance. How does that become +67%?

One part of the answer is to be found in an accounting program, technically known as a process simulation program, called ASPEN Plus. It was adapted by a USDA employee by the name of Andrew McAloon to apply to the corn ethanol calculation, according to Shapouri. The gist of the adjustment lies in what Shapouri et al. call the *coproduct energy credits*. There are certain byproducts of the ethanol production process, principally a substance known as distillers dried grains (DDG), and smaller quantities of corn gluten feed (CGF), and corn gluten meal (CGM). The DDG byproducts have some value in preparation of animal feeds for ruminants, although they are of limited value for feeding hogs and chickens, according to Pimentel and Patzek. In any case, their preparation by other means, if they had been produced, would have taken a certain amount of energy. The argument is, thus, that an energy credit should be assigned them.

Patzek believes their energy value is zero or less, because the costs of their production, including restoration of the soil, are greater than they are worth. Soybeans, which require no nitrogen fertilizer, make a much more effective animal feed, he points out. Pimentel has generously assigned an energy credit of 6,684 Btu per gallon to the DDG byproduct.

However, Shapouri et al., by means of ASPEN Plus, have given to the byproducts an energy credit of 19,167 Btu per gallon, or 26.6% of the total energy they had calculated for the entire ethanol production cycle!

But that's not all. Another 7,084 Btu per gallon of coproduct energy credit is allocated to the corn production and transport process. The argument is that ethanol is derived from the starchy part of the corn, and corn consists of only 66% starch by weight. Therefore, only 66% of the energy cost of corn production and of corn transport should be assigned to ethanol production. It would be as if a refiner of ore with a 5% useful metal content were to say that 95% of the cost of mining and hauling the ore should be discounted. Taking into account this additional gift, Shapouri et al. achieve a total *coproduct energy credit* of 26,250 Btu per gallon. The total energy consumed in ethanol production thus miraculously shrinks to 45,802 Btu per gallon. The energy value from burning a gallon of ethanol has been measured as 76,330 Btu per gallon, and thus a net energy value of 30,528 Btu per gallon, or +67% is achieved!

It is already past time for our new Congress to open vigorous investigations into this giant hoax.