Hydrocarbons to Carbohydrates, The Strategic Dimension

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I was quite honored to be asked to speak to you, particularly to be a warm-up act to Ralph Nader. But to tell you the truth, since, one, I am a lawyer, two, from Washington DC, and three, I have spent some time with the CIA, I am pretty well honored to be invited into any polite company for any purpose whatsoever.

I think that it is perhaps surprising to some of you to hear a presentation on the use of biomass as an alternative to petroleum by someone whose most recent government credential is head of the CIA. I spent twelve of the last thirty-two years in Washington in government, twenty of them in private law practice. The twelve years in government have been at the State Department, the Defense Department, the National Security Council, Congressional Staff, and the CIA — all in areas of national security of one type or another. Five years ago, Senator Richard Lugar invited me to testify before Congress on national security issues related to energy security and energy independence.

Over the past five years, as I have written and spoken on this issue, and a few small companies have asked me for advice and help. I have learned more about this subject. And the more I learn, the more I am convinced that the issue that has brought you here for this conference is right at the heart of many aspects of American security as we move into the twenty-first century.

Why do I say that? First of all, we are a society of networks. Some of them work, most of them work very well, e.g. electricity grids, transportation networks, fuel distribution networks, and the Internet. None of these was designed to be resistant to intentional interference. The Internet provides a recent example: the extraordinarily destructive “love-bug” virus may well have been either a prank by a young Filipino student or an accident. Think of the consequences of an adversary deciding to create problems, disruption, and destruction within that network. The same is true of the other networks upon which we depend for our economy and society. They are interrelated in unexpected ways. In 1966, there was an electricity blackout in New York City that lasted just over a day. At the end of that period, people were surprised to realize that all of the emergency vehicles were out of fuel— ambulances, police cars, and fire engines. Police, many hospitals and fire companies had been forced to curtail their activities because the fuel pumps were electrically powered and no one had considered the need for back-up generators. People in New York City hope that that particular problem has been fixed.

In modern society, with its great degree of interdependency, these networks can be disrupted by accidents and by nature. However, we have no strategies to deal with intentionally planned disruptions. Most of these networks are designed for ease of maintenance, ease of access, and to be user-friendly — not to be resistant to outside interference. Einstein said, "God may be sophisticated, but he's not plain mean," by which I think he meant that if you are trying to develop a theorem in physics, if you are playing against nature, or in a sense, God, you are not going up against someone who is trying to outwit you and make the problem harder. You are not up against someone who is just plain mean.

The interconnected, extremely elaborate and fragile nature of the networks we depend on poses a serious national security problem, as we try to maintain a modern society in the face of potential terrorist operations, or even serious pranks. To the degree that we can decentralize some or any of them, manage them locally, take local responsibility for what is produced, produce what we use locally, produce what we need in an economically sound and useful way without depending upon the intricate and fragile complexities of interconnections, to that degree, I think, we enhance our security. Obviously we cannot go overboard with this — we cannot all become family farmers growing everything we need, which would reject all that modern society stands for. But we can begin to focus on the networks that are the most fragile, the most difficult, and that create the most serious dependencies.

The network I will address briefly is the reliance on hydrocarbons, particularly petroleum, because it creates at least four sets of difficulties. First of all, there is the long-term problem of emissions that cause global warming. By burning petroleum and releasing CO_2 that was photosynthetically fixed by plants hundreds of millions of years ago, we contribute to long-term global climate change. Petroleum, of course, absolutely dominates the transportation industry, and burning it causes close to 40 percent of the world's contribution to man-made global warming emissions.

A study by five laboratories of the Department of Energy (DOE) a year and a half ago examined the global-warming implications of using, for example, gasoline in an automobile engine versus using ethanol that had been produced from biomass, i.e. cellulosic biomass (cellulose and hemicellulose), which includes about two-thirds of urban garbage, agricultural residues, grasses, and much of what grows except lignin, the woody, structural component of plants. If, on a scale of 0 to 200, the amount of global warming gasses emitted by a gasoline-burning car is set at around 200 — from pumping the petroleum, refining it and running the equipment — a gasoline and ethanol mixture, or even pure ethanol if made from corn, is at 140, 150, and 160 on that scale. The figure is high because petroleum products are consumed to produce the corn crop, i.e. to synthesize chemical fertilizers, for plowing, cultivating, harvesting, transporting, and processing.

It is interesting that electric cars on that scale are somewhere between 130 and 180, depending on whether natural gas or coal is burned to produce the electricity. Although an electric vehicle has nothing coming out of the tailpipe in the Los Angeles basin, out there in the Four Corners Power Plant in New Mexico, they are burning coal or gas in order to produce that electricity, and so CO_2 is still going into the atmosphere. Of course, this does not apply to electricity from renewable fuels, or, for that matter, from nuclear power plants, but global warming emissions from coal- and gas-fired plants are substantial.

If that same car burns ethanol produced from agricultural residues, there is a debate on whether it is 2 or 3 on the 0 to 200 scale, or -2 or -3. There is no net increase in global warming emissions since the CO_2 that is released in the production and burning of the ethanol had been recently fixed by the plants during photosynthesis. Therefore, from the point of view of global warming emissions, which are of concern to increasing numbers of objective scientists around the world, gasoline and other petroleum products, and mining fossil fuels to produce electricity for automobiles, is ill advised. The substitution of ethanol from biomass has much to recommend it.

Second, from the point of view of air pollution, to the degree that one mixes biomass ethanol with gasoline — let us say it is 50 percent ethanol and 50 percent gasoline — about 50 percent fewer pollutants comes out the tailpipe. At ratios of ethanol to gasoline below 22 percent ethanol, there is a slightly higher vapor pressure. So, although there is less pollution, there may be more evaporation of the pollutants that are in gasoline, particularly during the hot summer months. Thus, Brazil sells only E22, a fuel that contains 22 percent or higher ethanol. On average, vehicles in Brazil run on a 40/60 ethyl/gasoline mixture. This is relatively expensive because the ethanol is produced from sugar cane. If they made it from agricultural residues and other wastes, their costs would be considerably less. But, even so, Brazilians feel it is worthwhile to have independence from the global oil market and less air pollution as a result of using ethanol from sugar cane

There are ways of solving the problem of low percentage ethanol mixtures with gasoline, such as refining out butane and pentane from the gasoline for use in aviation fuels. Also credits may be traded between urban areas, where, in the hot summer months, the use of low ethanol mixtures is disadvantageous, and other parts of the country. These issues are being considered in the Congress in Senator Thomas Daschle's bill that is before the Senate Agriculture Committee.

The bottom line is that, in terms of air pollution and global warming, we have a serious problem with hydrocarbons. The methyl tertiary butyl ether (MTBE) used in reformulated gasoline to make it burn more cleanly has been found to pollute ground water. Therefore, many states, including California, are declining its use. Hydrocarbons are, and always will be, serious pollutants of the air and ground. Products from biomass offer the promise of an alternative to our dependence on hydrocarbons.

Third, there is an issue on which few people focus — hydrocarbons create a very serious economic problem for a number of developing countries and to a lesser extent for the US. Petroleum constitutes an extraordinarily high share of our imports: tens of billions of dollars a year. The US now borrows about $1 billion every working day from the rest of the world to finance our consumption — roughly the size of our trade deficit.

Developing countries have an even bigger problem. They tend to rely on what are today very low-priced agricultural commodities for their exports. Yet they have to import petroleum, for which the price is dollar-dominated. They can afford this even less than we can, and they continue to go deeper and deeper into debt as a result of their need for petroleum imports. If, for example, sub-Saharan African countries could produce their own transportation fuel, they would substantially change their balance of trade and the degree to which they must be indebted to the developed world. I might add, so would we.

Today, our booming economy can probably deal with a $200 to $250 billion dollar a year trade deficit. But the time may come, and I hope the stock market is not giving us an early indication of it, in which the world will tire of continuing to lend us $1 billion or more every working day to finance our consumption. To the degree that we can produce our own transportation fuel in this country and forgo many tens of billions of dollars in imports, our own international economic situation will be more stable. And, for the likes of Chad, Malawi, Bangladesh, etc., there is the opportunity to go from absolute poverty to a chance for self-sufficiency. They must break, or at least begin to break, the imported oil habit.

The fourth area we need to focus on — in which hydrocarbons create problems for the rest of us — is in overall strategy and national independence. Now, why do I say that? Is oil not always going to be around? And even if Saddam Hussein controls a fair amount of it, he cannot eat it. He has to do something with it. He is going to sell it to somebody. Maybe he will charge a bit more, but we will be able to buy it, right? Well, perhaps, but this is a question of wealth transfer.

Back during the 1973 and 1979 Middle East crises, there was much hand wringing in this country with talk of the price of oil going up to $100 a barrel!

There were many wild and crazy schemes for what the country ought to do in order to avoid having to rely on petroleum, and there was a lot of talk about how the world is running out of oil. Well, the world probably will never run out of oil. It is a matter of cost. The question is, "At what point does cost get to be a serious problem for us?"

Back in the early 1950s a man named King Hubbert, a geologist for Shell Oil, invented the King Hubbert Model, which is essentially a way of forecasting when oil fields are depleted to their halfway point. Once a field gets down to its halfway point in reserves, it begins to decline in total production, and the cost simultaneously begins to increase. As far as I know, Hubbert is the only individual to have successfully made major long-range predictions about oil exhaustion. He predicted that, in the lower forty-eight states of the US, production would peak around 1969. You have to remember that, in the 1950s, the US dominated much of the world's oil market. Hubbert hit it virtually on the nose — the peak came in 1970. Throughout much of the world of petroleum forecasting, Hubbert's model is used and relied upon.

The real question is, "At what point is it likely that the world production outside of the Middle East — Nigeria, Alaska, Venezuela, and other regions — will start to decrease?" At that point, not only will the costs go up, but we will also start to rely much more heavily on the very volatile and dangerous Middle East than is the case today.

The International Energy Agency of the Organization of Economic Cooperation and Development (OECD) in Paris is the major international group that looks at these matters. It predicts that, this year, net world production will decline outside the OPEC nations of the Middle East, and it predicts that OPEC production will start to decrease around 2010.

There are more-positive assessments, the most optimistic of which come either from oil companies or from oil-producing countries. But the most optimistic objective assessments indicate that total oil production, including that in the Middle East, will take a downturn no later than 2020.

I am aware of only one major institution that is neither an oil company nor an oil producing country that says that world production will not start a downturn until after 2020: the DOE. In my opinion, they do not rely on King Hubbert's or any other recognized models for predicting oil supplies. They rely on the Julie Andrews Model as in, "I'm just a cockeyed optimist."

Therefore, we may well see global oil production begin to decline — somewhat later in the Middle East than elsewhere — in the timeframe of 2010 to 2020. That is the year, by the way, when a child born this year enters fourth grade versus the year (s)he becomes a junior in college. So, we are not talking about the distant future. This means that world production starts to decrease a decade from now, or, if you are an optimist, just two decades from now. At the same time, populous Asia is growing economically, and the Chinese can actually afford to drive some of the Buicks that General Motors is building for them in China. If Asia starts to rise economically, increasing the demand for oil, and at the same time world production starts to decrease, then there is a very strong likelihood of substantial oil-price increases a decade or two from now. The most rational approach for the countries of the world dealing with declining oil production — and in some cases cut-offs from the Middle East — is to begin production of substitute fuels from what can be grown locally.

We have an opportunity to do so now as a result of improvements in genetic engineering. Some of the most important research has been done here at the University of Florida. Lonnie Ingram, as some of you know, does superb work in this area. The design and genetic modification of biocatalysts allows the break-down of biomass by fermenting the pentose components of hemicellulose and hydrolyzing cellulose. Those two steps are essentially the philosopher's stone that allows the conversion of agricultural residues, waste, grasses, kudzu, urban garbage, whatever grows, into ethanol, simply and cheaply. The pentose biocatalyst was developed by Ingram; substantial work is in progress to develop the other.

Once that second biocatalyst is developed, our dependence on imported oil will be greatly reduced. These biocatalysts will reduce the production costs of ethanol from today's approximately $1.10 per gallon to approximately $.45 or $.50 per gallon. Since ethanol has about 70 percent of the energy of gasoline, that is equivalent to about $.65 or $.70 per gallon wholesale gasoline, which is something over a $1.00 per gallon retail. But it is not wildly different from the price of gasoline, as long as oil costs $20 to 30 per barrel.

In short, biocatalysts hold out the possibility of making ethanol from cellulosic biomass — approximately 80 percent of all plant material, which is plentiful everywhere in the world — roughly competitive in cost with refining gasoline from oil at current world oil prices. That is a strategic change of the first order. It means that, in years to come, young men and women in the US and other countries would less likely be sent to fight to protect the flow of oil.

Before I close, I want to mention briefly two other technologies that hold a great deal of promise for future use of organic materials, including wastes to allow us to use the farm products to replace substantial amounts of petroleum-based energy and materials. One is the ability to use all sorts of organic waste products and biomass to produce electricity, useful organic chemicals, and fertilizers. Some small companies and several university research projects have embarked on this path and some that are moving aggressively will begin to show commercial promise within the next few months and, at the very most, in the next year or two.

The other is the subject that Ralph Nader and I first met to discuss: industrial hemp. Hemp is an extraordinarily useful plant with a long fiber that can be used to make paper, cloth, carpets, and many other products. In northern Minnesota, where farmers are netting $20 or so an acre from wheat, they look across the border at Canada where the cultivation of industrial hemp varieties with very, very low THC levels is legal. Canadian farmers are netting about $200 an acre from hemp because hemp has so many industrial uses.

The cultivation of industrial hemp is banned in the US for all practical purposes because it is the same species (*Cannabis sativa*) as high-THC marijuana. Industrial hemp may now be legally grown in Canada, Britain, and all of Western Europe. A number of countries have seen its utility and find it easy to distinguish it from marijuana both in appearance and with simple on-the-spot testing.

Yet, unlike Britain and Canada, the US government at this point has no inspection system in place that would permit the cultivation of a new cash crop for industrial uses that would be a great boon to American farmers. Industrial hemp would make it possible to replace substantial amounts of petrochemical products and even be used, as it is in Europe, to fabricate materials for car-body manufacture, for example. It may also replace trees as a source for paper.

Research into all three of these areas, of the sort that many here assembled are engaged in — ethanol from biomass, useful energy and chemicals from various organic waste products, and a wide range of useful products, particularly fiber, from industrial hemp — hold the following promises: improvement in the economic health of rural America, higher productivity for American farms, and a fundamental change in American and world security.