ETHANOL:

A 150 Year Struggle Toward a Renewable Future

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INSTITUTE FOR LOCAL SELF-RELIANCE

Environmentally Sound Economic Development

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The Institute for Local Self-Reliance (ILSR) is a nonprofit research and educational organization that provides technical assistance and information on environmentally sound economic development strategies. Since 1974, ILSR has worked with citizen groups, governments and private businesses in developing policies that extract the maximum value from local resources.

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Paul Valery, the French poet and philosopher once observed, "The central problem with our times is that the future isn't what it used to be." Nowhere is this comment more relevant than with regard to the past, present, and future of fuel ethanol.

The Star Crossed History of Ethanol

The history of ethanol reminds me very much of Greek legend of Sisyphus. Those acquainted with Greek mythology know that Sisyphus was condemned to roll a great stone up a daunting slope, only to have it tumble down just before it reached the top. This has happened to the fuel ethanol industry time and time again.

The current ethanol industry is heir to a long and star crossed parentage. Before the Civil War ethanol was one of the nation's premier illuminants and industrial chemicals. Almost 90 million gallons were produced in the late 1850s, over 3 million gallons a year from a corn mill just outside of Cincinnati. But in 1861, just a couple of years after the first oil well was drilled in Pennsylvania and kerosene, the first marketable product of petroleum, entered the commercial market in the US, the federal government imposed a $2.08 per gallon tax on liquor to finance the Civil War.

As we all know, ethanol is liquor. Indeed, it has been the everlasting curse of fuel ethanol that it is an edible liquid whose consumption gives us physical pleasure. In the 1860s ethanol's non drinkable, poisonous competitors, like methanol and kerosene, were taxed at a rate of only 10 cents a gallon. The unsurprising result was that ethanol disappeared from the market. In 1906, as a result of a popular outcry from farmers and President Teddy Roosevelt's hatred of big oil, the federal liquor tax was lifted. The New York Times editorialized in favor of the tax repeal, "It is only the heavy tax imposed by the United States that has prevented the use of a large number of vegetable products for the manufacturing of an exceedingly cheap and available alcohol".

Between 1861 and 1906, however, petroleum had taken advantage of its almost half century headstart in the automotive fuels market. By 1906 the automobile had been commercialized. A year after the liquor tax was lifted, gasoline surpassed kerosene as the best selling component of crude oil. The domestic oil industry had constructed a national pipeline system and consolidated into the powerful Standard Oil trust.

After 1906 ethanol was born again. By 1914 ethanol production had risen to 10 million gallons. During World War I ethanol was used as a fuel and, more importantly, in the manufacture of gunpowder and other weapons. By the end of World War I production rose to 50 million gallons. Henry Ford's Model T was able to run on ethanol as well as gasoline.

Then in 1919 disaster struck fuel ethanol for the second time when Prohibition came to America. The ethanol boulder again rolled down the hill. This was a critical time for America's chemical engineering industry for after World War I Congress seized the patents on chemicals held by Germany, which boasted by far the most advanced chemical industry. Congress channeled the royalties from these patents to the Chemical Foundation, which nurtured the infant American chemical engineering

profession. To assist domestic chemical production industries, Congress also imposed very high protective tariffs on imported synthetic chemicals.

All these developments would have benefited carbohydrate as well as hydrocarbon based chemical engineering except for Prohibition. In 1920 MIT established the nation's first Department of Chemical Engineering. The Department was financed by oil companies and was oriented toward fossil fuel based engineering processes.

Once again ethanol's sin was that it gave us pleasure. Indeed, the only ethanol allowed to be sold then and now had to have poisons added to it at the end of the production process. We use an entirely appropriate term to describe this process, "denaturing". In order to be legal we have to make our fuel poisonous, usually by adding 3-5 percent petroleum components.

By the end of World War I ethanol was no longer viewed as a substitute for gasoline but as a gasoline extender and octane enhancer. As Detroit built higher compression engines it needed to find a way to overcome the knocking problems of gasoline. The industry identified lead as an inexpensive material that would reduce knocking. In 1924, ethyl gasoline was first introduced. It was a product of the Ethyl Corporation, a joint venture of Standard Oil of New Jersey and General Motors. But a major mishap almost derailed the fledgling leaded gasoline industry. A large chemical retort in the Standard Oil refineries in Elizabeth, New Jersey, cracked and several workers died from exposure to lead fumes. A series of such accidents led to ethyl's being taken off the market. Several in the public health field expressed concern about the impact that large quantities of lead would have on human health. As Hal Bernton, Bill Kovarik and Scott Sklar point out in their book *Forbidden Fuel*, Dr. Wendell Henderson, a Yale University physiology professor, in 1925 called leaded gasoline "the greatest single problem in the field of public health that has ever faced the American public". He presciently predicted, "If leaded gasoline kills enough people soon enough to impress the public we may get from Congress a much-needed law and appropriation for the control of harmful substances, but it seems more likely that conditions will grow worse so gradually for this is the nature of the disease--that leaded gasoline will be in nearly universal use and larger numbers of cars will have been sold that can run only on that fuel before the public and government awaken."

In 1926 the US Surgeon General concluded that there were "no good grounds for prohibiting the use of tetraethyl lead in gasoline". By 1940, 70 percent of all US gasoline contained lead. Only a half century after the Surgeon General's clean bill of health did the public and government awaken to the health dangers of lead.

So in the 1920s the nation decided to rely on a highly poisonous material, lead, to enhance the octane rating of our gasoline, because the edible, drinkable plant matter derived alternative, ethanol, was banned.

In 1933 the Constitutional amendment prohibiting alcohol sales was overturned. Ethanol had still another lease on life. In 1937 the first fuel ethanol plant since Prohibition began operating. Iowa and Nebraska led the way, introducing legislation to mandate a 10 percent alcohol blend. The oil industry fought back, playing on the still substantial anti-alcohol sentiments in the midwest. The National Petroleum Association publicly declared, "To force the use of alcohol in motor fuel would be to make every filling station and gasoline pump a potential speakeasy."

During World War II ethanol production rose to an unprecedented 600 million gallons a year. Some of this was used for fuel but a much larger proportion was used to make synthetic rubber since the war in Asia had cut off our traditional access to natural rubber. The federal government gave two large contracts to the agricultural and petroleum industry for synthetic rubber. The agricultural community was able to produce significant quantities of synthetic rubber almost a year before the petroleum industry.

After World War II federal support for grain alcohol disappeared, this time because of cheap foreign oil and because huge export markets opened up for American farm products. The fuel ethanol industry died again, only to be resurrected in the late 1970s when two oil shocks galvanized federal support. By 1987 domestic fuel ethanol production had finally surpassed its previous peak production in 1945.

The ethanol industry is to be applauded for having persevered and succeeded against enormous odds. Those not involved in ethanol's development tend to believe that powerful farm interests persuaded Congress to enact substantial ethanol incentives and after that getting into the marketplace was a piece of cake. Hogwash. Tax incentives have been a necessary but by no means sufficient condition for ethanol's success.

Ethanol has face two potentially crippling obstacles to getting into the market: the car and oil industries. For ethanol to increase its sales it depends on the cooperation of the automobile and petroleum industry, the world's number one and number two industries. Yet these have more often than not been actively opposed to ethanol. Until the mid 1980s almost all automobile companies warned their customers that using ethanol would void engine warranties. The oil companies, for the most part, have fought ethanol as bitterly in the 1980s as they did in the 1930s. Until 1987 ethanol producers had to rely on their own distribution systems, depending on independent distributors and retailers since gas stations owned by the major oil companies rarely agreed to use ethanol.

It is a testament to the persistence and the ingenuity of the ethanol community that fuel ethanol has not only survived but in certain markets, has become a significant fuel additive. Because of federal and state mandates for oxygenated fuels ethanol now comprises almost 5 percent of the transportation fuels in some states like South Dakota and Minnesota.

Will We Make Ethanol Pay for the Sins of Gasoline?

But today, as the people in this audience are well aware, ethanol faces still another crisis. This is the controversy over its contribution to ozone formation. The White House will soon make a major decision about the future of ethanol when it issues rules related to the use of reformulated gasoline after 1995.

Let's agree to the obvious. Ethanol increases the evaporation rate of gasoline. To many observers that's the beginning and end of the argument. That is not only shortsighted but potentially tragic. For there's also no question that the emissions from ethanol combustion are not the problem. Air pollution is caused by the combustion of hydrocarbons, not carbohydrates. In scientific terms, it is the C_4 component of gasoline, not the C_2 component of ethanol that is the problem.

In short, ethanol is being asked to pay for the sins of gasoline. The problem is that at this stage in its development ethanol must

share a fuel tank with an extraordinarily dangerous and complex substance like gasoline. When you buy ethanol you know exactly what you are getting because ethanol is a single chemical. Buy gasoline and you can end up with any of a dozen or more different combinations of hundreds of individual chemicals it contains.

Ethanol does increase volatility but volatility alone does not cause ozone to form. Ozone formation is a result of the reactivity of the gases generated by the car. Back in 1990 some scientists suggested that if the federal government wanted to reduce ozone formation it should ban olefins and xylene, the two most reactive components of gasoline. If only the entire ethanol community had come together on that issue and mobilized a partnership with the environmental community at that time. But we didn't. The petroleum industry squashed the reactivity concept. Instead they and the environmental community successfully advocated for volatility as a surrogate indicator and now this chicken, or should I say turkey, may be coming home to roost.

If the White House and the EPA decide that ethanol cannot be used in ozone non-attainment areas it will, in effect, be labeling ethanol a dirty fuel and gasoline a clean fuel. Shades of the 1920s, when ethanol was dirty and lead was clean.

The volatility issue is easily resolved in the short and the long term. One could require gasoline companies to lower the volatility of their fuel by 1 pound Reid Vapor Pressure(Rvp). This would cancel out the 1 pound increase that occurs when ethanol is added.

One major oil company spokesman, testifying before a joint hearing of three Senate Committees in Minnesota a month ago informed legislators that lowering the Rvp of gasoline 1 pound would raise the price of gasoline a penny a gallon. Because 2 billion gallons of gasoline are sold in Minnesota each year, he warned that this would represent a heavy $20 million additional burden on Minnesota households.

One of the Senators responded by noting that in 1993 the Minnesota legislature had raised from one penny to two pennies a gallon the tax on gasoline simply to raise funds to pay for cleaning up the pollution from leaking and corroding underground gasoline tanks. Just this one form of environmental damage caused gasoline is costing Minnesotans twice as much as it would cost for them to lower the volatility of gasoline such that ethanol blends would cause no volatility increases above the maximum established by the Clean Air Act. And no one is going to have to clean up after an ethanol spill.

This colloquy with the Minnesota legislators highlights an important issue. Fuel ethanol is highly subsidized although one might note that these incentives have fallen dramatically since 1980. In 1980 incentives to ethanol were equivalent to $3.50 per gallon. By 1986 they had dropped to $1.25 per gallon. Today they are about 60 cents per gallon.

But one should ask, what are the subsidies to gasoline? California's Insurance Commissioner has recommended that people pay for car insurance at the pump as a way to provide for universal low cost coverage. Why not also pay at the pump for that part of the military budget used to protect our access to low cost oil? The Pentagon spends about $45 billion every year to protect the Middle East. We are not spending that money to make the world safe for democracy nor to guarantee our access to sand. We are paying to protect the world's access to two thirds of the world's oil reserves. If we had to pay this protection money at the pump it would cost about 40

cents a gallon. The American Lung Association a few years ago concluded that another 45 cents a gallon was the medical costs from the pollution caused by gasoline. Either one of these indirect subsidies to gasoline would come close to those given to ethanol.

The ethanol industry must deal with the subsidy issue directly. And it must deal directly with the environmental criticisms of ethanol. Frankly, I think the ethanol industry has been remiss in not reaching out more aggressively and consistently to the environmental community.

When I talk to environmentalists I stress that the modern ethanol industry did not exist 15 years ago. Technologically speaking, it is still in its teenage years. And as is true with any industry, it is experiencing a rapid learning curve. For example, in 1980 environmentalists had a legitimate criticism that it took more energy to make a gallon of ethanol than was contained in the ethanol itself. But today's ethanol plants use 85 percent less energy than their predecessors. Today we get as much as two units of energy out of a new ethanol facility for every one unit we put in, taking into account not only the energy used to make the ethanol but to grow the crop as well.

The Next Frontiers of Ethanol

The next frontier for ethanol is to begin the shift to a more abundant and environmentally friendly cellulosic feedstock and to boost its share of the gas tank above 10 percent.

If every last pound of corn starch grown in the United States were converted to ethanol, a theoretical but not practical possibility, it would provide sufficient ethanol to displace only about 8 percent of the country's transportation fuel. But enough waste cellulosic materials alone are available--yard waste, contaminated paper, corn cobs, rice hulls, wheat straw--to produce over 20 billion gallons of ethanol annually about 20 percent of our transportation needs. And several times more ethanol could be produced from virgin cellulose.

No one pretends that ethanol should or could displace all gasoline. The future will see multiple fuels: electricity, compressed natural gas, reformulated gasoline, ethanol, methanol and propane. On a national level, ethanol producers might strive to capture 15-20 percent of the total market although in certain regions like the midwest this could rise to 40 percent or more. Cellulosic conversion can bring us to the stage of using ethanol not simply as a fuel additive but an alternative fuel.

Those making ethanol from starch might worry about competition from cellulose. Yet it will be years before cellulose will make major inroads into the ethanol market. The prospect of cellulosic feedstocks will make every part of the country a potential ethanol producer, not just the starch rich midwest. Thus even before cellulose becomes a significant ethanol raw material its potential will attract a far wider political constituency in support of biofuels, a support which undoubtedly will enlarge the market.

Moreover, in the long term starch may have a much more valuable use as an industrial material. Ten years from now we may be converting millions of tons of starch into intermediate chemicals and plastics rather than fuels.

Not only must ethanol increase its market share of transportation fuels; it must increase its proportionate share of the gas tank. This is good not only for the farmer but for the environment. I mentioned before that the volatility issue could be dealt with by

lowering the Rvp of gasoline. But there is another way. Ethanol now displaces only 6-10 percent of gasoline. If it were to replace 20-25 percent the volatility of the gasoline drops to where it was before a drop of ethanol was added. If ethanol were to replace 85-95 percent of gasoline all environmental problems associated with gasoline would be lessened or eliminated.

This is not a utopian proposition. There is no technical reason why we should think of ethanol only as a minor supplement to our transportation fuel supply, especially in agricultural states which have sufficient home grown plant matter to provide almost all their transportation fuel needs. In Brazil 4.2 million cars, or about 45 percent of all cars, run on neat ethanol. The remaining cars run on ethanol/gasoline blends that contain on average 22 percent ethanol. In Brazil today virtually no cars run on neat gasoline.

The federal government requires first public and then private fleets to convert to alternative fuels over the next 10 years. Ethanol should be one of those alternative fuels. But today fleet managers hear about compressed natural gas and propane and electric vehicles and, to a much lesser extent, methanol. They do not hear about ethanol.

When it comes to promoting ethanol as an alternative fuel and not just a fuel additive, the ethanol industry faces another uphill but I hope not another Sisyphean climb. Last month GM said it would make no more E85 cars. Ford makes an M85 Taurus but Ford has warned that anyone using ethanol in its car will void the warranty. The General Services Administration just announced this week that it is converting 100 of its Minnesota based vehicles to run on compressed natural gas. To my knowledge, it is not buying any ethanol fueled vehicles.

From an economic perspective, ethanol turns out to be a competitive fleet fuel. A preliminary study compared the cost of compressed natural gas with ethanol for fleet conversions. The incentives for both ethanol and compressed natural gas were included in the calculations. The cost of the vehicles, on a per mile basis, was about the same. The government offers substantial incentives for the production of ethanol but offers equally substantial incentives for CNG refueling stations and vehicle conversions. Moreover, because the largest cost of CNG is in the refueling stations and vehicle conversion, CNG is far less attractive than E85 if the vehicles are driven less than 20,000 miles a year.

Yet despite the federal mandate for alternative fuels, and despite ethanol's impressive environmental benefits and its economic competitiveness, this renewable transportation fuel may not be able to realize its potential as a primary transportation fuel if no ethanol fueled vehicles are available.

Detroit says they're not building them because no one wants to buy them. Some auto makers say they need to modify the computer chip to allow for high ethanol blends and doing so will require extensive testing to meet EPA requirements. Some in EPA believe ethanol as a 10 percent blend is an environmental problem and don't want to accelerate its use even as an environmentally benign primary fuel. The GSA says it is not buying E85 vehicles because they are not available.

The ethanol industry has been stuck in this chicken-and-egg situation before. The federal government, working with industry and state governments, must step in and end this gridlocked situation. Not since the turn of the century has ethanol had such an opportunity to prove itself as a true alternative to fossil fuels.

Biorefineries and Rural Economic Development

There are many environmental reasons for supporting ethanol: lower carbon monoxide emissions from car exhausts, reduced pollution in the manufacture of the fuel, no pollution from leaking ethanol tanks or ethanol spills.

Yet it is not its environmental impact but its economic impact that makes ethanol so attractive. This Administration is very interested in rural development. There is no one answer fits all for rural communities but from my perspective two major policies that would help rural areas. One is a major expansion of telecommunications capacity to rural areas, similar to expansion of electricity into rural areas in the 1930s and 1940s. Extending the information highways of the future to rural communities will help them overcome their major competitive disadvantages--remoteness from markets and small populations.

The other policy, and one more relevant to this audience, is a major expansion of biorefineries. These would be sophisticated processing facilities that produce industrial chemicals and fuels as well as feed from agricultural resources. We need to build a carbohydrate economy, substituting not only biofuels for fossil fuels but biochemicals for petrochemicals. We need to make much more use of living carbon and much less use of fossilized, dead carbon.

Ethanol is now our largest non-food plant derived commodity, aside from paper. Ethanol has captured less than one percent of the transportation fuel market, but still has generated a very impressive $2.5 billion in investment in rural communities, 4,000 direct jobs and another 4,000 jobs in companies supplying services and goods to the ethanol industries.

Ethanol refineries have many economic advantages over petroleum refineries. First, they create more jobs. Petroleum refineries create about one half to one full time in-plant production job for every 1 million gallons of gasoline produced. Ethanol refineries employ 3-5 full time people in the plant for every 1 million gallons of ethanol produced. If ethanol were to gain just a 10 percent market share in my home state of Minnesota and the ethanol came from in-state producers, 700-850 in-plant jobs would be created.

In-plant jobs represent only one aspect of the economic benefits ethanol brings rural communities. Equally important is the beneficial impact of keeping in the producing state tens of millions of dollars in business spending.

A dollar spent on producing ethanol is largely spent inside the state while a significant amount of the dollar spent on producing gasoline leaves the state. For example, 45-55 cents of each gallon of gasoline represents the cost of the crude oil, all of which is imported into agricultural states. On the other hand, 40-50 cents of the cost of producing a gallon of ethanol is the cost of corn, all of which can and often is grown in-state.

One might argue that I am proposing a parochial development strategy, a kind of beggar-thy-neighbor plan in which any increased economic benefit to agricultural states from ethanol will come at the expense of decreased income by petroleum producing states.

But this need not be so. In late 1993 America is importing 50 percent of our petroleum. This could rise to over 60 percent by the year 2000. A strategic, coherent public policy would substitute ethanol for imported petroleum, not domestic petroleum.

Ethanol plants help state economies not only by keeping more money in the state and by generating jobs. They also help the state economy by keeping more of the profits in the state. This can be a sensitive issue for the ethanol industry to raise because currently 60 percent of the ethanol produced in the US is made by a single large firm and 95 percent is produced by corporations whose owners do not live within the state.

But I want to make a pitch for local and cooperative ownership as a key element in any strategy to promote ethanol and biorefineries.

Cooperatives distribute profits to their farmer owners. A typical profitable ethanol refinery may distribute 50 cents to $1 per bushel. This injects ten million dollars or more into the local economy from a modest sized ethanol facility. Locally owned production facilities tend to be more rooted and more tied to the community. The children of the owners go to the local schools. The owners themselves tend to be involved in civic affairs. To rebuild the rural economy we need not only to create jobs but to create the kind of diversified and self-reliant communities that result from widespread local ownership.

The fuel ethanol industry is almost 150 years old. Today the industry stands at a cross roads. It needs to reach out to the east and west coasts, to the cities and the environmental community and aggressively promote ethanol as a key element in a renewable materials based future. It cannot give away the alternative fuels, as opposed to the alternative fuel additives, future to compressed natural gas and electricity.

The ethanol future never seems to be what it used to be. The people in this audience have never been able to rest on your laurels and reap the rewards of your efforts. Today more than at any time in history the time may be ripe for the ethanol industry to finish its Sisyphean task and move the boulder to the other side of the hill. The enormous interest in a carbohydrate economy, the serious bridge building that is now going on between sustainable agriculture advocates and the new uses community, the scientific advances that continue to improve the productivity and lower the cost of biologically derived fuels and industrial materials, all converge to offer us an unparalleled opportunity.

If we put our shoulders together, not only farmers and ethanol producers but urban environmentalists and economic developers we can push that rock over the crest of the mountain and march proudly down into a new era, a sustainable, renewable future.