

CHALLENGES AND OPPORTUNITIES IN DEVELOPING ENERGY ALTERNATIVES FOR TRANSPORTATION IN THE UNITED STATES

I. INTRODUCTION

The premise of this presentation is that the technology exists and has been around for some time to replace petroleum fuels such as gasoline, kerosene and diesel oil for transportation with domestically derived renewable fuels and to reduce fuel consumption with more efficient vehicles and fuel systems. I suggest that market forces will drive the United States and the rest of the world to adopt these technologies. Some countries have already adopted alternative energy strategies. The United States lags behind Europe, South Africa, Brazil and other countries that have adapted policies and are on the way to replacing petroleum based fuels with renewable fuels.

The world consumes the equivalent of 31 billion barrels of petroleum (crude oil) per year. In the United States which consumes 25% of the worlds demand, approximately 8 billion barrels of crude oil equivalents are consumed every year or about 336 billion gallons per year. Transportation fuels account for approximately 40 % of total consumption in the United States or about 130 billion gallons per year. If we can convert stationary users of crude oil to alternative sources such as atomic energy, solar energy, wind, water and waste to energy, we will have two and a half times as much transportation fuels as we do now. The stationary fuels may be different than fuels for transportation, but these subjects are intimately related. (www.eia.doe.gov)

In addition new vehicle technology can decrease fuel consumption in vehicles to half present consumption. Alternative fuels such as ethanol and biodiesel can virtually replace gasoline and petroleum diesel in cars, trucks and planes. The result of this mixture of developments makes it possible to substantially decrease demand for imported oil in a reasonable time period.

A brief word about references: To make information more available to today's students and researchers, I have often included web addresses as references directly in the text for immediate access to this information from electronic copies of this paper or by typing these addresses directly to the internet. Where conventional references are employed they have been included at the bottom of the page to match Cumberland Law Review practice.

II. ECONOMIC AND POLITICAL DRIVERS

The economic and political drivers for a switch from petroleum fuels to more efficient energy conversion equipment and alternative fuels (which in reality is already taking place in the United States) include the following;

- Almost half of all the crude oil ever created by global processes has already been pumped out of the ground.
- Hubbert's Peak has occurred. This means the point in time at which the increase in demand is greater than the increase in reserves (new oil discoveries) which also seems to correspond to the point of maximum world wide production of crude oil, sometimes called peak oil.¹ (see also http://en.wikipedia.org/wiki/Hubbert_peak) see also Wall Street Journal articles²
- Saudi Arabia, which has the worlds leading reserve of crude oil is running out of oil. Recent projections describe Saudi Arabia's reserves as lasting between fifteen and thirty years before they run out. In actuality no one in this country knows and the Saudis either do not know or are not telling. What oil is still in the ground gets harder and harder to bring up.
- The oil industry in Iraq has not been able to produce the crude oil said to be in the ground for a number of reasons.
- Developing nations including China and India which together have one third of all the people living on earth are increasing their demand for oil and gas as their growing populations climb into the middle class and demand the kind of life style that your parents formerly enjoyed in the United States.
- This means that in your lifetime and shortly after you leave school and set up families and households of your own, you will be using more efficient vehicles and alternative fuels or you will be in real trouble.
- As America loses influence in the world we will have to start paying what the Canadians and the Europeans pay for gas or about five bucks a gallon or more in today's dollars. It is possible that the price will go down until the next crises. However at that point it will rise dramatically again. (this speculation has been variously reported in the press. See WSJ articles above and on the hurricane crises). Perhaps one of you can undertake a project to determine why gasoline is so cheap in the United States as compared to our neighbors and the rest of the world.
- Domestically produced renewable fuels will be inherently less expensive as fossil fuels become scarcer.
- Vehicle technologies are already in production to drastically alter the United States demand for petroleum fuels

A switch to more economical systems and fuels will have the following advantages for the United States:

- Renewable fuels are almost carbon neutral and therefore do not contribute to increase of carbon dioxide in the atmosphere. (see www.ilsr.org and

¹ KENNETH S. DEFFEYES, HUBBERT'S PEAK THE IMPENDING WORLD OIL SHORTAGE (Princeton University Press 2001)

Stating:

Global oil production will probably reach a peak sometime during this decade.

www.eia.doe.gov/ for various information on greenhouse gases and renewable fuels standards www.eesi.org)

- Domestically produced fuels do not require the United States to support Middle-East and South American governments and to protect their energy stocks. The actual effect on American foreign policy deserves extensive study, perhaps by someone in this room.
- Domestically produced fuels add to the nation's economy and reduce the deficit balance of payments that the United States carries with other countries
- A renewable fuels industry in the United States would strengthen our agricultural and forestry sectors.

Getting down to the individual citizens of this country, more efficient vehicles and renewable fuels will be produced in this country in response to consumer demand. In my case, I would rather spend twenty dollars to fill up my gas tank every week than fifty or sixty dollars and if I have that choice I will take it. However, most consumers will only buy renewable fuels when its price matches or is lower than the price of petroleum fuels. In actual fact some renewable fuels are already less expensive to produce and are beginning to sell for the same price as gasoline and diesel at the pump.

In the case of corporations, you should know that General Motors and Ford are on the verge of bankruptcy and reducing work force by thousands of employees while they wait for the hydrogen economy and continue to produce inefficient vehicles. Toyota and Honda are doing very well thank you as they convert their entire line of automobiles and SUV's to hybrid technology. Just lately General Motors, Ford and Chrysler announced new flexible fuel vehicles which will encourage the production of ethanol.

Exxon-Mobil has profited from the high prices of crude oil, gasoline and diesel oil. However, BP (formerly British Petroleum) is looking ahead and now signs its advertisements "BP Beyond Petroleum".

According to the Wall Street Journal, in 2005, the demand for crude oil increased faster than the discovery of new sources of oil. This is the classic definition of Hubbert's Peak , originally applied by M. King Hubbert, an employee of Shell Oil's research laboratories to United States production of petroleum crude oil but now applied to global production. If in fact 2005 saw the arrival at Hubbert's Peak, then you will be among the first graduating classes to personally experience the end of the oil age.

There is of course the possibility that there is really an unending supply of petroleum and that it is of geological rather than biological origin. (www.gsreport.com/articles/art000019.html and other sites for Thomas Gold, Professor at Cornell University) Professor Gold has maintained that petroleum seeps up from the middle of the planet to renew the petroleum that is pumped

out of underground sites. If this is true it means that the price of oil is kept artificially high, either because of ignorance and incorrect science or because Exxon-Mobil and Saudi Arabia are concealing this fact in order to inflate the price. This is sort of like the diamond cartel DeBeers concealing the fact that diamonds are plentiful and cheap to recover as some have claimed. Nevertheless we pay a bundle when we buy diamond engagement rings and I think we will continue to pay a bundle for our gasoline for some time to come. If Saudi Arabia hasn't run out of oil in twenty or thirty years we can revisit this theory.

III. DEVELOPMENT OF ALTERNATIVE FUELS

In the 1920's two German scientists, Professor Franz Fischer and Dr. Hans Tropsch continuing research originated in Germany from about 1897, developed one of two processes for the production of liquid fuels including from coal. (www.fischer-tropsch.org and many other sites from Google) This made it possible for Germany to recover from World War I and also to conduct the Second World War as Germany had no access to petroleum fuels. The major industrial energy source in Germany was coal from the Ruhr Valley. Their process was called the Fischer-Tropsch Process. The process involved gasification of coal by burning in an oxygen poor atmosphere to produce a syngas of carbon monoxide and hydrogen. The syngas was then reacted in the presence of heat and pressure and a catalyst to produce a mix of straight chain carbon molecules similar to crude oil. The crude mix was then distilled to produce gasoline and diesel fuel and the process could be fine tuned to emphasize either gasoline or diesel fuels.

If you saw the movie *Battle of the Bulge* with Henry Fonda, Robert Ryan and Telly Savalas, you may remember that the German Panzer (and Tiger) Tanks ran out of fuel in the battle and the entire German tank corps got out and walked back to Germany. If true, this was because the Allies were constantly bombing the synthetic fuel plants to put them out of operation. At the peak of the war there were about twenty-five Fischer-Tropsch synthetic fuel plants making diesel fuels and gasoline in Germany. (see www.fe.doe.gov/history/syntheticfuels_history.html for the whole sad history including congress shutting off funds to United States synthetic fuels plants.)

At war's end The United States captured the documentation for Fischer-Tropsch technology and took them back to the United States. (see www.fischer-tropsch.org/ and www.syntroem.com . Approximately 300,000 pages of documents were examined. In the early 1950's using this information oil companies got together to construct a synthetic fuels industry in Brownsville, Texas and at other sites based on Fischer-Tropsch. I wrote my under-graduate thesis on this process. However due to the low price of petroleum fuels from the United States (and elsewhere) the plant was not considered economical and closed down and a synthetic fuels industry was never established in the United States. We simply imported the crude and the fuels from the Middle-East even

though Hubbert accurately predicted that the United States was running out of crude oil.

In 1972 South African Coal, Oil and Gas Corporation (SASOL) (www.sasol.com and other sites) designed and constructed the first synthetic fuels plant in South Africa, utilizing coal as raw material and based on Fischer-Tropsch. Subsequently two more plants were built based on the process but using natural gas as the primary raw material. These plants operate successfully today producing synthetic diesel fuels and gasoline, chemicals and waxes from coal and natural gas using the Gas-to-Liquid (GTL) technology described above. I do not know how SASOL acquired Fischer-Tropsch technology unless it was through Chevron or other oil producers who got it from the United States captured documents.

In 2001, Qatar, a small country in the Middle-East with natural gas reserves licensed this technology from SASOL CHEVRON. QATAR intends to spend billions of dollars to build a synthetic fuel industry comparable in scope to the petroleum industry in Saudi Arabia.

In 2005, an agreement was signed by SASOL CHEVRON with Algeria for a Gas-to Liquid Project. (www.sasolchevron.com) So if we run out of petroleum, we still will have transportation fuels from natural gas. But these sources are also imported and derived from fossil sources.

In the 1970's both the United States and Canada took steps to develop the vast oil sand and oil tar reserves in both countries, but when Carter left office to be replaced by Ronald Reagan, our government lost interest in alternative fuels and commercialization was halted. In 1973 and again in 1979 the OPEC nations raised the price of oil dramatically and for a while you had to wait in line for hours to get any gas for your car.

With the price of gasoline at the pump between two and three dollars a gallon, China has been attempting to buy up rights to the Canadian oil sand reserves. (www.cos-trust.com)

In the early 1970's a new industry was started in the United States to produce fuel grade ethanol as a partial replacement for gasoline in cars. Large farm coops were involved producing the ethanol from corn. Archer Daniels Midland (ADM), a large industrial firm produces a large percentage of the ethanol produced in this country. The process is similar to producing whiskey from corn except the fuel grade ethanol is distilled to 200 proof or 100% purity and production is on a much larger scale. The resulting fuel blend had up to 10% ethanol in gasoline and was called gasohol. For a while the pumps stated that the gasoline contained ethanol. Now, however much gasoline sold in the United States has about 5 or 6 percent ethanol and is unlabeled. Approximately five billion gallons of fuel grade

ethanol are produced annually in the United States. Ethanol is considered an oxygenating agent to increase the fuel octane rating of gasoline.

Today, production of ethanol from corn is a major growth industry with new plants announced regularly. At last count there were some eighty plants in the United States. (www.ethanolrfa.org) Ethanol is legal in most states up to a value of 10% with ordinary vehicles and up to 85% (E85) in Flexible Fuel Vehicles (FFVs).

If you prefer to fly to your next meeting with your own plane, E85 can be used with most piston engine planes. The renewable fuel for jet engines has not yet been approved, but may also include some ethanol.

Now it is proposed by a number of firms³ to create additional ethanol capacity using as raw material agricultural and forestry biomass. Raw materials will be available and inexpensive and will not be sources of human food. Fortune Magazine has stated that so called cellulosic ethanol represents our best opportunity for development of alternative fuels as one step out of four to “kick our addiction to foreign oil”⁴ See this reference for an in-depth study of energy strategy.

The cellulosic ethanol process consists of digestion of the cellulosic and hemicellulosic materials to convert these constituents to starches and sugars. The starches and sugars can then be fermented by non-aerobic fermentation (conventional ethanol process) to an ethanol solution that is then distilled to pure ethanol. Capital costs for this complex technology are very high. However new microbes are being developed that simultaneously convert cellulose and hemicellulose to sugars and the sugars to ethanol. At present no plant has been completed to commercialize this technology. The first plant in Jennings, Louisiana if built will use sugar cane bagasse and is awaiting financial commitments. A pilot plant in Canada produces a million gallons a year. (www.bcintlcorp.com and www.iogen.com)

Several other biomass sources are contemplated for cellulosic ethanol plants. These include corn stover, special fast growing energy crops such as switchgrass, waste agricultural biomass, and forestry waste. One concern is that stripping the soils of waste biomass will rob the soils of valuable nutrients being put back into the soil by the rotting of this waste material. I have seen no actual data on this however. The availability of biomass sources in the United States makes it a very viable raw material for the production of fuel grade ethanol.

Meanwhile Brazil has developed its own synthetic fuel resources based on ethanol in its vehicles using sugar cane as the raw material.

³ Wyman CE, 1995. “Economic Fundamentals of Ethanol Production from Lignocellulosic Biomass”, American Chemical society Symposium series 618, Washington, DC, pp 272-290

⁴ Nicholas Varchaver, Fortune Magazine, August 23, 2004, “How to Kick The Oil Habit” pp 100-114

In the last few years soy bean cooperatives have begun producing methyl esters, called biodiesel as a replacement for diesel fuels and heating oils. We may now replace the polluting petroleum diesel with from 20% to 100% (B20 or B100) biodiesel. Biodiesel fuels are authorized for use in diesel engines in trucks vans, auto and marine engines and are derived from soy beans or other oil seeds by reaction with an alcohol and a catalyst. The resulting methyl esters may be used in all diesel engines.. Biodiesel is also being used as heating oil for oil fired furnaces. Most biodiesel fuels and lubricants are produced in the Midwest by soybean cooperatives and large farms although a number of manufacturers are trying to get into the business. Biodiesel is especially interesting for fleet operators due to the reduction in health effects that some users find when they switch to biodiesel. Operators of commercial buses, trucks and vans find their drivers suffer less from headaches, nausea and resulting absenteeism when biodiesel is used than when petroleum diesel is used. More and more gas stations are offering biodiesel blends to diesel users and oil suppliers are starting to sell biodiesel heating oil.

While demand for biodiesel is still relatively low, it is increasing dramatically every year with used restaurant cooking oil, soy bean oil, rapeseed oil and other vegetable oil sources used as raw material.. Enormous potential remains to be realized in replacement of petroleum diesel 100 % in all trucks, diesel cars, buses, ships and residential and commercial heating plants in the United States. For instance the City of Seattle, Washington recently reported first attempts to replace petroleum diesel with biodiesel on all its ferries. In fact the use of biodiesel fuels in the United States increased 200% in 2005 from 2004 and a number of states now mandate the use of biodiesel in the fuel mix as high as 10 % by 2012. (www.ewire.com) One interesting aspect of this new industry is that the increased use of soybean oil and canola oil to produce biodiesel may make the oil seeds from which the oil is pressed more economical. Therefore the price of meat and milk could be heading down as more of the oil meal becomes available for animal feed.

In Vermont and elsewhere in the United States many people go to great lengths to run their diesel cars with vegetable oil. Originally Dr. Diesel, developed the engine named after him for a variety of fuels and demonstrated it with peanut oil as a fuel. Vegetable oil is a viable fuel but for many technical and economic reasons should not have the potential market that biodiesel is beginning to enjoy.

One other energy source needs to be discussed. This is the gasification of renewable biomass from agricultural and forestry wastes. Here gas-to-liquid technology will be used.

IV. THE HYDROGEN ECONOMY

At universities and research centers in the United States, much research capital is being devoted to the so called hydrogen economy. This research includes the

development of fuel cells to replace or supplement the internal combustion engine. The United States government has set a high priority on the development of this technology. (www.ilsr.org for papers on the hydrogen economy). Hydrogen can be produced by simply passing an electric direct current through water. Hydrogen will bubble up from one terminal and oxygen from the other and the two gases are separated. However, most commercial hydrogen is generated today by the steam reforming of natural gas.

Demonstration technology already exists. On a demonstration level you can purchase hydrogen powered vehicles and some cities have done this already. These vehicles of course are very expensive. Small hydrogen generating stations to fuel a fleet of these vehicles are available.

In fact in the tiny town of Burlington, Vermont (population about 40,000 people) the Burlington Electric Department which has one of the largest biomass to electricity plants in the United States, is going ahead to purchase a hydrogen fueled Toyota Prius. A hydrogen generating station is also being purchased using wind power to provide the electric power to electrolyze water and separate it into hydrogen and oxygen. A hydrogen fueling station will also be purchased. The Prius is being modified with a five thousand PSI high pressure fuel tank and the conventional engine will be modified to use hydrogen fuel. The vehicle will have a driving range of 80 miles or more between fillups, more than enough for a day's operation in a small town. The project will cost about a million dollars and the entire system will be up and running by spring of this year.

Several factors may delay large scale commercialization of hydrogen powered fuel cell vehicles. Automobiles and trucks powered by fuel cells using hydrogen seems further away than the less exciting fuels and technologies discussed elsewhere in this paper. Important economic and technical factors for commercialization of the hydrogen economy include the following:

- Hydrogen is the smallest of the elements and as such is the most dangerous. Hydrogen is a gas at room temperature. Hydrogen will leak through the smallest microscopic tears or cracks in metal and through any joint imperfections in pipes and tubing.
- Hydrogen will explode in air between certain limits in the presence of a spark. An impact can create a spark. Therefore it will be hard to design vehicles to ensure safety in millions of private and commercial vehicles.
- Storage of hydrogen on board the vehicle is a major problem. Current technology restricts vehicle range to one hundred or one hundred fifty miles. The practical technology to store enough hydrogen to drive a car 300 miles without refueling does not yet exist.
- Hydrogen is not found alone in nature in any large quantity although it is a constituent of water. Therefore until it is generated by solar technology, hydrogen should be considered a fossil fuel derived from natural gas no

matter what the ads say using hydrogen today contributes to greenhouse gas emissions.

- On board generation of hydrogen from natural gas is in development.
- On-board generation of hydrogen from water has not yet been developed.
- A large cost will be required to convert our fuel transportation, distribution and fueling infrastructure systems to handle and dispense hydrogen and do it safely. These costs could be reduced if hydrogen is generated at each fuel station from water using solar or wind power. In that case only the local generation plant, tank and stationary fueling equipment need be provided. Hydrogen powered cars will of course come equipped with the special fueling gear to receive the hydrogen.
- On-board generation of hydrogen from water will require even less infrastructure development. We would pull up to the pump and fill our tank with water. Or we might simply take a hose from our garden and turn it on to fill our tank. Think about this one. All the oil companies would go out of business or start selling us water. I have my own water source under the land that I own. Therefore I may never need to buy fuel. I do not imagine this happening in the next ten years.

In any case, it seems conservative to say that the hydrogen economy if it ever comes is still about ten or twenty years away from commercialization and is already way behind the current expanding status of fuel efficient vehicles and alternative and renewable fuels.

V. COMPETING FOSSIL FUEL SOURCES

The United States and North America have large reserves of fossil fuel based energy that is already replacing petroleum based energy. These reserves include the world's largest reserves of coal, large reserves of natural gas and nuclear energy potential. Usage of these reserves for stationary energy is growing significantly every year. These energy sources can be exploited to step into the place of petroleum derived products for transportation. Technologies available for this fossil fuel utilization in transportation include the following:

- Coal based technologies including gasification of coal and Gas-To-Liquid technologies.
- Development of oil sand and tar oil reserves at reasonable prices.
- Gas-To-Liquid technologies based on natural gas.
- Pyrolysis of waste materials including old tires and plastic to produce an oil like liquid.
- Nuclear Energy for the production of hydrogen.

While hydrogen generation and pyrolysis seems further away, it must be said that gas-to-liquid plants from coal and natural gas already exist and much capital, in fact many tens of billions of dollars are being invested world wide to exploit

these potential energy sources for transportation. Coal based Gas-To-Liquid in the United States, especially, seems a near term possibility assuming that the industry can increase its safety record. It really means that fossil derived transportation fuels will be around for some time even after petroleum reserves are nearly exhausted.

Wind, water and solar powered central stations are of course being built at a rapid pace in this country. Nuclear power stations are being talked about for the long term. Without the construction of new nuclear plants some existing nuclear plants are being licensed with increased capacity. Their application to transportation is indirect however but central station power frees up crude oil for use in transportation and makes possible the generation of hydrogen fuel and generation of electricity for plug-in vehicles.

VI. MOTOR VEHICLE DEVELOPMENT

There is great demand from consumers and from Federal and State government regulations for more fuel efficient vehicles. Corporate Average Fuel Economy (CAFÉ) Standards are law and constantly debated to get industry to produce more fuel efficient vehicles. (www.doc.gov/td/auto/cafe.html)

However, the most effective current technology for increasing vehicle fuel economy is the hybrid vehicle. In 2005 212,000 hybrid vehicles were purchased in the United States and by 2012 approximately 780,000 hybrid vehicles are expected to be sold. (www.consumeraffairs.com) We get between 40 and 55 miles to the gallon with our Prius Toyota hybrid and 23 to 35 miles per gallon with our Lexus 400h SUV. Why would we ever go back to ordinary cars? For the Prius at least, we did not spend much more money than we would have for a conventional vehicle of comparable size and quality. These vehicles are equipped with the latest technology including gearless true variable speed transmission so that the engine always runs at optimal speed. Global positioning is optional with maps of every highway, road, town, city and village in the United States and Canada (maps of the world available soon). With all this we have already cut our purchase of gasoline from half to one third of last years monthly expense. It does however, make a difference what sort of hybrid vehicle you purchase.

Meanwhile manufacturers are working to bring out pluggable hybrid vehicles and to reintroduce some kind of electric vehicles in the United States. It is all a matter of how the car is designed to emphasize the engine or the battery and electric motor.

Simple factory produced modifications of gasoline engines changes vehicles to flexible fuel vehicles (FFVs) The technology for this change already exists in production with certain manufacturers and a number of vehicles are offered every year. With an FFV you can run E85 in your gas tank. Ford, General Motors and

Chrysler are all pressing to produce more FFV vehicles and advertising E85 in these vehicles.

If you have a hybrid FFV with little technology development you will use only seven and a half percent of the petroleum gasoline you are currently using in your car. If only half of the cars in the near future are hybrid FFVs our problems with importation of crude oil will have been completely solved without any really exciting new scientific developments.

Current diesel engine powered vehicles can with a little improvement of biodiesel fuels make complete replacement of petroleum diesel with renewable fuels possible.

All kinds of combinations such as diesel hybrid vehicles are being worked on.

The fuel cell is more efficient than the internal combustion engine but relies on development of hydrogen and natural gas fuels as discussed above.

VII. SAFETY AND REGULATORY ISSUES

In the 1930s Germany established a lighter than air passenger industry based on the zeppelin airship design. Many safe trips were made and three large airships were built. Unfortunately helium was not available to Germany during the Nazi years and they elected to use hydrogen to fill the vessels. Upon landing in New Jersey, the Hindenburg Zeppelin burned killing a number of passengers and crew. The result of this accident was the complete shutting down of lighter than air industry for passenger travel in the 20th century.

(<http://en.wikipedia.org/wiki/Zeppelin>). Recent studies indicated that the aluminum coating rather than the hydrogen was the cause of the accident.

In 1963 the Cincinnati Gas & Electric Company started construction of its Zimmer Nuclear Power Station in Moscow, Ohio. Approximately ten years later after spending 1.9 billion dollars and as a result of lax regulatory oversight and fraudulent inspection practices to hide sub standard construction, CG&E shut down construction on its Zimmer Plant. They would have had to spend another 1.5 billion dollars to make it right. The virtually complete plant was converted to a coal fired plant at another very large cost.

(www.ohiohistorycentral.org/entry.php?rec=1717)

At the time the United States was on its way to building a substantial nuclear power industry. Some 100 plants were already in operation and many more planned. (www.nrc.gov/reactors/) An accident at Three Mile Island Nuclear Power Station in Pennsylvania on March 28, 1979 resulted in a partial melt down. Not a single person was injured in this accident however one of the two nuclear

reactors at the site was completely shut down. The resulting publicity caused the industry to stop all new construction. Since 1979, not a single new nuclear power station has been built in the United States while France generates at least 25 % of power from nuclear power.

Now this past month 14 miners were killed in a coal mine accident below ground in a recently restarted mine with a history of regulatory and safety violations. This plant and the lax regulatory environment of the past few years is a result of the recent high energy prices and the revival of coal as a major energy source. We do not know what effect this accident will have on coal mining but in actual fact many miners are killed each year in the United States. Many more in China where safety is not an important issue.

The lesson here is that without strict regulations and industry wide safe practices no new industry can survive for very long.

VIII. SUMMARY

The drivers for replacement of petroleum fuels for transportation with more efficient vehicles and alternative fuels are political and economic. These include availability of carbon sources at competitive prices, tax breaks for private and industrial investment and other factors. Safe operation of these new technologies is crucial to their growth.

The technology exists today and with a little extra development to reduce the demand for petroleum derived fuels with alternative fuels and more efficient vehicles. Other fossil fuels are competing to replace liquid petroleum fuels. The change is market driven and is already underway. It is possible that many technologies and sources will continue to grow and that no single source will replace petroleum. Before you know it you will be using new vehicle technology and alternative and even bioenergy fuels. In a real way the choice of which alternatives to use will be entirely up to you.

So what can you do to help the process. This is a four point program:

1. Educate yourself by first learning every thing you can about your true energy situation.
2. Take personal action to protect yourself and your family from the shock of the change. Purchase fuel efficient vehicles and conserve as much energy as you can. This could include purchase of hybrid, diesel, flexible fuel or plug in vehicles. Where possible purchase ethanol or biodiesel fuels.
3. Take professional action to help your country and your community become self sustaining in energy and transportation by advocating for new laws, energy incentives and new technology.

4. Advocate passage and enforcement of strict local, state and federal environmental and safety laws and assure compliance with these laws to protect the public and encourage the development of new energy technologies.