THE RENEWABLE FUELS SITUATION

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Energy and Economic Growth

To sustain and grow the global economy and to provide acceptable standards of living for world's growing population will take an enormous amounts of energy. Energy in all its forms is crucial to the functioning and growth of a modern economy such as exists in the United States, Europe, and Japan. For economies such as China and India to develop will take an increasing amount of energy. The question is where are we going to get the energy? It has been estimated; maybe hoped is a better word, that by 2050 one-half of the world's energy will come from non-petroleum sources, including wind power, solar, hydro, hydrogen cells, nuclear, and bio-fuels. Though various types and forms of energy will be discussed, this paper is mostly about liquid bio-fuels.

A wide range of industries are reliant on petroleum as an input; a raw material for producing other goods. But liquid, petroleum-based fuels are vital for motive power. These include gasoline, diesel, jet fuel, and natural gas. Natural gas is included because it can be used to generate motive power, although its primary uses are to provide heat, to generate electricity, and as in input in the manufacture of nitrogenous fertilizers. Diesel fuel and closely related products can also be used to provide heat and generate electricity.

Fossil Fuels

There is growing concern over the use of fossil fuels which currently provide about 90% of the world's energy needs. One concern is the emission of green house gases from the combustion of fossil fuels. Switching to renewable fuels does not solve that problem. The other major concern with fossil fuels is the perception of scarcity. The world does use extremely large amounts; about 25 billion barrels of oil per year, but, fossil fuels are not scarce and we are not about to run out. It is a matter of economics and geopolitics. We are running out of fossil fuels that are easy and inexpensive to extract and much of the world’s supply of fossil fuels are located in unstable parts of the world.

If all liquid or semi-liquid bituminous hydrocarbon sources are included, we have more than 100 year’s supply at current rate of usage. If natural gas and coal are included, we have about 450 year’s supply. Extraction of oil from tar sands and oil shale and making liquid fuel from coal is expensive. Using natural gas as a motive fuel is not convenient. When oil is priced at $20 per barrel, these alternative sources of liquid fuel are not economically feasible. When oil is selling at $70 per barrel, or higher, they become much more attractive.

The United States uses about 20 million barrels of oil per day, but produces only about six million barrels. We increase oil usage about two percent per year, but our economy has been growing at about 3.3 percent per year. As we have moved from a manufacturing-based economy to a service and high tech economy we are using proportionately less oil. U.S. usage of oil in barrels per dollar of GNP generated is about one-half of what it was in 1947.

Imported Oil and OPEC

We have had to turn increasingly to imported oil. It has been estimated that the cost of extracting a barrel of oil in the United States is $10 to $12. On the Arabian Peninsula the cost has been estimated to be $1 or less. In some places the oil is under pressure and there is no pumping cost. Of course, the cost of transportation raises the delivered cost to U.S. ports.

The United States spends $175 to $200 billion per year purchasing imported oil. A list of the ten largest suppliers of U.S. imported oil begins with Canada and includes only four OPEC member countries. The OPEC nations have formed an international joint monopoly; a cartel, to control the supply and price of oil. However, the current high price of oil is due more to demand-side factors and geopolitical unrest than OPEC. Cartels work well only if members have absolute control over supply, there are no substitute products available, and members don't cheat on one another. None of those conditions exist for OPEC. United States oil companies have diversified by purchasing oil from non-OPEC nations. We don't buy much from Russia because of transportation costs, but the large increase in Russian production has reduced the power of OPEC to control price.

A side note: OPEC has always worried about killing the goose that lays the golden eggs. In other words, forcing the price of oil so high that it causes a drop in usage of petroleum products or a global recession, either one of which would hurt OPEC countries. Economists use to warn that oil prices above $30 per barrel would slow economic growth and perhaps cause a world-wide recession. But oil price broke through the $30 ceiling without any apparent impact on economic growth. However at $75 per barrel there are signs that economic growth is weakening. But OPEC members now know that the upper limit on oil price is much higher than they thought; and they like the money. It is estimated that a one dollar per barrel increase in the price of oil results in a five billion dollar transfer from American consumers and businesses to overseas oil producers.

Renewable Fuels

The high prices of liquid fuels, the transfer of billions of dollars out of the U.S. economy, reliance on unreliable and sometimes antagonistic overseas suppliers, and the perceived need to reduce the usage of fossil fuels has led to wide-spread support for producing liquid fuels from renewable agriculture-based feedstock. Producers, consumers, politicians, and the investment community have embraced the idea and given support in the form of subsidies, grants, tax breaks, and investment capital. Ethanol production has ramped up quickly to become a major industry that is impacting agricultural production, livestock feeding, and rural communities. The bio-diesel industry has been slower to develop, but promises to have similar impacts as ethanol production.

The interest in producing fuels by biological means is part of a movement to biological value-added processing, sometimes referred to as bio-refining. This means fractionating agricultural commodities into component parts and using biological or chemical processes to produce useful bio-products or intermediary compounds. The assumptions underlying these efforts are:

- petroleum will remain expensive for the foreseeable future
- bio-products will be less expensive than comparable petrol-based compounds
- the raw materials for bio-products can be grown anew each year
- biotechnology may yield entirely new chemical and biological compounds.

Although the technology has been understood for decades, renewable fuels gained legitimacy with the signing into law of the Energy Policy Act of 2005, which created a national renewable fuels standard. The legislation established a baseline for renewable fuel use at 4 billion gallons in 2006; growing to 7.5 billion gallons by 2012. The ethanol industry will be the primary beneficiary initially and is expected to double in size in the next six years. Currently the industry has production capacity of about 4.3 billion gallons, with an additional 2 billion gallons under construction. Another major boost to the ethanol industry was the rapid phase out of MTBE in the spring of 2006. MTBE was an oxygenate, fuel additive used to raise the octane level of gasoline. The State of California banned the use of MTBE because of groundwater contamination. When petroleum companies were not granted legal protection from MTBE-related lawsuits, they replaced MTBE with ethanol. Even though ethanol production had increased dramatically in recent years, there was a relative shortage for a few months which caused the price of ethanol to spike. Price has since dropped to more normal levels.

Net Energy Balance

Ethanol production involves the biological processing of agricultural products; corn and sorghum. The grains are processed to convert carbohydrate to sugar and to ferment the sugar. It is capital intensive, requires close monitoring because of the biological organisms used, and requires energy. Bio-diesel production is a much less complicated process. It involves converting vegetable oil mixed with methanol into diesel fuel and glycerin. No microorganisms are used, it is less capital intensive, and the conversion process doesn’t require much energy. One concern people have had, especially with ethanol production, has been with the net energy balance. Both ethanol production and bio-diesel conversion have positive net energy balances. More energy comes out of ethanol and bio-diesel production processes than goes into them. What many people overlook is gasoline production has a negative net energy balance. In other words, it requires more than a gallon of gasoline energy equivalent to get a gallon of gasoline out of a refinery.

Ethanol

Ethanol requires large amounts of corn. In 2006-2007, approximately 20% of the U.S. corn produced will be utilized to make ethanol. Corn usage for ethanol production is expected to equal exports. Although grain sorghum can be used in the ethanol production process on a one-to-one basis with corn with no adjustment in the production process, corn makes up about 98 percent of the grain going into ethanol production.

Total corn usage in 2006/07 will exceed corn production by about 800 million bushels. The U.S. had a relatively large carryover going into the year. From now on, U.S. corn growers will need to produce at least 11.8 billion bushels per year, and that has occurred only one time in history. Any reductions in yield will push corn prices up, dampening exports, livestock feeding, and ethanol production. To produce that much corn will require competing acres away from other crops or increasing corn production yields.

Another implication of increased ethanol production is the generation of large amounts of the by-product distiller’s dried grain. DDGs retain about 30% of the nutritional value of corn and in usage replace corn and soybean meal in livestock rations. Because of the high energy cost of drying distiller’s grains, ethanol plant managers prefer to sell wet DDGs. But wet DDGs are expensive to haul long distances and will spoil in two or three days. Dried distiller’s grains will not flow well when handled if they are not dried properly.

Efforts are well along to fractionate corn before it enters the dry-grind, ethanol production process. The oil germ is removed and the oil can be used to produce bio-diesel. Ethanol plants operators are looking forward to producing two fuels from one grain.

There is considerable interest in cellulosic ethanol. Although switch grass is usually cited as the feedstock, nearly any cellulosic material can be used such as wheat straw, corn stover, or waste hardwood material. However, cellulosic material will not be free, as many imagine, and there may be problems with variations in quality that will make ethanol production process control even more challenging.

Currently cellulosic ethanol production is not feasible. A technological breakthrough will be needed to make it economically viable. The process used now requires enzymes to break cellulose down into fermentable sugars. Currently, enzymes are expensive and take along time to break down cellulose. Even when improved enzymes work faster, the process will require large holding tanks. The cellulose conversion process will take place in a three story front-end add-ons to existing grain-fed ethanol plants. Long term, cellulosic ethanol production may become viable. Projections show the process has the potential to yield ethanol at a price competitive with gasoline.

For now, and perhaps for a long time to come, corn will be the preferred feedstock for ethanol production. The corn to ethanol production process has been made highly controllable and efficient. Corn has characteristics that have great appeal to processors: large quantities are available, quality doesn't vary much, it is easy to handle, and it can be stored.

Other feedstocks are being evaluated for ethanol production. Sugar beets are a good source of fermentable sugar but are seasonal and can not be stored for long periods. Sugar cane produces the most fermentable sugar per acre of any crop currently grown. But the acreage of sugar cane in the United States is limited. If investors can be convinced to fund sugar-based ethanol plants in subtropical parts of the U.S., there will likely be an expansion in sugar cane acreage.

One of the dangers faced by the ethanol industry is overcapacity. Total industry capacity is about 4.8 billion gallons of production per year. There are 39 plants under construction and 7 expansions taking place. All together, the industry will have total capacity of 7.4 billion gallons. The baseline for renewable fuels is 7.5 billion gallons in 2012. If oil price remains very high ethanol can compete directly with gasoline. But a drop in oil price, a rise in corn price, or a drop in ethanol price could squeeze industry profits and force some producers to shut down.

There is one other danger on the horizon. Producers of MTBE are converting facilities to produce iso-octane and iso-octene from isobutylene which is a product of oil refining. They are oxygenates that can substitute for ethanol and may take market share away.

The food or fuel debate is one of those issues where emotion could trump economic or scientific evidence. It is difficult to argue against feeding starving people or hungry livestock. Of course, ultimately the market will decide who gets the grain, food, feed, or fuel through the pricing mechanism. The price of corn is still far below the point of causing major reduction in human food consumption or livestock feeding. But if there is are severe shortfall in corn production one year, the market will allocate the available supply through the pricing system based on the willingness to pay. It is likely corn will go to human food first, then to livestock feeding, and then to ethanol production.

Bio-diesel

Bio-diesel is made by chemically reacting vegetable oils or animal fats with an alcohol, usually methanol, to produce fatty-methyl ester and a by-product, glycerol. A simple formula is 100 gallons of oil or fat plus 10 gallons of methanol equals 100 gallons of bio-diesel and 10 gallons of glycerol.

Bio-diesel is superior to petrol-diesel in several ways. Bio-diesel emissions are free of sulfur and have less carbon compounds. Bio-diesel has a higher cetane number than petrol-diesel and far superior lubricity. Sulfur provides lubricity to petrol-diesel, but government regulations will soon require a reduction of sulfur from petrol-diesel. This will create an opportunity for the addition of bio-diesel to petrol-diesel to provide the needed lubricity. A two percent mixture, called B2, would be sufficient. One drawback to bio-diesel is it will jell at cold temperatures and requires an additive.

Currently there are 65 bio-diesel plants in the United States with total capacity of 365 million gallons per year (gpy). The bio-diesel output from these plants in 2005 was only 7.45 million gallons. Most of the plants are small, under 10 million gpy batch process plants. They are inexpensive to build, but tend to be relatively high cost per unit of output to operate. They primarily use waste fats and oils as feedstock and produce soap and shampoo rather than bio-diesel. A major problem for these plants is quality variability in recycled fats and oil feedstock and in output.

The rising interest in bio-diesel has stimulated an expansion in the industry. Fifty-eight plants are expanding or are under construction. In the next 18 months, bio-diesel industry capacity will increase by about 700 million gpy. Most of the new plants will be in the 30 million gpy range. ADM has announced an 80 million gpy plant in North Dakota to convert canola oil to bio-diesel. These plants will use a continuous process to convert multiple feedstocks of vegetable oil. The large-scale plants are capital intensive to build, but are relatively low cost per unit of output to operate. Catalysts and process chemicals can be captured for reuse. There is very little data available for large-scale plants, but it is believed they can compete directly with petrol-diesel when oil is priced as low as $40 per barrel.

An average sized bio-diesel plant; of the type currently under construction, 30 million gpy, will require the oil from about 400,000 acres of soybeans each year. Feedstock for bio-diesel plants will be soybeans oil in the Americas, palm oil in Southeast Asia, and rapeseed oil in Europe. The key to profitability in bio-diesel production is to have a reliable source of large quantities of reasonably price vegetable oil. Bio-diesel producers who rely on imported vegetable oil will be at a cost disadvantage in an industry where low cost production is a major objective.

Research is underway on production of oil from algae which has the potential to yield as much as 20 times the oil on a per acre equivalent basis as the best vegetable oil crop. If algae oil works out, bio-diesel made from it may be competitive with petrol-diesel, but it will be many years before we know if that is economically feasible.

It is curious that farmer/investors have not been as active in forming the bio-diesel industry as they have for ethanol production. The reason for this is growers can not benefit directly from a bio-diesel investment as they can from an investment in an ethanol plant. A farmer/investor can sell his corn directly to an ethanol plant, receive dividends from the plant's operations, and enjoy an appreciation of his original investment over time. A soybean producer that invests in a bio-diesel plant would have to sell his soybeans to a crusher, then the bio-diesel plant would buy soybean oil from the crusher to convert to bio-diesel. It is not certain the soybean producer could receive a higher price for his soybeans, but the crusher would certainly include his crushing margin in the oil price. That arrangement would reduce the profitability and investment value of the bio-diesel plant. The conclusion is a farmer-owned bio-diesel plant should negotiate a long term oil purchase agreement with a crusher or also include a crushing plant. Five farmer-owned cooperatives with crushing facilities are expanding existing bio-diesel plants or are building new bio-diesel plants with combined capacity of about 122 million gpy.

A consequence of increased soy-diesel production will be an increase in soybean meal production. Up until now, the meal component contributed more to the soybean crushing margin than the oil component. But demand for soybean oil will cause the price of oil to increase, changing the value equation. When the value of the oil component becomes greater than the value of the meal component, meal will become the byproduct and meal price is likely to fall. The result will be an increased supply of lower priced soybean meal available for livestock feeders and for export.

There was interest in producing renewable liquid fuels during the oil crisis of the mid-1970s. Renewable fuel projects were put on the shelf when oil price fell in the 1980s. Industry experts are quoted as saying this time oil price will not drop and renewable liquid fuels will be a significant source of energy for consumers in the United States in the future.