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BRYN MAWR COLLEGE

Emeritus Gatherings

The Oil Business: Some Facts and Some Fictions

Lucian B. Platt

February 5, 2004

It is a pleasure to be here again with long time friends. A few years ago I tried to interest you in the hard data about global warming, a subject still distorted in the public media as alarming Alarmism sells papers, but it is a bad foundation for policy. My aim was to reduce the alarmism. Here my aim is the opposite - to provide data that may be alarming but deserve attention.

Today I want to talk about the oil business, frequently presented as evil and not well understood by the general public. Full disclosure requires me to note that almost half the geologists in the world are employed in the oil business, but I have never been on the payroll of any oil company, though I received unsolicited offers in three different decades.

The oil business is, well, fluid, if you will forgive the choice of word. The business flows into new shapes over time, but one doesn't see the changes - in part because they are gradual though persistent, in part because writers in the media don't understand oil, and in part because oil is such a large and complex business that little changes here and there, for example the geography of sources, escape notice. You have no idea where the oil came out of the ground that produced the gasoline at your neighborhood pump. An example of the complexity is Talisman Energy, a company you probably never heard of. It operates in 15 countries on four continents.

My remarks today present a little history. I show how oil became a significant factor in international relations and thus a substantial factor in the world strategic posture of many countries. There is a bit of discussion about how oil is generated and produced, noting improvements in finding new fields. At the end a look into the fog of the future.

Apparently the first hole dug in the ground specifically to get oil was in western Pennsylvania a century and a half ago. However, in many places around the world oil seeps out of the ground all by itself. It had been used by indigenous peoples for a long time. Conestoga wagons used oil seeps in SW Wyoming for axel grease in 1845.

In 1890 Gottlieb Daimler founded a company that produced an automobile named the Mercedes after his daughter. In 1892 Rudolf Diesel patented his design of an internal combustion motor. A few years later he came by ship to get a gold medal at the Franklin Institute downtown. The growth of the oil business was "under way," a phrase I return to.

We can trace a few steps in the change of the human condition from subsistence farming in the 1500s and 1600s with frequent local catastrophes of famine in those cold times. The steam engines, inventions by Thomas Savery in 1698, by Thomas Newcomen in 1712, and by James Watt in 1763, made possible a more dependable propellant than wind for ships and on land a

Some numbers on the oil business

Table from Yergin footnote on page 830, condense
Production in barrels per day. One barrel is 42 gall

Year	USA	Russian W.
1885	60,000	38,000
1915	770,000	188,000
1945	4,695,000	408,000
Current data	9,000,000	

Fig. 1

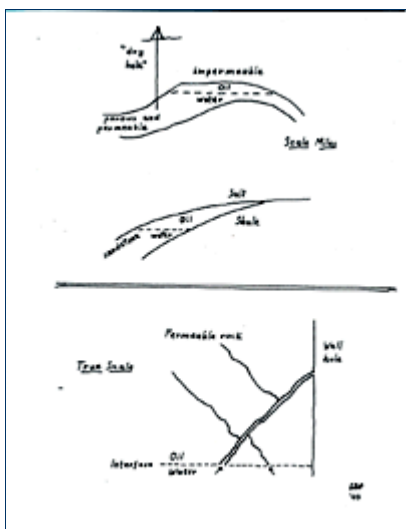


Fig. 2



Fig. 3

Fig. 3

made possible a more dependable propellant than wind for ships and on land a faster mode of transportation than horses, namely the railroad. The steam engine industrialized western Europe and eastern United States where coal was available near iron ore. The Ruhr in Germany and Bethlehem, PA, come to mind. Use of coal and iron increased as railroads were built, though high pressure steam boilers exploded too often. I have gone through this change in human circumstances to point out that the 1800s were the coal century. Among other benefits coal made possible the electricity we depend on. It made possible improvement in our food because railroads could bring food from farther than two days on a horse. Coal is still an important fuel in Poland, Russia, China and South Africa, and it generates a third to a half of our electricity.

I describe the twentieth century as the oil revolution in order to differentiate it from the coal revolution, and thereby to point out that what is commonly called simply the industrial revolution was not a single event or step. Kerosene was used in lamps by the 1870s. Through the inventive enterprise of Daimler and Diesel and the business drive of Henry Ford and John D. Rockefeller, to name just a few, oil slowly became a major world commodity.

A name you probably never heard is Aeilko Jans Zijiker. He single handedly started the Royal Dutch Company on Sumatra in the 1880s based on oil seeps the natives had used to enhance torches according to Daniel Yergin. Zijlker died in 1890, but a man named Kessler re energized the enterprise, and what is known as the Royal Dutch Shell Group, headquartered in The Hague, is the fifth biggest shareholder corporation in the world with revenues of \$550 million every day, including the Fourth of July and Sundays. It is not a trivial matter that of the ten biggest corporations in the world, three are oil companies and four more are automobile companies.

Fig. 1

In addition to the first handout sheet, here is some perspective on oil's growth. Tzarist Russia in 1895 produced 126,000 bbl/d (barrels per day) from Baku on the western shore of the Caspian Sea. In USA 144,000 bbl/d were produced in various places. For example, the first successful oil well in Wyoming was drilled before it became a state, which was in 1890. All the rest of the world combined produced less than 10% of Baku plus USA in 1895.

Those in the navy will remember the words "under way." Before World War I the First Lord of The Admiralty shifted the British navy from coal burning to oil burning, thus maintaining the world supremacy for the British navy. His name was Winston Churchill, and he was pushed to this decision by an Admiral Fisher who noted that oil was cheaper than coal east of the Suez Canal, and east of the canal was where most of the British Empire was located.

For this significant point and some other facts of history I credit the Pulitzer Prize winning book by Daniel Yergin titled *The Prize*, published in 1991 by Simon and Schuster. Other bits came from *The Oil and Gas Journal*, the magazine *World Oil* both put together by and for oil people and very dependable and various other sources. Yergin's history of the oil business is meaty and has a good index. I recommend it if the subject interests you.

Here are a few bits and pieces about finding and extracting oil and natural gas. Organisms living in shallow seas may settle to the bottom when they die. If they get covered fast enough by sediment they don't rot. If the sediment gets buried and gets hot enough, say 100 degrees centigrade or 200 degrees Fahrenheit, the mess of organic material gets reconstituted into the mess we call petroleum or natural gas. If it gets too hot it oxidizes to carbon dioxide. And it may leak out of the ground anyway.

Viscous oil moves through the former mud inches per year or a few feet per year, so a hole drilled into these so called tight shales yields no oil even though it is nearby; it doesn't flow to the hole in the rock, the well. But in surprisingly common cases the oil has oozed over time into more permeable rocks that are beneath less permeable layers. A hole drilled down to these so called traps yields oil or gas. The second handout illustrates two simple kinds of traps. The figures are cross sections into the earth. Note the scales of the upper and lower halves of the page.

Fig. 2

The upper diagram shows one kind of structural trap, an arch in layers of sedimentary rocks. The second shows a stratigraphic trap, where sandstone tapers out in impermeable rock such as salt and thus traps the oil. If one drills, one may just get water, anomalously called a "dry hole." If there is oil, that's nice, but there is a finite amount of oil in that trap. It runs out eventually.

The oil is not in a pool like a lake, though the word pool is often used. The oil is in the pores in the rock, for example between the sand grains in sandstone. Rock that is 1 % or 2% pores is a good source if the pores are connected, in other words if there is permeability so the oil can flow to the well. Even 1 % porosity in a large trap can yield a lot of oil. A cubic mile of rock with 1% oil contains about 1.5 billion cubic feet of oil, or 250 million barrels. A pertinent question is whether enough oil will come out fast enough to amortize the debt incurred in exploration, drilling successes and failures, and then developing the new field with feeder pipes, etc. How fast and for how long?

Only a third to a half the oil can be recovered in most cases. And there is an optimal rate of flow in each field and even from well to well in one field because of variations in permeability and incursions of water, typically along cracks, illustrated in the lower diagram of the handout. Because water is less viscous than oil, it can get past the oil. It flows easily in cracks past oil in the bulk rock, so the oil is left behind and never comes to the well. If one takes oil more slowly, one may get more oil eventually but be bankrupt by then for lack of cash flow.

To sum this up, finding and developing an oil field is a problem in four dimensions plus finance, this last a prediction into the fog of the future on such matters as the price of oil, the price of renting supertankers, and the price of money into the future of the field, itself uncertain. Answers to any of these questions are just guesstimates, never mind corruption and political breakdown at the source or in transit to a refinery and on to market. These points are fundamental to the oil business. If you don't find more oil tomorrow than you took out yesterday, you go broke.

In the early days oil was found unexpectedly under such great fluid pressure that it pushed out the drilling mud and gushed in huge fountains some of

that it pushed out the drilling mud and gushed in huge fountains some of which caught fire. For example, Spindletop, the first oil well on a salt dome, gushed in 1901 and ushered in major SE Texas oil production. One result is Houston. I have not heard of a gusher anywhere in decades because modern drilling rigs have automatic pressure controls. The pressure comes not from compressed gas but from the curvature of the meniscus between oil and water in the tiny pores in the rock.

This was shown by M. King Hubbert when he worked at the Shell Development Lab in Houston. King was a brilliant crank who did not suffer fools at all. He was the head of the lab in the 1950s, its most productive years in my opinion. During a downturn in the oil business I think it was in 1959 a senior vice president came over from The Hague and told King that his people weren't doing much finding of oil, and he was going to have to cut his staff. I heard that King replied, "My people are worth more in the shower than your people are worth." I've heard the same story told about the head of Bell Labs, whom I never met, and it fits both their reputations.

King left Shell and went to the US Geological Survey in Washington where I got to know him. He made startling predictions about the time and rate of decline of US oil production and of world oil production. I brought him here in the early 70s to talk about this and the implications. His predictions for this country are proving pretty good, but for the world he was too pessimistic, in part because he did not foresee advances in drilling capabilities, particularly in deep water. Production from a region undrilled at that time is used to illustrate how oil and gas have affected world strategy and international relations, not just international economics, during the last 50 years, but the story begins long before that.

The Suez Canal was constructed by a French Company and opened for traffic in 1869. The British maneuvered a financial take over of the canal in 1875, and British troops occupied Egypt in 1882. In 1888 an international commission agreed that the canal, entirely inside Egypt, was effectively "international waters." Anyone could put a ship through by paying the fee. The phrase "international waters" is significant in world oil flow because running through a nation's waters costs a shipping fee and may subject the ship to stoppage. Important examples of "international waters" include the Strait of Hormuz out of the Persian Gulf and the Strait of Malacca between Malaysia and Indonesia near Singapore. In each of these cases artillery on either side could sink any ship in the deep water channel. A ship not going through the Strait of Malacca from the Indian Ocean must go an extra 10,000 miles around Tasmania to reach Japan or China.

During World War I world production of oil was 1.2 million bbl/d, 70% from the USA. Note seven zero percent! Russia was still second but way behind. Mexico was significant, but Rumania and the Dutch East Indies were third and fourth. World War I was the first mechanized war. Britain and France imported oil from us, their only possible source. The German war machine ran on Rumanian oil at 33,000 bbl/d. I am not sure an aircraft carrier could stay in combat for a day on 33,000 bbl/d now. A dream was to take Baku but not really tried.

In 1938 the Mexican government confiscated the oil business there. By then Venezuela was producing several thousand barrels per day, and this country was producing several million barrels per day, and still more than half the total world amount. Admiral Fisher's statement in 1910 that oil was cheaper than

world amount. Admiral Fisher's statement in 1910 that oil was cheaper than coal east of the Suez was still true, but there was NO oil west of the canal except on this side of the Atlantic. So again US oil ran the second war in Europe. The Germans took Rumanian and Hungarian oil and pushed for Baku but never made it.

When Nasser grabbed control of the Suez Canal in July, 1956, the canal was the artery for the economic life blood of Britain, France and Germany. Though coal was still very important, oil was growing fast, and it all came through the canal. Nasser's grab was a true economic crisis for western Europe. France and Britain landed troops at Suez in November. The US press, remarkably provincial then as now, presented as a victory for President Eisenhower the forcing of Britain and France out of Suez and thus in some vague sense saving Egypt.

Of course, Eisenhower was in a position of strength; the US was not at that time importing any oil, though exporting it had stopped. The British Pound Sterling continued down, and building supertankers accelerated.

In 1959 one of the biggest gas fields ever found was drilled under Groningen in northeast Holland. The geology under the North Sea is similar to the geology under Groningen. Seismic exploration techniques, especially at sea, had improved considerably. It really began after WWII with leftover depth charges. Within a few years Norway and Britain had agreed on the demarcation line between them, and giant structures were designed and built thought to be safe for drilling in the stormy 300foot deep North Sea, and techniques were developed to connect the wells safely to pipe and bring oil and gas to shore.

The first oil came out on the Norwegian side in 1969 and on the British side in 1971. There had been huge expenditures of capital for a decade with nothing to show for it until then. Is this how you invest ten years on a hope? Oil companies must. In the 80s Margaret Thatcher as Prime Minister was able to face down the coal miners not just with her backbone but because she had an alternative to the coal.

Among the benefits of this then new but now declining major oil and gas province, the North Sea, is the end of the London pea soup fog. Instead of millions of inefficient little polluting coal stoves, people now heat and cook with natural gas so, even though London is still dreary in the winter (do they hope for global warming? not after last summer) , anyway the pea soup is gone. Another benefit is that Britain and Norway, even Denmark, export oil instead of importing it, and this improves the monetary exchange rate. Britain, not using the euro, was in 2002 the second biggest source of oil for France and Germany, each without any domestic source. But their biggest source was still Saudi Arabia, now by supertanker 40 days around Africa.

I reviewed this history in order to point out a more recent international political strategy matter. A war in Iraq might have brought a stoppage of supertankers out of the Persian Gulf. Forty days after the last one got out there wouldn't be any more arriving in France or Germany, each with a politically weak government. There might have ensued not just political breakdown but economic collapse. You can see I don't eat "freedom fries," but I can understand their opposition to a war in Iraq. I saw no mention of the oil factor bearing on their world position in anything I read in American papers in 2002.

papers in 2002.

In January of 2003 French President Chirac suddenly appeared in Algeria after decades of no such visit by a French head of state. I can almost hear him whisper in the traditional hug, "Will you cut us off in a war?" And I imagine the head of state of that Muslim country beset for years with terrorist killings and producing a million bbl/d responding, "I don't know." The same position against the war applies to China and Japan. Both governments are under stress, and both countries are heavily dependent on oil from the Persian Gulf. Obviously my message here is that the strategic reality is different from the nice sounding righteousness in the American media.

I would like to give a few minutes to OPEC, a possibly misunderstood operation the history of which in the early years contrasts with today's organization. A sort of gentlemen's agreement among the governments of four countries exporting oil began in the 1950s. Some of them may have been gentlemen, and there may have been bits of agreement in the fiercely competitive world oil selling game of the time, perhaps even between Persia and Saudi Arabia, the two biggest exporters then. Gentlemen's agreements among governments are one thing. Signed contracts willingly entered into by both parties are something else.

During the 1950s oil was discovered in southern Algeria, Libya and Gabon, and production in the Soviet Union went up faster than consumption. There was then what was called the seven sisters the world class oil producing companies. You will remember the names: The California Company (later Chevron), The Texas Company (later Texaco), Socony Vacuum (SOCONY standing for Standard Oil Company of New York), Esso (S O standing for Standard Oil), another company now gone from Pittsburg and pretty much gone completely, Gulf, a company now called British Petroleum or BP, and the Royal Dutch Shell Group (still maintaining its name and position, the only one). Five of the seven were American companies for the obvious reason that most of the oil business was in this country until then. Years later an executive of one of the seven sisters said of the situation in 1960, "The reality of world oil was U.S. import quotas, Russian oil exports, and competition," quoted in Yergin's book. You might have forgotten, as I had, that Eisenhower imposed import quotas in 1959.

In 1962 Tariki was fired as Saudi oil minister, and Ahmed Zaki Yamani became the minister. By then the majors were drilling all over the world outside the Iron Curtain and with great success. The result was a glut and a plunge in prices. The governments in OPEC grew to ten including Indonesia, Libya and by then Nigeria. They took back ownership of oil in their countries from the companies who thought they had bought the right to find and take it. In the Fall of 1973 the OPEC governments simply announced the world price of oil triple what it had been in the summer. At that time OPEC governments controlled more than half the world oil production, and so the cartel the only cartel of governments I have heard of was able to make the price stick.

An amazing outpouring of jackass remarks came from an amazing bunch of jackasses. A senator from the state of Washington, which doesn't produce any oil or gas, claimed that supertankers were sitting off New Jersey waiting for the price to go up. This, according to the senator, was a conspiracy by the oil companies to increase profits. The fact was that the supertankers were waiting until other tankers finished emptying and left the berths. You cannot land a

until other tankers finished emptying and left the berths. You cannot land a second ship in one berth. Why didn't he ask the N.Y. Port Authority? He knew so little he didn't know that he didn't know.

Conspiracy claims against oil companies still come out. I have never heard of any shortage anywhere at any time caused by an oil company. Every shortage was caused by politicians. A final point about sources of supply: in 1973 more oil wells had been drilled in this country than in all the rest of the world combined. But by then the companies were drilling mostly elsewhere because that is where likely untapped prospects were. This is just common sense, so today oil companies are truly world corporations. It is necessary.

OPEC is no longer a very effective cartel. The now eleven governments produce less than a third of world production. The now smaller Russia is expanding its output about 5% per year and apparently surpassed Saudi Arabia in 2003 because the Saudis curtailed their flow. At the moment an impediment to expansion in Russia is lack of pipeline capacity. Expensive new infrastructure is needed, called long term investment. The major oil companies are risking billions there in the belief that contracts in the new Russia will be kept. Well, maybe, and maybe they are gentlemen too.

My subtitle was "Some facts and Some Fictions." I have given you enough facts. Here come four fictions about the future.

Let's consider the present and look ahead. Today oil is adequately available and at a reasonable price everywhere in the world if politicians and government corruption do not interfere. In the US oil production is going down perhaps 1% per year, and consumption is going up about 1% along with our population growth. These figures are smoothed over a few years but accurate enough and reasonable as projections into the fog of the future. The US Dept. of Energy has predicted a 1 increase in this country for the next 20 years, but I don't believe it is possible.

Fiction 1. Frequently repeated assertions that we can reduce our dependence on foreign oil by mandating more efficient automobiles are bunk. Do the arithmetic. Even if all 16 million new cars sold this year were suddenly 20% more efficient, an impossibility in view of slow changes in the auto industry, this would not counteract the increase in consumption about 40 million barrels not consumed versus the 70 million annual increase. I am not against conservation, but it will not accomplish what is claimed.

Fiction 2. Frequently repeated assertions that drilling in the Alaska National Wildlife Refuge would reduce our dependence on foreign oil are also bunk. ANWAR could eventually somewhat slow the continuing decrease in domestic production, but not for several years and only for a couple of decades anyway. So here again the gap between consumption and production, thus our dependence on imports, would never decrease.

Fiction 3. Other facts you should know concern the dangers of drilling there, namely to the environment. Damages to the environment were predicted prior to the development of Prudhoe Bay and building the Alaska pipeline. All these predictions have failed to occur. You may have seen reindeer grazing under the pipe. I saw a photo of a family of bears walking on the pipe where it is five feet above ground. The biggest danger to this endangered species would appear to be that a cub will fall off. Incidentally, statements by Lovins and Lovins in Foreign Affairs in 2001 about the pipeline deserve more ridicule than I was allowed to print.

ridicule than I was allowed to print.

Well, so what? That was then at Prudhoe. What is now? Drilling technology and drilling practice have advanced in 30 years since Prudhoe exploration, just as they advanced in the previous decades. If you went to Elk Basin, a field on the border of Wyoming and Montana south of Billings, all your worse fears about pollution would have visual confirmation. But the field was developed in the 1920s when no one thought about such things. The field still produces a little, but the antelope come right to the edge of the field to graze, and hawks sit on the poles.

Fig. 3

ANWAR is 30,000 square miles, almost the size of Indiana.' It is shown in yellow in the upper right of the third handout. The area of the main map on this figure is colored in red on the inset. The main map outlines the area of oil targets, totaling 2,500 square miles. Modern drilling is done from a pad including everything about the size of a football field, but from that one derrick many holes can be drilled aimed accurately to whatever potential oil targets there are within several miles of the pad. So the concern about drilling in ANWAR involves four football fields in an area half the size of Connecticut or a third the size of New Jersey, which doesn't seem much of a threat to 100,000 migrating reindeer.

Fiction 4. You have heard that by the time we have finished with ANWAR oil we will have the hydrogen fuel cell to save us from foreign oil. This is pie in the sky. There is no way to make hydrogen cheaply. I mean cheap energy, not money. There is not even a design for the infrastructure to get hydrogen from the separation plant to your car.

I called Ballard Power Systems, a hydrogen fuel cell developer in Vancouver, B.C., and got through to an engineer. My question was, "How much do you pay for hydrogen?" His answer was, "We don't make hydrogen." I talked around the subject indicating that I know a little thermodynamics, and he said the same four words again. I guess he knows that fuel cells are not realistic for cars. The chief engineer for developing fuel cells at Honda was quoted in Business Week in December, 2002, as saying that he hoped to get the cost of a fuel cell car in as little as ten years down to \$100,000. I recommend you place your orders now; at that price they will sell like hotcakes.

The Amer. Assoc. of Petroleum Geologists, a professional group, predicts that oil will continue to increase as a share of total energy production in the world for about 50 years. How fast the number of barrels a day will go down, as opposed to percent of total energy used, is not clear, but almost everyone in the business believes a steady decline will be well started by the end of this century. Ken Deffeyes at Princeton wrote that maximum production will be during this decade, as Hubbert did 40 years ago.

So civilization will have to do something different. Forty years ago King Hubbert's proposal was nuclear power. I've heard that France gets 3/4 of its electricity from 59 nuclear plants. With 70 million people, a quarter of our population, they have more than half our 103 nuclear plants. Japan has 57, but a quarter of them are out of service because of government mistakes. Nuclear power plants are not politically correct right now, but they might come back. The nuclear power company in France, government owned, is talking up building more because they are cheap. Another solution for the

talking up building more because they are cheap. Another solution for the near term - in this context near term means decades - is under way, to use that phrase yet again, a new solution by ship.

In many oil fields natural gas comes up with the oil. In the past the oil was sent off to a refinery, but the gas was simply flared. There was no market for it and no way to get it to market anyway. But so much gas was found that big natural gas pipelines were built to eastern Pennsylvania and New York where coal gas had been used so the local pipes to houses were already available. In southern Oklahoma are towns named after our Wayne, Wynnewood, and Ardmore. Ardmore, Oklahoma, is the center of a big gas province. In the winter of 1974, during the first OPEC crisis, bumper stickers appeared there reading, "Let the bastards freeze in the dark," The point was that their gas had been contracted for up here, so there wasn't enough left for Oklahoma. Gas is still flared, perhaps ten billion cubic feet a day, in various places, e.g. Kazakhstan, offshore west Africa, and some in Saudi Arabia, though the Saudis are building chemical plants to use the methane.

You may have noticed last summer our central banker reporting to Congress about a natural gas shortage in this country. Greenspan mentioned eventual availability of liquefied natural gas, to be imported like half our oil is now. Liquid natural gas has been coming on fairly rapidly. Pipe the gas to a port where it is cooled to minus 100 and something centigrade to become liquid. Put it in a refrigerated and pressurized ship and send it to another port where it is turned back into gaseous methane, then into a pipe to market.

The plants and ships are expensive capital investments taking years to build, so the shortage will not be solved this way this winter, although a few such operations exist. One contract has been shipping LNG from Borneo to Japan. In July a letter of agreement was signed between the governments of Indonesia and Japan for a new LNG supply of about eight million tons per year, new gas to go more than 20 years. Now, a million tons a year is only 125 million cubic feet per day, not much in the big picture. We, here in the US, import 1.6 Billion cubic feet a day.

Japan has also been negotiating with Russian companies and American companies to build a gas pipeline from Shakhalin Island, eastern Siberia. American companies would have to be involved. Russian companies don't have enough capital, and no one would lend to them. If you have kept up with the career of Khodorkovsky, the head of the biggest, you know why.

New gas is being developed all around the North Atlantic. Trinidad, west Africa, off the north coast of Norway, perhaps Murmansk, even Algeria, all to move to market by ship. Oil and gas already proven up offshore the Canadian Maritime provinces will come directly by pipe to New England. So even though North Sea gas flow is decreasing, North Atlantic gas will increase my guess is several billion cubic feet a day when the infrastructure is finished over the next five to ten years. The new proven gas will last a few decades, and I expect more will be found farther off Norway and perhaps off the coast of Russia. The world expansion of natural gas production is such that we really should, from now on, talk about the oil and gas business.

Here is my proposal. Skip the wishful thinking about becoming independent of foreign oil. And forget about pie in the sky technology. Let venture capitalists put their money into hydrogen fuel cells if it is such a good idea, instead of throwing tax dollars at it. Here is a hint about its potential: four years ago

throwing tax dollars at it. Here is a hint about its potential: four years ago Ballard stock sold for \$140 a share; today it sells for \$12.

So let's go with something we know works. Cars fueled with propane were economical in Vienna half a century ago. Propane, you see the little tanks everywhere. The infrastructure already exists. And changing the cars that exist to burn propane is a small adjustment. So my vision into the fog of the future is less smog from gasoline exhaust because propane burns more cleanly, and produces less diesel soot because modern diesel engines are much cleaner. And the carbon dioxide in the atmosphere will start down quickly when we shift to something else in a century, not after many centuries as is claimed.

This talk has been too long because the oil and gas business is gigantic and complicated. To return to my opening remark, it is fluid. It is changing in interesting and in international ways. Even government owned oil companies are international. Here are some examples, and then I really will quit.

1. Statoil, the Norwegian government oil company, is building a liquification plant for natural gas on the shore of Algeria.
2. A Chinese company is extracting oil from Sudan. Whether this will be better for the people in Sudan than the Canadian company that sold it two years ago is unknown.
3. Petrobras, owned 57% by the Brazilian government, recently discovered a new field under 1.6 miles of water and another five miles into the rock in the Gulf of Mexico, not home turf.

Last Spring Petrobras hit a major gas field offshore Sao Paulo. This is an international event because Bolivia has found big gas fields but has no place to sell it. If Sao Paulo has enough gas of its own, Bolivian gas has no market. Bolivia is in big trouble, with a weak government and a weaker economy except for the poppies. The gas cannot be exported west through Chile because of history.

Contrast Chad in central Africa. Oil in Chad, which claims to be a country, has recently begun to flow through a new pipe to the coast. Because of this, the gross domestic product of Chad is predicted to go up 50% this year, and another 50% next year as the pipeline gets up to capacity. So much new money in a poverty stricken region is almost certain to cause corruption in the short term. Maybe in a few years healthy development will ensue.

Oil changes the world economy in the short term and in the long term. I will try to respond to any comments.