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The Post-Petroleum Paradigm -- and Population

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The use of oil has changed world economies, social and political structures, and lifestyles beyond the effect of any other substance in such a short time. But oil supplies are limited. The peak of world oil production and the beginning of the irreversible decline of oil availability is clearly in sight. This paper examines the role of oil in two contexts: Its importance in countries almost entirely dependent on oil income, and the role of oil in world agricultural productivity. Possible alternatives to oil and its close associate, natural gas, are also examined. Countries almost solely dependent on oil income are chiefly those of the Persian Gulf region. The prosperity which oil has brought to these nations has resulted in a rapidly growing population which is not sustainable without oil revenues. World agriculture is now highly dependent on oil and natural gas for fertilizers and pesticides. Without these, agricultural productivity would markedly decline. As a base for the production of these materials, oil and natural gas are irreplaceable. Lifestyles and affluence in the post-petroleum paradigm will be quite different from today. World population will have to be reduced if it is to exist at any reasonable standard of living. At that time concern will be much more centered on obtaining basic resources, especially agricultural, by which to survive.

THE EPIC IMPORTANCE OF OIL

No other substance has so changed the world and affected so many people in such a short time as has oil. Oil has become a vital part of industry, agriculture, and the fabric of society at large. Oil by its derivatives, gasoline, kerosene, and naphtha, fuel more than 600 million vehicles worldwide. But oil is a finite resource, and we are using it at an exponential rate. There will soon be a post-petroleum paradigm. What problems lie ahead in adjusting to it, and what will be some of the major aspects of life at that time?

Little has been written in detail about the world after oil. Some people seem to believe it will not happen, at least not to them. Governments and societies at large face crises when they arrive, rather than anticipate them and take preventive or ameliorating action. The focus of the discussion about oil, when it does occur, has generally been regarding the peak date of oil production, with geologists favoring an earlier date and sociologists and economists suggesting a later time (Campbell, 1997; Campbell & Laherrere, 1998; Anderson, 1998; Fouda, 1998; Edwards, 1997; Hatfield, 1997; Ivanhoe, 1995; Lynch, 1996; Adelman & Lynch, 1997).

Forecasting the date when world oil production peaks is useful and important, but whenever it occurs, the more important concern is what begins to happen after that. Rather than spending energy debating the date of peak, the issue to be addressed is that the beginning of an irreversible permanent time beyond petroleum is coming into view. One fact makes this crystal clear. The world now uses about 26 billion barrels of oil a year, but, in new field discoveries we are finding less than six billion. The world is going out of the oil business. Then what?

That oil production will peak and then decline is not debatable. If the more optimistic are right, and the peak date is a little further away than most geologists now predict, this would simply exacerbate the problems, for it means that the population at the turning point of oil production will be even

larger than it would be at an earlier date, and it will be then more difficult to make the adjustment toward life without oil.

Envisioning what the post-petroleum paradigm will be like involves consideration of myriad facets of the world scene. The worldwide decline of oil production, ultimately to the point where it is insignificant relative to demand, will have many ramifications, changing world economies, social structures, and individual lifestyles.

This paper presents two especially significant aspects of the post-petroleum paradigm, together with an assessment of alternatives to petroleum. The two matters considered are:

- The effect of the decline of oil production in the countries which are almost wholly dependent on oil for their survival.
- The effect on world agriculture of diminishing and eventual depletion of oil and closely associated natural gas supplies, and the corresponding effect on the ability of agriculture to feed the population.

COUNTRIES CHIEFLY DEPENDENT ON OIL INCOME

Some countries have become almost totally dependent on income from oil. What happens to economies and social structures which have been built largely or almost entirely on the base of a nonrenewable resource--oil? This is the situation of the Persian Gulf countries of Kuwait, Saudi Arabia, Iraq, Qatar, the United Arab Emirates, Bahrain, and Oman. Iran and Venezuela, with modest agricultural bases, are not quite so dependent on oil, although both countries get most of their foreign exchange from the sale of oil. Elsewhere, both Libya and Brunei are almost totally oil-dependent.

The arrival of oil wealth brought changes to all these countries more rapidly and more profoundly than has happened in any other nations of the world at any previous time in history. Saudi Arabia made the transition from a largely nomadic culture, to a highly organized, wealthy nation in less than 60 years. To a large extent this is true of all the newly oil-rich countries.

Before they had wealth from oil, all of these nations were underdeveloped. There were no government social programs, very limited medical facilities, and the infrastructure of roads, public and private transport, and electric power was negligible.

The arrival of oil money brought great social and economic changes to these countries. Among other things, various social programs were inaugurated, all of which were designed to support people at a higher standard of living. These include subsidized food supplies and free or low-cost medical care. In the largely desert nations, imported and subsidized food supplies are a particularly pleasant change from the limited diets of the past. But what has been the result?

Prosperity and Population

Contrary to the common idea that increased prosperity results in a reduction in birth rate and population growth, Abernethy (1993), with several examples, makes the point that economic development may spur population growth. With better expectations for the future, more children can be afforded, and improved medical care means a better survival rate. Abernethy's view is fully validated by what has happened in the newly oil-rich nations. With the social programs supported by oil income, and the Muslim tradition of large families, the growth rate of all the Gulf nations (which are all Muslim) and Libya, also Muslim, has been well above the average for the world which is about 1.6%. For example, the annual growth rate and doubling time' of the population in Saudi Arabia and in Libya is 4.1% (doubling in 17 years), Kuwait 6.0% (doubling in 11.6 years), Qatar 6.5% (doubling time 10.7 years), and United Arab Emirates 7.3% (doubling time 9.6 years). As a result of these high growth rates, about half the population of the Arab world is now under the

age of 15, portending a continued and perhaps even an increase in the population growth rate over the next two decades (Fernea, 1998). Also, this new generation is the first to live predominantly in cities. This has been made possible by oil wealth which allowed people to move beyond primarily agrarian and nomadic economies. (This is similar to what happened earlier in the United States when the need for farm labor was greatly reduced by oil-powered machinery, and people moved to the cities to engage in manufacturing and other enterprises.)

Building on a Finite Resource

As early as within two decades, by some estimates, even the Gulf nations, now holding most of the world's oil, will be experiencing a decline in oil production. Higher prices may cushion the economic effect of this decline, but inevitably, as oil deposits are consumed, oil income will eventually cease to be significant. Prosperity and anticipation of continuing good times has been the experience in the oil-rich nations until recently. But now oil income has begun to increase less rapidly than in the past, and the population continues to grow. In the case of Saudi Arabia, which holds the largest oil reserves of ~ny nation, the government has actually been running a deficit, and various social programs and subsidies are having to be curtailed. One of the reasons for the brief drop in oil prices in early 1998 was the fact that Saudi Arabia and other Gulf countries were overproducing their OPEC oil production quotas in order to maintain their oil income to keep their social programs afloat and the citizenry content.

Reed and Rossant (1995) write:

Experts are calling it the Gulf Disease. The roots of the problem are the same across the Gulf. The era in which ruling families could use seeming endless oil revenues to buy the loyalty and silence of the population is coming to an end. Cash-strapped governments are cutting back on social services while the stream of rich contracts which helped oil the economy dwindled to almost nothing (p. 54).

How the increase in population affects per capita wealth is illustrated in further remarks by these authors:

A population explosion has also helped sharply erode per capita gross domestic production from more than $12,000 in 1982 to little more than $7,000 today [1995]. Some 3 million Saudis -- 44% of the labor force -- work in the public sector where salaries have been frozen for almost a decade. This year, in a huge departure from traditional largesse, King Faud is more than doubling the fees charged residents for electricity, water, and other services... Such erosion of the desert welfare state sorely strains the paternalistic social contract between the ruling AI-Saud clan and the population.

Chandler (1994) writes:

Although much of the oil windfall of the 1970s was invested wisely in Saudi Arabia -- on hospitals, roads, and bridges, seaports and power plants and the like -- a huge proportion was devoted to social programs which cannot possibly be sustained in a nation whose population is growing at a rate of nearly 4 percent a year, one of the highest rates in the world (p. 41).

The Saudis do understand the finiteness of their oil resources. They have a saying "My father rode a camel, I drive a car, my son rides in a jet airplane -- his son will ride a camel." It may be more than one generation beyond the present before the Saudi oil is depleted, but it inevitably will be. Without some other large economic base, and none is now visible, huge adjustments will have to be made in lifestyles and probably in population size. It will not be easy.

Kuwait is oil. Its less than 7,000 square miles hold more oil than does the United States in 3.5 million square miles. It was a very rich prize in a conveniently adjacent small package that Saddam Hussein wanted. Kuwait has no income tax, housing and utilities are subsidized, medical care is free, and the government gives every couple on their marriage more than $7,000. It has its own airline, Kuwait Airways, which flies Boeing 747s on regularly scheduled service from New York and London to Kuwait, and the government has built an olympic-sized ice skating rink. Kuwait has

invested considerable money abroad and recently has been earning more money from these enterprises (including a large chain of gasoline stations) than it does directly from oil exports. Kuwait's hope is that when its oil runs out, these foreign investments will continue to support Kuwait's way of life. However, the gasoline stations abroad (symbol on the signs in western Europe is "Q8") may then not produce much income, and the population growth rate which is now doubling every 11.6 years, may exceed the rate at which the investment income grows. It will be an interesting example to watch. Kuwait has virtually no agricultural base, and all its manufacturing is oil-based (petrochemicals). Kuwait has become an oil supported welfare state beyond any other of the Gulf nations (Reed, 1996).

Venezuela, which holds more than half the oil reserves of South America, also has a number of social programs supported by oil revenues. However, in a preview of things to come, in 1989, when oil income briefly faltered, the government had to change its free spending ways. When government subsidized bus fares and previously cheap gasoline prices were raised, riots erupted in Caracas and 17 other cities. More than 300 people were killed, 2,000 injured, and several thousand arrested. The government had to rescind these increases (Moffett, 1995).

In 1995, with continuing increase in population and per capita oil revenue unable to keep up, troubles arose again. University students threatened street demonstrations if such things as cut-rate hot lunches, and public transportation costs were raised. In 1996, the Venezuelan government, because of a deteriorating economy, made application for a $2.5 billion loan from the International Monetary Fund (Vogel, 1996).

Oil revenues in Venezuela have not kept pace with the growth in population and the corresponding growth in costs of social services established during more affluent oil income years. 'Oil production and income have gone up, but population growth has outraced the oil statistics. Venezuelan oil output is expected to peak within ten years. Population growth is 3.5% annually which means a doubling in 20 years. By the next population doubling oil production will be declining.

Peak of Oil Production and Significance

It is not when the last drop of oil is pumped, but rather the peak of production (maximum daily amount) after which there is an irreversible decline in oil production, which is important. Then all social and economic programs based on oil income will have to be curtailed. Countries, such as Kuwait, which have been investing some of their oil income abroad may be able to sustain their social programs to a modest degree, but if the growth rate of population continues, it is very doubtful that the income on a per capita basis can equal the income now received from oil. Most countries now are consuming their oil income as it comes in.

The peak of world oil production, by the most recent studies is now projected to occur sometime between 2003 (Campbell, 1998) and 2020 (Edwards, 1997). Of special interest is that in March, 1998, the International Energy Agency, for the first time forecast a possible date of the peak of world oil production stating: "... a peaking of conventional oil production could occur between years 2010 and 2020" (International Energy Agency, 1998). In more detail, a study has just been completed projecting the peak of oil production in 42 countries (Duncan & Youngquist, 1998). The largely oil-dependent countries and their estimated peak years are Kuwait, 2018; Oman, 2002; Syria, 1999; United Arab Emirates, 2017; Yemen, 2002; Saudi Arabia, 2011; Venezuela, 2005. Qatar, Bahrain, Iran, Libya, and Brunei have already passed their peaks. Qatar's oil decline is cushioned by huge gas deposits now being developed. Both Bahrain and Iran have seen increasing unrest as the decline in oil income has undermined the standard of living. Iran passed its peak of oil production in 1973. With the population now increasing much beyond what the declining oil revenues can support, Iran will be the first oil-rich Gulf nation that within 10 years will be poorer than it was twenty years ago. Population growth dilutes the available oil wealth base.

Iraq's peak of production is expected in 2011, but may be delayed further by the current U.S. oil

embargo sanctions. However, note how the present lack of oil income is hurting the citizens of Iraq, becoming desperate for basics of life, including food and medicines. Relief shipments are being sent in. But, when the time arrives that Iraq will have little or no oil to sell, how will Iraq support its people? Oil has been 99 percent of Iraq's source of foreign exchange, and they are not even now self-sufficient in food supplies. Will the rest of the world indefinitely make up the difference when Iraq has no more oil to sell for food? Or, importantly, will the traditionally food exporting nations at that time even have surplus grain to sell?

The effect of the depletion of world oil and its close associate, natural gas, on overall world food production cannot be ignored.

OIL AND WORLD AGRICULTURE

A second aspect of the post-petroleum paradigm is not confined to the oil-rich, oil dependent countries, but relates to the world as a whole. How the decline and eventual depletion of oil, and its close associate, natural gas, will affect world food production is of vital importance. Bartlett (1978) succinctly makes the point: "Modern agriculture is the use of land to convert petroleum into food" (p. 880).

Mechanization, Petrochemicals, Genetic Engineering

These three factors have combined to produce the green revolution which has so greatly increased agricultural productivity during this century. Two of these elements, mechanization, and petrochemicals, are provided by oil and natural gas.

The mechanization of agriculture has put huge acreages economically into cultivation, which could not have been possible with only human and animal labor. In the U.S. in the early 1900s, teams of 20 or more horses pulled huge combines and plows slowly across the fields. And all during the winter these horses had to be fed, drawing upon plant production which otherwise, at least in part, could have been used for human food. Now vast acreages can be plowed, planted, and harvested by means of huge machines which run on oil derivatives (diesel or gasoline). Machines do not have to be fed (fueled) when they are not working.

Crops are hauled to central collecting and processing points from widespread and often relatively remote areas by huge trucks for which the only fuel that can presently power them is oil. Food is distributed to cities and to remote areas by vehicles largely run on oil. About 2% of the working U.S. population now provides all the food for this nation, which is the world's largest grain exporter. Oil and natural gas make this possible.

Oil and Natural Gas, More Than Energy

For most people, their chief relationships to oil and natural gas are as a source of energy for home heating and cooking, and fuel for personal vehicles. The very important roll of oil and natural gas in agriculture, beyond the obvious fueling of agricultural machinery, is often unknown. But these raw materials are the base for fertilizers by which to increase crop yields and for pesticides to protect crops from insects and diseases and to control weeds that compete with food plants. The most widely used fertilizers are compounds of ammonia, made from natural gas.

"Ghost Acres"

The "green revolution," which has enabled the Earth to support so many more people now than in the past, is a combination of genetic engineering in plants, mechanization, and the petrochemicals provided by oil and natural gas.

Emphasizing the importance of petrochemicals, Pimentel (1998a), states:

If the fertilizers, partial irrigation [in part provided by oil energy], and pesticides were withdrawn, corn yields, for example, would drop from 130 bushels per acre to about 30 bushels.

However, this is assuming legumes can also be used to provide a little nitrogen. Without the use of legumes, yields would decline to about 16 bushels per acre. This is about the corn yield in developing countries.

The additional hundred bushels has been produced from "ghost acres" which do not exist except in the form of the fertilizers, largely made with natural gas, and oil for pesticides. When the "ghost acres" provided by oil and natural gas no longer exist, the agricultural productivity will be dramatically reduced.

The gains which genetic engineering have made for agriculture will remain, but probably to a lesser degree than we have them at present. Brown and Kane (1994) report that "... fertilizer has been at the center of advances in world food output during the last four decades" (p. 122). But they further observe "... the new varieties [from genetic engineering] have high yields precisely because they are much more responsive to fertilizer than traditional ones." Thus it is doubtful that another great productive "green revolution" leap forward can be made in the future. When less and less fertilizer and petrochemicals will be available, total worldwide agricultural productivity seems certain to fall.

Pimentel and associates have researched the role of energy in agricultural systems, and present significant statistics. Pimentel (1998a) states:

Approximately 90% of the energy in crop production is oil and natural gas. About one-third of the energy is to reduce the labor input from 500 hours per acre to 4 hours per acre in grain production. About two-thirds of the energy is for production, of which about one-third of this is for fertilizers alone.

Fleay (1995), noting that Australia is the world's fourth largest wheat exporting country, discusses the importance of oil and gas in that country's agricultural production, particularly to offset Australia's relatively poor soil. Fleay (1995) states:

Fertilisers have played a key role in offsetting nutrient-poor soils for our agriculture this century... A dramatic twenty-fold increase in nitrogen fertiliser use has occurred since 1965. Fossil fuels are needed for fertiliser manufacture -- 1500-2500 MJ per tonne for superphosphate... However, nitrogen fertilisers use natural gas or petroleum as a feedstock and had an energy intensity of 37,000 MJ per tonne in 1980 (p. 15).

Fleay makes the summary statement:

A very large proportion of the world's population depends for food from high agricultural yields achieved by the use of fossil fuels. The world may only be able to support a population of 3 billion without this input· Petroleum is a key fuel ... The principal grain exporters are the U.S.A., Canada, Europe, Australia and Argentina -- all highly dependent on petroleum-based industrial agriculture.

Grant (1996) notes the critical importance of petrochemicals to farmers, stating:

... the dependence on pesticides and herbicides has risen dramatically because they would lose part or all of their crops if they stopped spraying... (p. 27).

Grant adds:

The 50-year rise of yields is slowing or ending, and the world is paying a high and rising price for the effort to keep raising yields. Countries that have become dependent on high yields should be seeking to escape the squirrel cage of rising demand. Countries that are not yet hooked on commercial fertilizers should recognize their potential limits and costs, and look to controlling demand -- population growth -- rather than hopefully relying on higher food yields to solve their problems (p. 28).

Agriculture, Petroleum, and Population

Civilization exists on the crops grown in topsoil which around the world averages no more than a foot in depth. It is food or famine for the human race, and humanity has known famine in the past, and knows it now in places. There are now two trends clearly on collision course: First, population is growing at the astounding rate of nearly a quarter of a million a day, and is highly and increasingly dependent on oil and natural gas for food production. Second, the end of petroleum supplies are clearly in sight· Gever and associates (1991) have presented an excellent book-length analysis of the future without oil with special reference to food, and see large problems ahead.

FOSSIL FUEL ALTERNATIVES

We are now living not only on "ghost acres" but also living on "ghost centuries" -- the past centuries, back to more than half a billion years, when petroleum including natural gas formed at various times in the Earth's crust. We are rapidly consuming these resources inherited from eons past, and those centuries, now ghosts of the past, will soon have their petroleum resources exhausted.

We are fortunate to be living in what has been called the Age of the Hydrocarbon Man. This time includes coal, oil, and natural gas, of which oil is the most important. But it will be but a brief bright flash in human history -- at the most perhaps two hundred years. We are already more than half through the time of oil. Natural gas supplies will last only a bit longer.

With the imminent decline of petroleum (including natural gas), the question becomes what are the alternatives? Over the years, and more recently since the oil crises of the 1970s, the search for alternatives to petroleum has increased. A variety of alternatives have been identified, and most have been tried to a greater or lesser extent.

Renewable and Nonrenewable

Alternatives to petroleum can be grouped into renewable and nonrenewable sources. Ultimately the renewable must completely fill the gap left by the depletion of oil, for the nonrenewable beyond oil which include coal, nuclear, oil sands, shale oil (so far an unrealized source), geothermal energy, and hydro-electric power, will also ultimately be gone. (Note: Dammed reservoirs eventually all fill with silt, and all geothermal electric power facilities show some decline to a greater or lesser extent. In the longer term, neither hydro-electric power nor geothermal energy for electric power generation is a renewable resource). The renewable include wind, solar, biomass, tides, ocean thermal energy conversion (OTEC), and the possibly unattainable fusion.

When one examines suggested alternatives to petroleum, two facts stand out. First, the use of oil and natural gas as a huge supply of raw material for myriad petrochemical products importantly including fertilizer and pesticides, is unrivaled. Second, energy is energy in a sense, as it is defined as the ability to do work. The common thought is therefore that one energy form such as electricity can substitute for another energy form, gasoline. But, clearly this is not readily the case. A gallon of gasoline has the same energy content as one ton of conventional electric storage batteries. Physics of the storage of electricity cannot compete with the convenience of gasoline where a five gallon can of gasoline can be carried, if needed, hundreds of miles to a remote location to be used in some machine. The equivalent would have to be several tons of storage batteries.

The inability of fuels to be easily interchangeable in their end uses is a major problem. The fuel to effectively power the huge machines used in large scale farming, or even in smaller operations with smaller machines, beyond gasoline or diesel, is not yet in sight. The versatility of oil in convenience of handling and transport, and in end uses (motors of all sizes, useful in all climates, able to be stored over long periods of time in remote areas) is unequaled by any other energy source.

Biofuels and the Ethanol Myth

Oil derived from plants is sometimes promoted as a fuel source to replace petroleum. However, a comprehensive study by Giampietro and others (1997) concludes: "Large-scale biofuel production is not an alternative to the current use of oil and is not even an advisable option to cover a significant fraction of it." The facts and experience with ethanol are an example.

Ethanol is a plant-derived alcohol (usually from corn) which is used today, chiefly in the form of gasohol, a mixture of 10% ethanol and 90% gasoline. Because it is used to some extent (mostly by federal mandate in certain places and at certain times) it is commonly thought that ethanol is a partially acceptable solution to the fuel problem for machines. However, ethanol is an energy negative -- it takes more energy to produce it than is obtained from ethanol.

Pimentel (1998b) states:

Ethanol production is wasteful of fossil energy resources . . . This is because considerably more energy, much of it highgrade fossil fuels, is required to produce ethanol than is available in the ethanol output. Specifically, about 71% more energy is used to produce a gallon of ethanol than the energy contained in a gallon of ethanol.

Furthermore, ethanol production from corn cannot be considered renewable energy. Its production uses more nonrenewable fossil energy resources both in the production of the corn and in the fermentation/distillation processes than is produced as ethanol energy (p. 5).

Pimentel also points out the negative environmental effects of producing ethanol from corn:

Increasing ethanol production will increase degradation of vital agricultural and water resources and will seriously contribute to the pollution of the environment. In U.S. corn production, soil erodes some 20-times faster than soil is formed.

Located in the premier corn-growing region of the world, scientists at Iowa State University (Reilly, 1988) state that ethanol production is an energy negative. Ethanol production survives by the grace of a subsidy by the U.S. government from taxpayer dollars. Continuing the production of ethanol is purely a device for buying the midwest U.S. farm vote, and may also be related to the fact that the company which makes 60% of U.S. ethanol is also one of the largest contributors of campaign money to the Congress -- a distressing example of politics overriding logic.

Electricity Not an Adequate Substitute

It is important to note that the end product of many alternative energy sources such as nuclear, hydro-electric power, wind, solar, geothermal, and tides is electricity, which is not a replacement for oil and natural gas in their important roles as raw material for a host of products ranging from paints and plastics, to medicines, and inks. But probably the most vital of all uses is to make the chemicals which are the basis for modern agriculture. Electricity is no substitute.

In Summary: No Comprehensive Replacement in Sight

A recent review of the future prospects of all alternatives has been published. The summary conclusion reached is that there is no known complete substitute for petroleum in its many and varied uses (Youngquist, 1997). The distinguished British scientist, Sir Crispin Tickell (1993), expresses a similar view: "... we have done remarkably little to reduce our dependence on a fuel [petroleum] which is a limited resource, and for which there is no comprehensive substitute in prospect" (p. 20).

WORLD BUILDING ON NONRENEWABLE WEALTH

The oil-rich countries are clearly building economies and social structures on nonrenewable wealth. But the entire world is also doing so, particularly with regard to agriculture. The social, political, and economic ramifications of this fact will be huge.

An Unsustainable Situation

With the present rate of population growth, when oil supplies are essentially depleted, the world population will be substantially larger than at present, perhaps even double what it is today. The inevitable conclusion is that in terms of today's living standards and food supply, the situation then will not be sustainable. (Pimentel & Giampietro, 1994a, p. 250). In a later more numeric statement Pimentel and Pimentel (1996) state:

Even tripling the food supply in the next 40 years would just about meet the basic food needs of the 11 billion people who will inhabit the earth at the time. Doing so would require about a 10-fold increase in the total quantity of energy expended in food production. The large energy input per increment increase in food is needed to overcome the incremental decline in crop yields caused by erosion and pest damage (p. 291).

Almost all of the energy Pimentel and Pimentel state would be needed would have to come from oil and natural gas. Thus the relationship which exists between population and oil and gas resources cannot be exaggerated. Oil and gas eventually will be gone. Even if conservation and other measures may reduce the demand, at best, this is not likely to significantly extend the time of oil and gas, and reducing the demand seems unlikely against the increasing food needs of a growing population. Decreasing use will only be caused by decreasing available supplies.

THE POST-PETROLEUM PARADIGM

A future without oil is difficult to visualize in detail, but some aspects of the post-petroleum paradigm can be anticipated with some degree of certainty.

All possible economic energy sources will have to be used, but replacing oil in its great energy use versatility probably will not be completely possible. Replacing the role of both oil and gas in agricultural production will be the most critical problem, and may not be entirely solvable.

World population will have to adjust to lesser food supplies by a reduction in population. Pimentel and Pimentel (1996) state: ... the nations of the world must develop a plan to reduce the global population from near 6 billion to about 2 billion. If humans do not control their numbers, nature will." Because stopping and then turning around the freight train of population growth can only be done gradually, this is a project which should be started now (Cohen, 1995). If it is not done, famine on a large scale is likely to ensue.

The excellent personal mobility of those people now fortunate enough to enjoy the use of automobiles and airplanes will be greatly reduced.

The lifestyles of the high energy consuming nations will become much simpler. Nations which do not enjoy high energy use have less to lose and may not experience relatively large changes.

The focus of society at large will be much more directed toward securing the basics of existence than is now the case, particularly in the affluent societies where abundance is taken for granted and the good life lived accordingly.

Scientists, economists, sociologists, and political scientists will increasingly be concerned with the effects of the depletion of oil. Mitigating social and economic strains will have high priority.

REALITY

Reaching and passing the peak of world oil production will be the most important happening in human history to date, affecting more people in more ways than any other event. It will happen, and during the lives of most people now living.

The fast approaching peak and then the irreversible decline of petroleum production is not a myth. Until 1998, the International Energy Agency never projected a peak in world oil production. But in March, for the G8 Energy Ministers' meeting in Moscow, the IEA stated that a peak in world oil production is likely to occur between the years 2010 and 2020. This is in general agreement with other recent estimates already cited. Perhaps this signal forthcoming event will now get the worldwide serious attention it fully merits. So far political circles have generally ignored the matter. Governments have a very short range vision.

The Limits of Science and Technology

Present society seems to have come to the comfortable conclusion that no great problems can now overtake us. The thought that "Scientists will think of something" is a popular public placebo by which to ignore the facts. Will something come to the rescue?

Pimentel and Giampietro (1994b) have warned:

Technology cannot substitute for essential natural resources such as food, forests, land, water, energy, and biodiversity... we must be realistic as to what technology can and cannot do to help humans feed themselves and to provide other essential resources (p. 250).

Bartlett (1994) has observed the general complacency about the future and writes:

There will always be popular and persuasive technological optimists who believe that population increases are good, and who believe that the human mind has unlimited capacity to find technological solutions to all problems of crowding, environmental destruction, and resource shortages. These technological optimists are usually not biological or physical scientists. Politicians and business people tend to be eager disciples of the technological optimists (p. 28).

What Bartlett is saying is that "We scientists might NOT be able to think of something."

To put it bluntly, science and technology cannot indefinitely rescue the human race from whatever predicaments into which it gets itself -- the overriding one now being population size, its current exponential growth, and how it can be supported in the future.

Reasonable Affluence: How Many People?

The debate on the date of oil production peak should be secondary. Concern should be turned toward the fact of the fast approaching post-petroleum paradigm, and developing both social and economic programs which will allow the human race to survive then in a reasonable degree of affluence. Degree of affluence is important, and therefore the size of the population should be further defined not as how many people can the world support, but how many people should the world support. Various estimates have been made, and the consensus among scientists is that the figure is considerably less than the population size of today.

The social and economic means to achieve this adjustment without chaos are not within the province of the geologist, the chemist, or the physicist. They are social, economic, and political matters. Those in leadership first need to recognize the facts, then convincingly get the facts across to the general public, and then see that logical actions are begun. What has to be installed is a global "will to do." We are all now on the increasingly unsustainable populated commons.

CONCLUDING VIEWS

In a remarkably perceptive book, The Next Million Years, written in 1952, Charles Galton Darwin describes historic changes in the human condition, calling these "revolutions." He states there is one more revolution clearly in sight:

The fifth revolution will come when we have spent the stores of coal and oil that have been accumulating in the earth during hundreds of millions of years.., it is obvious that there will be a very great difference in ways of life.., a man has to alter his way of life considerably, when, after living for years on his capital, he suddenly finds he has to earn any money he wants to spend . . . The change may justly be called a revolution, but it differs from all the preceding ones in that there is no likelihood of its leading to increases of population, but even perhaps to the reverse (p. 52).

Kennedy (1993) summarizes both concern and hope for the future:

What is clear is that as the Cold War fades away, we face not a "new world order" but a troubled and fractured planet, whose problems deserve the serious attention of politicians and publics alike... The pace and complexity of the forces for change are enormous and daunting; yet it still may be possible for intelligent men and women to lead their societies through the complex task of preparing for the century ahead. If these challenges are not met, however, humankind will have only itself to blame for the troubles and disasters that could be lying ahead (p. 349).

Facts do not cease to exist because they are ignored.
Aldous Huxley

ENDNOTE

1 To compute doubling time in years, enter the percentage rate (i) into the formula, 70/I = years to double.

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