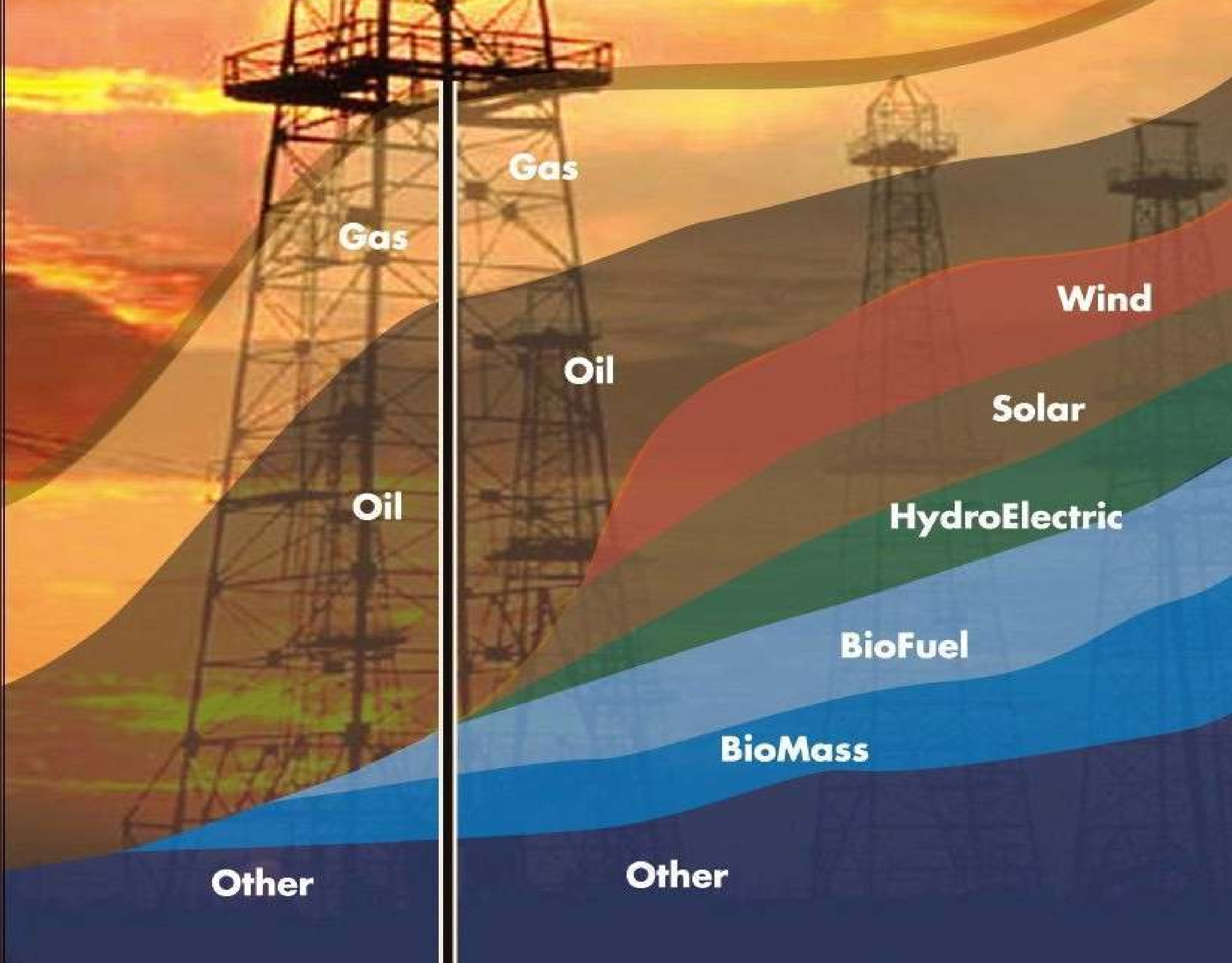
Peak Oil Paradigm Shift

The Urgent Need For a Sustainable Energy Model

by Bilaal Abdullah



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Introduction

This short book is intended as a wake-up call on the question of Peak Oil which is an issue of global importance that will greatly affect the lives of people all over the world in the very near future. Peak Oil refers to the stage of oil production when the level of production can no longer be increased in response to increasing demand.

The recent dramatic rise in oil prices is an early warning of the imminent chaos that could result from permanently high and escalating prices for crude oil and its cousin natural gas. Contrary to much of the conventional wisdom, the upward surge of oil prices in mid-2004 was structural and there is virtually no likelihood of a return to cheap oil. It now seems ages ago that Saudi Arabian Light fell to $10 per barrel in June 1998 and stayed at that level for 9 months.

Other voices have long been crying in the wilderness on this issue, in an attempt to capture the attention of a majority who seem intent on pretending that the finite and depleting stocks of the planet's oil will forever be available at cheap prices. The harsh reality is that other energy sources must be found, exploited and utilized, with due regard for environmental concerns, to complement petroleum if countries worldwide want to continue to pursue the energy-rich, highly technological model of modern society.

One problem in trying to understand this essential topic is that much of the relevant information is scattered over a range of books, journals and institutional studies, some of which use technical language solely intended for petroleum industry professionals. This text will attempt to make the issues clear to ordinary interested readers with a willingness to take the moderate amount of time needed to go through this presentation.

Another problem facing those trying to understand the implications of an imminent peak in the supply of crude oil and subsequently natural gas, is that relatively little has been written on the likely repercussions of an end to cheaply available oil and natural gas or on measures that citizens should be implementing in their own lives and urging their governments to implement to deal with the threatening new reality.

Furthermore, in the limited number of sources that attempt to deal with how to cope with Peak Oil, the viewpoint has been almost entirely that of the developed countries. Little thought seems to have been given to how less developed countries should position themselves to handle a situation that threatens to derail all their development efforts and send large segments of their populations back to pre-industrial times, or keep them there indefinitely.

This book will clearly show that crude oil supplies are about to peak, marking an end to cheap oil and the development paradigm spawned by cheaply available oil. A new way of doing things is called for to deal with the reality of imminent Peak Oil.

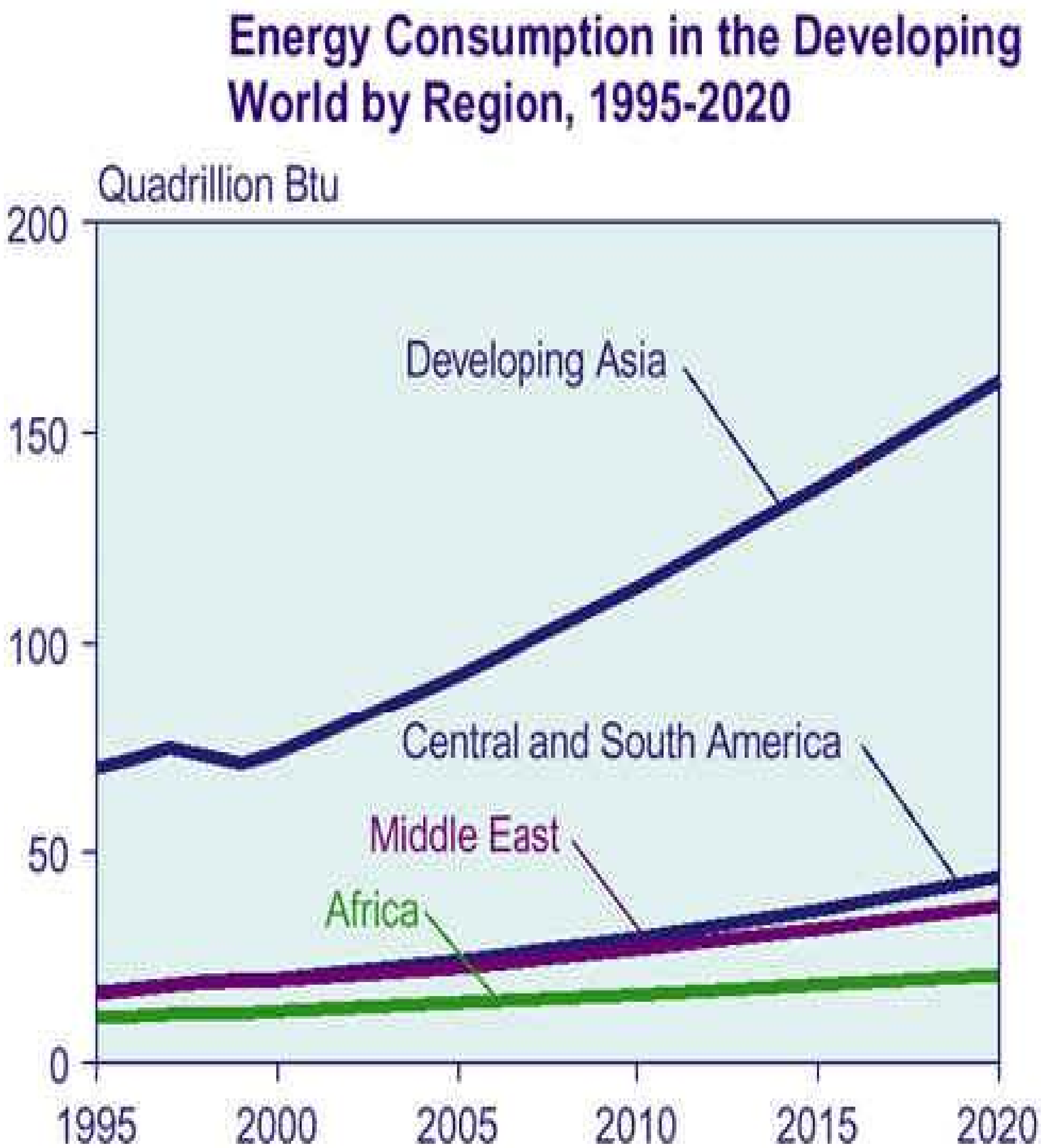
The technological means to deal with the challenges of peaking and subsequent declining crude oil production are available and the time to start is now! Individuals, communities and countries need to first come to terms with the reality of the crude oil and natural gas supply situation and then take the necessary steps to address the world's overall energy needs differently.

Petroleum has had a critical role in helping to develop today's technological and industrial capacity by providing an extremely convenient, easily transportable and versatile source of energy and chemical by-products at low prices. The almost total reliance on oil and natural gas for key aspects of modern life was a necessary stage of human development.

The world community now has the mature technological and industrial base to harness other energy sources to complement and in some cases replace the current over-reliance on petroleum. So far, however, the will to do so has been sorely lacking as nations appear to be racing unconcerned toward the precipice of Peak Oil.

In all of this, the impact of the burning of oil and gas on atmospheric carbon dioxide (CO_2) levels and global warming also needs to be considered. According to a recent report based on Antarctic ice cores, the planet's current carbon dioxide levels are the highest in 440,000 years. The possibility of dramatic climate change due to warming of the earth as a result of the greenhouse gas effect and the consequent melting of polar ice must be factored into the solutions that the world's nations adopt to meet their soaring energy needs.

China and India are currently increasing their demand for oil at rates of 20% - 30% per annum. If they cannot access sufficient oil, refined petroleum-based fuels and natural gas they may further increase the burning of the coal deposits that both these countries have in abundance, with potentially damaging effects on atmospheric carbon dioxide levels. Significantly, the Christian Science Monitor reported on February 25, 2004 that, "At least 94 coal-fired electric power plants - with the capacity to power 62 million American homes - are now planned across 36 states."



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[1] Btu is an abbreviation of British Thermal Unit; the amount of energy required to raise the temperature of 1 pound of water by one degree Fahrenheit. A quadrillion Btu = 1,000,000,000,000,000 Btu

All the world's nations are going to be impacted by Peak Oil; but some countries, corporations, groups and individuals will seize opportunities presented by this crisis and thrive; others will be overwhelmed. The difference will lie in acquiring the necessary knowledge to deal with Peak Oil and having the capacity and resolve to act swiftly to implement the required Paradigm Shift. By the end of this book it is hoped that readers will be convinced that the threat Peak Oil poses to our collective future is real and commit themselves to doing something about it.

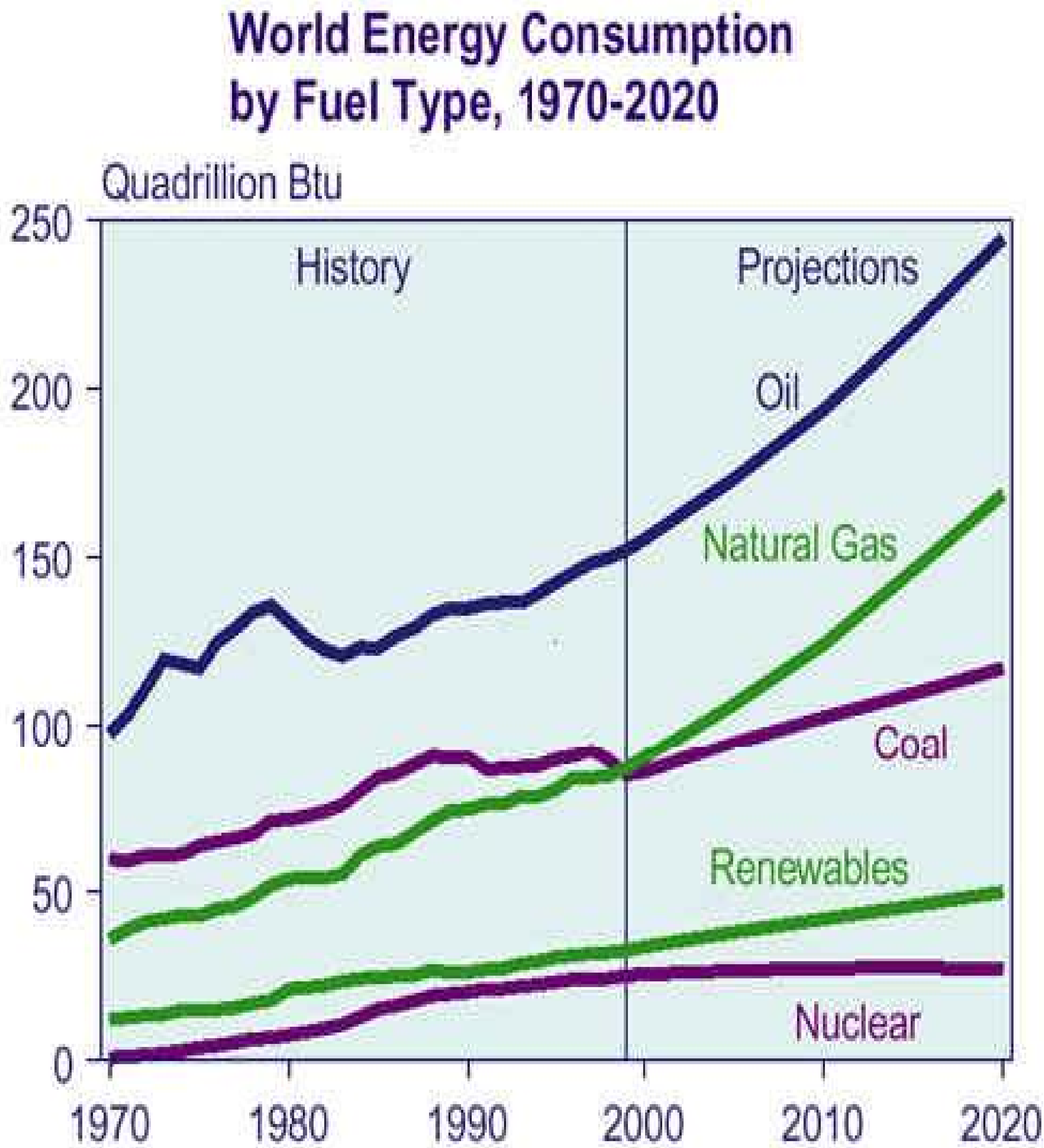
The Problem is Urgent

On July 14 2004, the Wall Street Journal[2] reported that the International Energy Agency (IEA) had estimated that world oil production was 81.1 million barrels per day with a spare production capacity of just 0.62 million barrels per day. Coupled with the fact that demand was expected to increase by as much as two and a half to three million barrels per day by early 2005 with the normal rising consumption of the northern winter, no one should feel comfortable about the world's crude oil supply situation. The fact that demand is pushing production capacity to its very limits is causing continuous upward pressure on oil prices and threatens to throw a very large monkey wrench into the workings of the global economy.

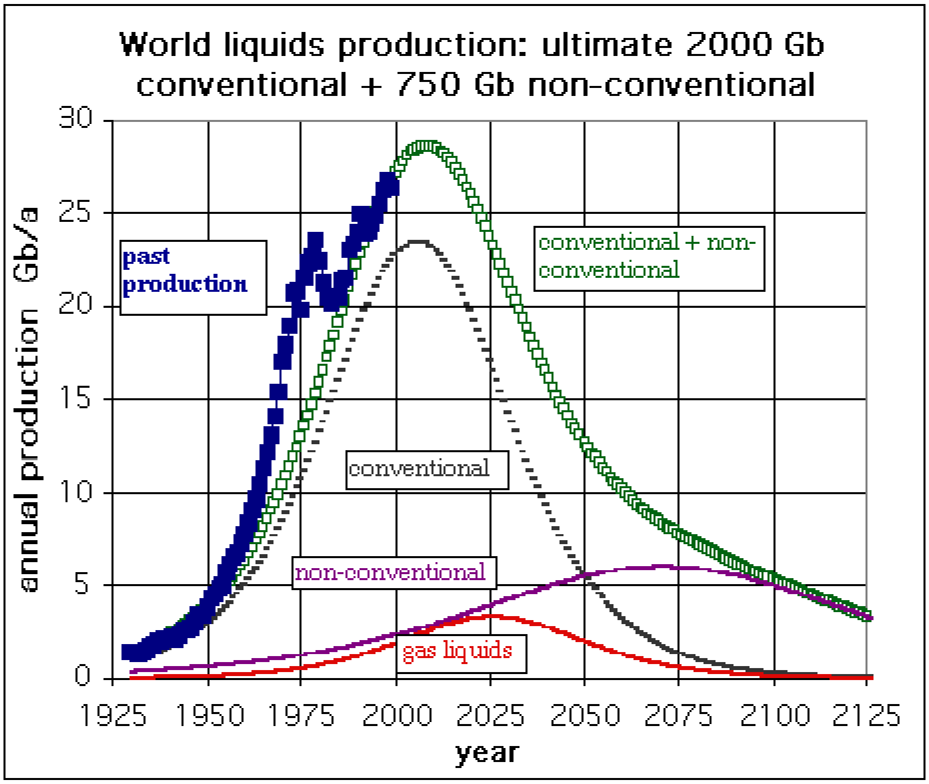
After the oil price shocks in the 1970s, the US enacted several energy conservation measures including federally mandated speed limits, tougher home insulation requirements and other measures that brought the reliance on petroleum to the fore. Renewable energy sources were researched and pilot projects implemented, as the world seemed to come to the realization that cheap oil could not be taken for granted.

As oil prices dropped in the 1980s and 1990s, the United States and to a lesser extent other countries resumed their love affair with gas guzzling cars, disdained mass transit and adopted other wasteful energy practices. The amount of energy produced from renewable sources in the US actually dropped between 1989 and 2002. This occurred as the doctrine of everlasting cheap oil and natural gas held sway. All over the world, countries planned their futures on the assumption that there would be no problem in increasing the supply of petroleum and other energy sources to match demand.

[2] Wall Street Journal, July 14, 2004 "World Oil Supply Faces Stress in Months Ahead"



As opposed to the anticipated demand for oil and natural gas shown in the previous graph, the projections for production of crude oil reveal a very different pattern. The oil production trends show an oil industry straining to keep up with demand and the inevitability of an imminent decline in global oil production with natural gas production scheduled to peak a decade or so later. A look at the following graph showing the history and projected production of oil and gas liquids in comparison with the continuous upward trend of projected demand indicates there will be a growing gap between demand and supply that can be viewed as being at the heart of the problem of Peak Oil



Today, the world is unprepared for the crisis that is about to unfold as oil production capacity gets ready to peak and then slide into inevitable decline even as the world community simultaneously continues to plan on an unending supply of cheap oil and gas.

The encounter with the reality of imminent Peak Oil will likely be traumatic unless the world starts to immediately make the necessary adjustments. Otherwise mankind will simply have to fasten our collective seatbelts for the crash as the energy-rich, modern technological global village runs into the stark reality of an inability to increase the supply of oil.

Little Time Left

In 1998, a detailed European study found that if the development of renewable energy systems was supported by decisive and well-coordinated government action, a sustained program lasting 50 years could provide 35 per cent of the energy currently used. This illustrates the point that even in a developed region like Western Europe, there is a substantial lag time between making a decision to develop renewable energy sources and actually realizing that goal.

The world does not have the luxury of another 50 years before the crisis of Peak Oil arrives, indeed we do not even have 25 years. Somewhere within the next 5 to 10 years, and perhaps much sooner, the most serious oil shock ever will force itself to center stage whether the world is ready for it or not.

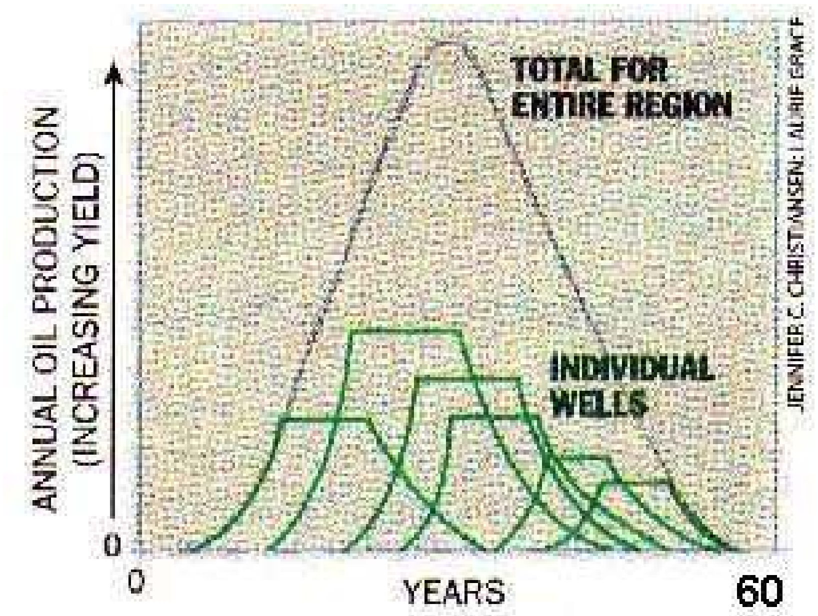
Most nations do not even have a Peak Oil contingency plan far less an actual program for dealing with the problems it will cause. And whereas many energy corporations have been diversifying and otherwise putting their houses in order, the vast majority of large and small business enterprises worldwide are totally unprepared for the sharply rising energy prices and critical shortages that will result.

Ignoring the myriad other products and services that are currently dependent on the availability of cheap oil, it would be highly instructive to consider the “chokepoints” of transportation, electricity generation and food production to realize how energy-rich modern societies would be thrown into turmoil if the supply of oil cannot meet demand. Even countries that prudently make sound preparations for Peak Oil may find themselves negatively affected by the ravages of Peak Oil on the economies of their trading partners.

The urgency of the situation needs to be appreciated and determined efforts made to avoid the worst effects of a post Peak Oil world. The technology to supplement oil and natural gas with other energy sources exists and efforts can be made to conserve and become more energy efficient in a wide range of activities. If such efforts are made now the world can overcome the problems posed by Peak Oil and emerge with a more sustainable and robust global economy. On the other hand, if nothing is done, even at this eleventh hour, the harvest will be bitter but probably well deserved.

What is Peak Oil?

Oil production generally follows a bell curve, whether in an individual field, a large collection of reservoirs or on the planet as a whole. On the up-slope of the curve, production costs are significantly lower than on the down-slope when extra effort and finances are required to extract oil from depleting reservoirs. Simply put; oil is abundant and cheap on the up-slope, but scarce and expensive on the down-slope.



Since the start of commercial Oil production in 1859, oil producing countries have been moving along the up-slope of the global oil production curve. **"Peak Oil"** is the industry term for the top of the curve. It is often referred to as "Hubbert's Peak", a reference to M. King Hubbert, the geologist who in 1956 observed that in any large region, unrestrained extraction of a finite resource rises along a bell-shaped curve that peaks when about half the resource is gone. The previous graph shows the typical production of an oilfield over a period of 60 years. As is shown later, many oilfields decline even faster, especially with the use of new extraction technologies.

To demonstrate his theory, Hubbert fitted a bell curve to U.S. oil production statistics and projected that crude oil production in the lower 48 U.S. states would rise for 13 more years, then crest in 1969, give or take a year. U.S. production peaked in 1970 and has continued to follow Hubbert curves with only minor deviations. The flow of oil from the former Soviet Union and the collection of all oil producers outside the Middle East has followed Hubbert curves quite faithfully.

The global picture is more complicated, because the Middle East members of the Organization of Petroleum Exporting Countries[3] (OPEC) deliberately reined back their crude oil exports in the 1970s, while other nations continued producing at full capacity. However, it is estimated that by 2010 most Middle East countries will themselves have peaked, having produced more than half of their reserves.

The Iranian Oil Minister stated recently that with current production trends and the present rates of growth of domestic demand, Iran could become a net importer of oil by 2010-2011[4]. Indeed, during the first decade of the 21st century Indonesia may have the dubious distinction of being the first OPEC country to become a net importer of oil.

Fulfilling Hubbert's Predictions

It is noteworthy that many people laughed at Hubbert when in 1970 U.S. oil production hit 9.6 million barrels per day, but just as he predicted the decline began and in the 3rd quarter of 2004 U.S. oil production was about 5.6 million barrels per day[5] according to the U.S. Energy Intelligence Agency (EIA), with over 80% of US wells producing less than 3 barrels per day.

Consider also that the North Sea has the world's best field by field production data, all the worlds' best operators and state of the art technology. Its peak was assumed to be many years away in 1996 and 1997. In 1999 the U.K. Sector peaked and in 2002 the New Eastern sector peaked.

Matthew Simmons,[6] the leading energy investment banker and an energy adviser to the Bush administration, commented at a recent conference: "In the early nineties the Caspian seemed to be the next Middle East. In 2001 we had 20 out of 25 dry holes that dampened the enthusiasm for the Caspian significantly. In 2001 Kashagan was finally discovered, deemed to be the greatest field in the decade. In 2002 BP and Stat Oil quietly sold their 14% of Kashagan for 800 million dollars. In 2003 British Gas put their 17% on the block for 1.2 billion dollars. Which raises, in my opinion, the question, "What do these original parties know about *the world's greatest field* or do they merely want to spread the wealth? I think what this all means is that non-OPEC oil, particularly outside the Soviet Union, is either peaking as we speak, or has already peaked."

Incidentally, Kashagan was supposed to be the largest oilfield found in the last 30 years. Most of the oil consumed today comes from fields discovered more than 40 years ago. Since the early 1980s more oil has been produced and consumed than new oil discovered.

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[3] There are 11 countries in OPEC: Algeria, Indonesia, Iran, Iraq, Libya, Kuwait, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, Venezuela.
[4] There is some skepticism about this estimate which some see as mere justification for building nuclear power plants
[5] Total oil supply was about 8.8 million barrels per day including crude oil, natural gas plant liquids, refinery processing gain and other liquids such as fuel ethanol blended into finished motor gasoline and oxygenate production from merchant MTBE plants
[6] Matthew Simmons is an energy adviser to the Bush administration, Vice President Cheney's 2001 Energy Task Force and the Council on Foreign Relations. An energy investment banker, Simmons is the CEO of Simmons and Co. International, handling an investment portfolio of approximately $56 billion. He has previously served on the faculty of Harvard Business School.

What the above all means is that once the peak or plateau is passed, the steep down-slope is not far behind. The further down the slope, the higher the cost of producing crude oil, and its cousin, natural gas and the greater the gap between demand and supply.

Applying Hubbert's Curves to the world's oil production would suggest that if say, 2005 is the year of Peak Oil, worldwide oil production in the year 2025 will be approximately the same as it was in 1985. However, the world's population will be larger, with more advanced industrial and post-industrial economies demanding ever greater quantities of energy and in particular oil in 2025 than was consumed in 1985. Consequently, worldwide demand for oil will out-pace the worldwide production of oil by a significant margin. The more demand for oil exceeds the production of oil, the higher the price must go.

The question then is not,

"When will the world run out of Oil?"

Answer: In the distant future

But rather,

"**When will the world run out of Cheap Oil?**"

Answer: **Soon!**

Why a Paradigm Shift is Needed

Development, as we know it, has been based on the assumption of the availability of Cheap Oil, and more recently, Cheap Natural Gas. Hydrocarbons not only provide us with the most efficient and versatile transportation fuels, but are essential for electricity generation, fertilizers[7], pesticides, plastics, clothing fibers, detergents, pharmaceuticals and other products essential to the modern world. However, as National Geographic said in a June 2004 article, "Humanity's way of life is on a collision course with geology."

According to many of the industry's leading authorities, world oil production is about to peak[8]. Once oil production peaks, increasing or even constant demand cannot be matched by a sustained supply.

It is not that we will have run out of oil, but that we will be unable to further increase its supply to match increasing demand, ending the era of Cheap Oil. In economic terms, once demand exceeds supply, the price of oil will be set by the price of the marginal barrel and market forces will drive that price steadily upward as the supply continues to decline.

In 2003, Jon Thompson, President and CEO of Exxon-Mobil, stated that by 2015 the oil industry would need to produce an additional 60 million barrels per day to meet anticipated demand i.e. the equivalent of 10 North Sea finds at full production. No reputable oilman believes this is possible, especially since the reservoirs producing the current approximately 80-85 million barrels a day would have declined in the interim.

Reaching Peak Oil production is likely to cause a range of destabilizing effects on the relationships between nations that could range from the relatively benign to the catastrophic, including:

- Fierce price competition for the scarce resource and its derivatives, including food: Witness the dramatic rise in oil prices in mid-2004.
- Disputes between neighboring countries over terrestrial and maritime boundaries to secure hydrocarbon exploitation advantage.
- Military actions (at times couched in Weapons of Mass Destruction or Clash of Civilizations language) to seize this strategic resource for the benefit of powerful nations.

Regardless of what combination of scenarios comes to pass, life in a post Peak Oil world will experience a Paradigm Shift. Although the effect will be felt globally, developing countries may find themselves hardest hit if they do not prepare adequately and in a timely fashion for the new realities. In particular, the development goals of many such nations will not be accomplished if they are not formulated with the concept of a Peak Oil Paradigm Shift **(POPS)** in mind.

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[7] The US uses the energy equivalent of 100 million barrels of diesel per year to produce its nitrogen-based fertilizers.

[8] E.g. Petroconsultants, now known as IHS Group and The Association for the Study of Peak Oil and Gas (ASPO) a network of scientists affiliated with institutions and universities from virtually all Western European nations.

Like the wise Pharaoh who heeded Joseph's counsel and prepared for the seven years of famine, governments and civil society can prepare their countries to negotiate the coming tsunami whose signs are quite evident. The alternative would be a failure of our duty to future generations of monstrous proportions.

Although the developed countries have the economic, technological and human resources as well as the military means to best adapt to the dramatic changes in the global economy that Peak Oil will trigger, there are some developing countries that possess definite advantages in confronting the challenges of a Post Peak Oil world.

For example, in the Southern Caribbean region Trinidad and Tobago, Columbia and Venezuela are exporters of oil and natural gas, have good potential for the development of solar, wind and wave renewable energy sources (leaving more oil and natural gas for export), fertile soil, rich fisheries, a reasonably well educated population and a political leadership with the hydrocarbon expertise and sophistication to chart a course through the approaching troubles.

Countries that lack many of the above resources will be harder pressed to meet the challenges of Peak Oil, even though there is no guarantee that countries that possess natural advantages will put them to good use. In too many cases the tendency of oil and gas producing countries is to assume that their good fortune will last forever and such complacency can retard efforts to galvanize action in preparation for the inevitable decline of these finite natural resources.

The very title of this book indicates that the challenges involved are manageable and need not condemn the world to a future of doom and gloom. However, they are only manageable if it is immediately recognized that they represent a new international landscape that will demand a Paradigm Shift in terms of what is needed for survival and success once oil production peaks then inevitably starts to decline. Without aggressive, concerted and well-funded efforts to address the challenges of a post Peak Oil world, the future for much of mankind will indeed be bleak.

When will Peak Oil occur?

In 1995, the world's leading oil and gas consulting firm, Petroconsultants, produced a report on world oil resources called **World Oil Supply 1930-2050.** This publication concluded that the planet's oil supplies would be exhausted much sooner than had previously been thought.

Oil industry insiders paid US[9] $32,000 per copy for the report which predicted that world oil production and supply probably could peak as soon as the year 2000 and decline to half the peak level by 2025. Significantly, some major oil companies disagreed with the Peak Oil estimate of the Petroconsultants study and commissioned their own study which concluded that Peak Oil would occur in the period 2006-2018. In so doing, they essentially arrived at the same conclusion, which was that the Peak Oil phenomenon was both real and imminent.

Though a review of the many authoritative sources suggest Peak Oil will occur somewhere between 2005 and 2010, it is noteworthy that world oil production declined in 2001 and 2002 and then grew to just half of one percent (0.5%) above the 2000 level in 2003. Given that every attempt will be made to keep pace with demand, Peak Oil will likely take the form of a plateau over a period of five to ten years during which there will be very little variation in oil production, as is now the case.

Estimates of the International Energy Agency (IEA) suggest that under normal circumstances worldwide excess capacity is between 2.5 and 3 million barrels per day. Almost all of this surplus capacity resides in Saudi Arabia with virtually every other producer operating at maximum sustainable output.

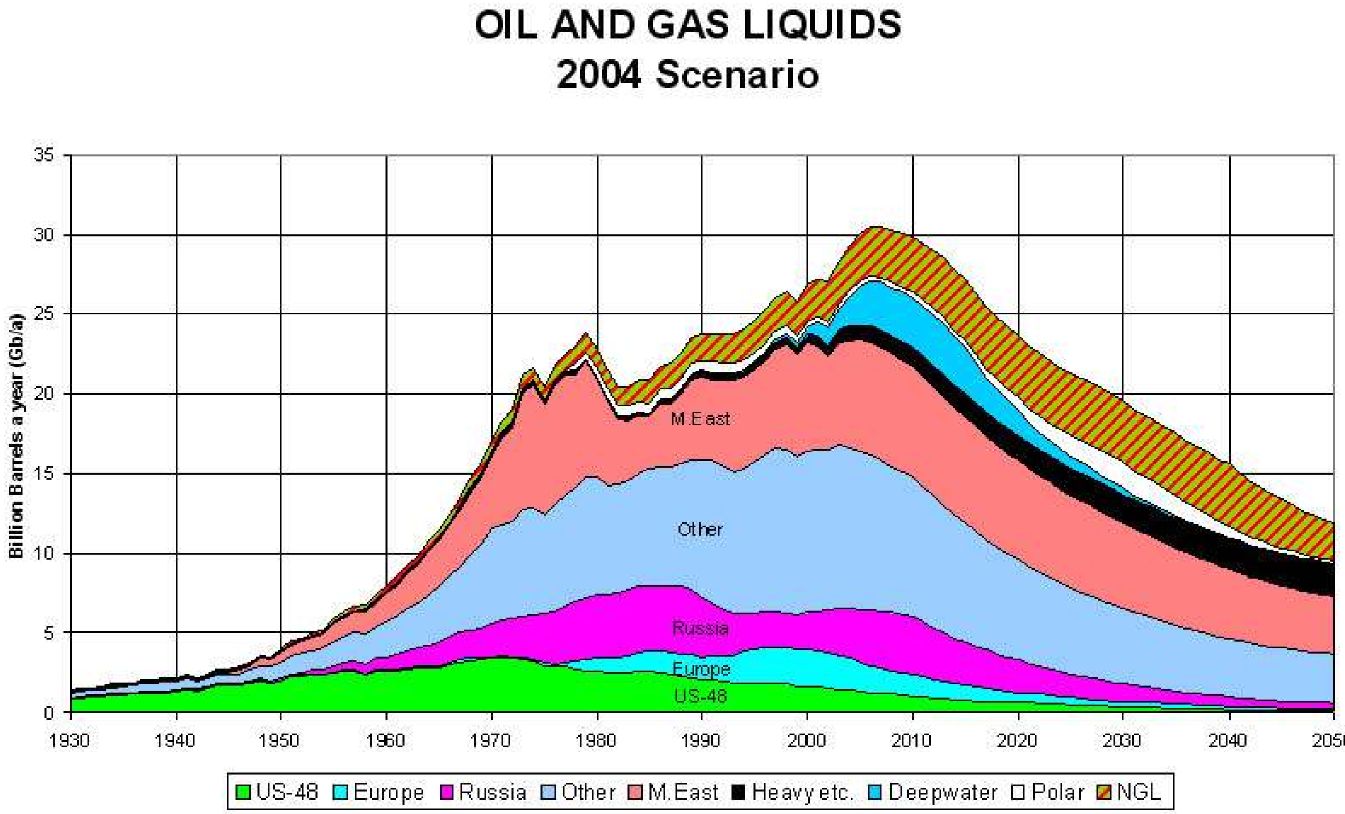
However, that spare production capacity is often much less than indicated. The Wall Street Journal recently quoted IEA sources to the effect that world production in mid-July 2004 stood at 81.1 million barrels per day with a global spare production capacity of only 0.62 million barrels per day. Thus the market supply situation was as tight as a drum with an anticipated increased demand of at least 2.5 million barrels per day for the 2004-2005 winter season.

The fact that since 2000 oil production levels have remained virtually unchanged and reserve production capacity has dwindled is in itself an argument for the world being in the Peak Oil phase.

A State of Decline

The Uppsala Hydrocarbon Depletion Study Group, based at Uppsala University, Sweden staffed by such eminent authorities as Colin Campbell and Kjell Aleklett, now estimates Peak Oil will occur by 2008. Their recently published findings include the 2004 upgrade of its Peak Oil model shown in the following graph:

[9] Throughout this book the dollars referred to are United States dollars



It is a fact that the rate of discovery of new oil has been declining for decades and that historically, production in a reservoir usually peaks 30-40 years after the start of exploitation. North Sea Oil started to decline after 27 years and most of the deep water finds, such as those off the West Coast of Africa, are subject to even faster declines; perhaps due to the greater efficiency of modern production techniques.

The best estimates of the amount of oil the world started with are in the range of 1.7 to 2 trillion barrels. It is known that well over 900 billion barrels have been produced. This means that supplies are approximately at the mid-point and hence at the peak or plateau phase of production.

One very optimistic estimate says that there is a 50% chance that there might be 700 billion more barrels than that. But at current rates of consumption and current rates of rising demand, the extremely doubtful 700 billion extra barrels will only postpone Peak Oil by six or seven years!

The debate as to exactly where Peak Oil lies in the range between 2000 and the highly optimistic 2020 is really sterile. The fact is that Peak Oil is imminent. As the reality of demand outstripping supply makes itself manifest, the world will have to adjust to the end of Cheap Oil. The usual estimate of the rate of annual decline after oil production peaks is 3%. This means that the global community would have to substitute for the loss of about 660 million barrels of lost production per year.

The world is nowhere near being prepared for such an eventuality with solar energy contributing less than 0.01 % of world energy today and wind power providing under 0.1 %. In addition, when looking at substitute energy sources, even natural gas does not produce the huge array of chemical by-products that are derived from oil[10].

Some will argue that production in say, Iraq can be increased, but even if it can be increased in a reasonable timeframe - despite the military and political situation - production in other parts of the world would simultaneously be in decline.

Even the massive Orinoco heavy oil deposits in Venezuela would not be a panacea. For, by the time the technology to efficiently, effectively and economically extract and refine crude from that source is deployed, production from most of the world's other reservoirs would have further declined.

It must also be remembered that very heavy crude such as the tarry Orinoco deposits are difficult and expensive to extract, transport and refine. Furthermore, they require much more energy to extract, pump through pipelines and refine than light crudes, yielding less net energy per barrel. Heavy crudes also yield less gasoline than light crudes, so replacing declining light crude with heavy crudes will still cause problems in terms of the need to produce the vast amounts of transportation fuels modern economies need.

The best that such measures might achieve is slightly extending the peak's plateau or diminishing the initial rate of decline of the down-slope of the oil production curve.

Can New Technology Save the Day?

There are those that hold the view that new geological and geophysical technology will help us find more oil. The view that new exploration technology will rescue the situation can be seen to be manifestly untrue on the basis of the fact that the rate of discovery of new oil has been in actual decline since the 1960s despite the deployment of the latest exploration technology.

Such arguments fail to grasp the fact that new technology can help us better find and more accurately map small fields, but that no technology can create super-giant oilfields like those in Saudi Arabia which underpin current global supply. It seems that satellite mapping and various other high-tech tools used in the hunt for oil are providing us with the evidence that the world will more or less have to make do with what it has and prepare itself for the eventual decline of a finite depleting resource…painful as that may be to accept.

Some also argue that as prices rise it will become economically feasible to extract oil from currently unprofitable deposits. But there are thermodynamic limits to this. It takes energy to drill for oil, lift it to the earth's surface, let alone refine it and transport it to market. In order to benefit from an energy resource, the finished product must be able to release more energy when put to work, than was used to find, extract, transport, refine and otherwise prepare it for final consumption.

Once the net energy to bring a barrel of oil to market exceeds the energy contained in that barrel, price no longer matters…thermodynamics takes over and would dictate leaving the oil in the ground or extracting it

[10] Over 500,000 products are derived directly or indirectly from crude oil.

at a very high price for non-energy use such as manufacturing pharmaceuticals and producing other petrochemicals.

In the 1950s it took the energy equivalent of only one barrel of oil to produce fifty barrels of usable crude oil, whereas in 2004 one barrel of energy invested yielded between five and ten barrels of usable oil from conventional oilfields. This is the norm for any kind of mineral extraction where the highest quality and most accessible deposits are exploited first and the lower quality, less accessible deposits are recovered later and at higher costs.

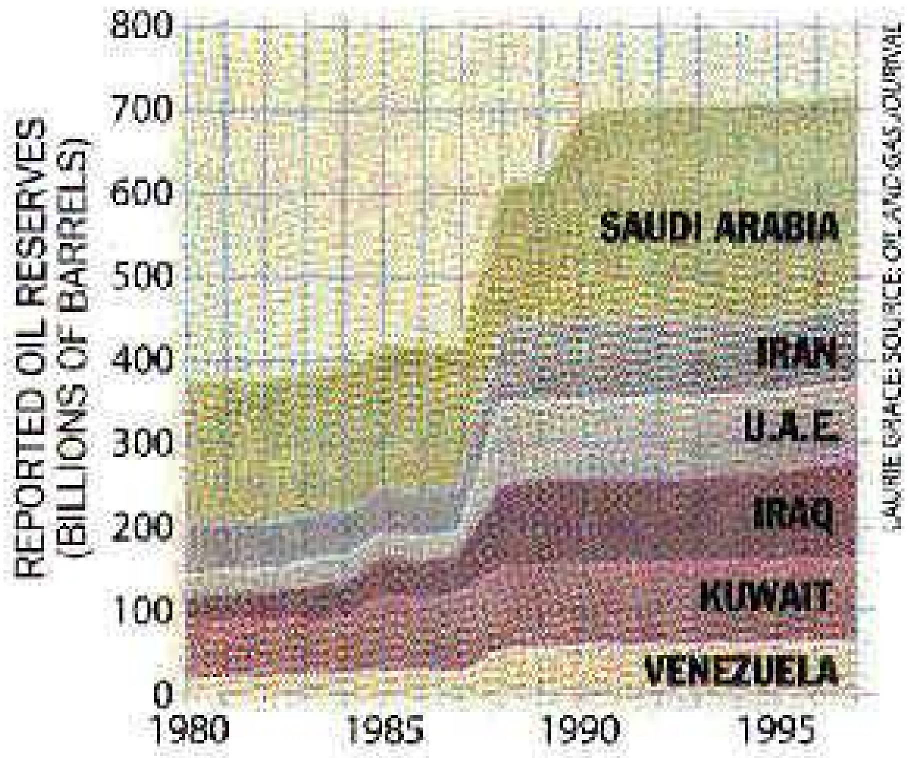
As the average depth of a new oil well continues to rise from 300 feet in 1870 to 6,000 feet in 1980 and even higher at present, the energy required to lift the oil to the surface has become more significant, especially in declining reservoirs. Some recent offshore finds have been in depths in excess of 8,000 feet of water, so that the actual lifting depth, considering the depth of the oil reservoir below the ocean floor, will make producing oil from such wells less thermodynamically feasible once reservoir energy decreases and more pumping is required.

In some cases the total lifting depth is 20,000 – 25,000 feet. For example, the Thunder Horse Reservoir currently being drilled by British Petroleum in the Gulf of Mexico lies 120 miles offshore in 5,000 feet of water and the reservoir itself is another 17,000 feet below the seafloor.

Given the sophisticated nature of today's geological and geophysical technology and the quality and accuracy of the information it yields and bearing in mind the thermodynamic costs, the major oil companies make little effort to try to increase production from existing reservoirs in the lower 48 states of the United States. This is because, even if one could sell oil for $500 a barrel, exploring, drilling, refining and transporting it to market would conceivably consume more energy than could be recovered from the oil. Land production in virtually all countries with a long history of oil production will similarly, over time, become less thermodynamically efficient.

Phantom Oil

Oil companies and even producing countries have a vested interest in overstating their reserves. For example, in the late 1980s six of the eleven OPEC countries raised their estimated reserves by 300 billion barrels without the discovery of any significant new reservoirs. This was due to an OPEC ruling that a country's production quota would depend on its reserves. Voila! Three hundred billion barrels appeared out of convenient, optimistic upward revisions of national reserves.



Non-government oil companies have also been guilty of falsifying their reserves. In March 2004, the chairman of Shell was removed from office when the company was forced to admit that it had overstated its oil reserves by 22% or 4.5 Billion barrels. In another example of wishful thinking, ChevronTexaco claimed that it had increased its reserves by 14% over the last six years and publicly promised in 2002 to increase production by 22% by 2006. In reality, its actual production has dropped by 15% over the same six-year period during which its reserves supposedly rose.

Meanwhile, other major oil companies (including BP and El Paso) have been quietly reducing their estimated reserves as the situation with Shell has highlighted the tendency to overstate reserves to impress investors.

Most publicly available statistics on Oil and Natural Gas reserves are taken from surveys conducted by the *Oil and Gas Journal* and *World Oil.* Every year these two trade journals query oil firms and governments around the world. They then publish whatever production and reserve numbers they receive but are not able to verify them.

Companies and countries are often deliberately vague about the **likelihood** of the reserves they report, preferring instead to publicize whichever figure, within a P10 (10% probability) to P90 (90 % probability) range, best suits them. The difference between a P10 estimate and a P90 estimate can easily exceed a factor of 3 to 1. Exaggerated estimates can raise the price of an oil company's stock or boost a producing country's credit worthiness, providing great incentive to present unrealistically high reserve estimates.

Nail in the Coffin

Advances in geological and geophysical sciences have accurately mapped the earth's oil and gas reservoirs so that there remains little likelihood of any really mega finds in the offing. Even recent so-called significant finds like Britain's Thistle Oilfield with its estimated 420 million barrels pale in comparison with the current rate of global consumption which runs at about a billion barrels about every 12 days i.e. the Thistle Oilfield would supply the world's current oil needs for about five days.

But perhaps the nail in the coffin of the overly optimistic projections of those who wish to lull others into a false sense of security while they prepare for the inevitable, is that the rate of discovery of new oil has been falling steadily since the 1960s and in 2003, more than 3 times the new oil discovered was extracted.

It is over 20 years since more oil has been discovered than consumed in a year and in 2001 and 2002 the top 10 non-state oil companies actually spent more money on exploration than the value of oil they discovered. Applying the differential between extraction and discovery rates leads inexorably to the realization that a decline is imminent.

It is no wonder that many large energy companies are expanding aggressively into solar and wind power. For example, General Electric (GE) the world's largest supplier of electricity generators has purchased the wind-power generation assets of Enron and recently acquired AstroPower a leading manufacturer of photo-voltaics for solar energy conversion. Perhaps British Petroleum's (BP) new slogan "Going Beyond Petroleum" says it all.

The Saudi Arabia Factor

Many skeptics will point to Saudi Arabia's reserve production capacity that is pictured in terms of the Saudis being able to simply open the valves a little wider and flood the market with oil. The facts are far less comforting. More than half of Saudi Arabia's production comes from the giant Ghawar field that was discovered in 1948. To maintain production levels in the Ghawar field, Saudi Aramco employs a technique called Maximum Reservoir Contact (MRC) or bottle-brush drilling combined with massive water flooding of the reservoirs.

Bottle-brush drilling involves drilling long horizontal shafts in the reservoirs and making a number of brush-like openings into the reservoir to improve the flow of crude from the oil reservoir. About 7-8 million barrels of seawater a day are pumped into the lower levels of the reservoir to force the oil toward the well-heads. Although such measures increase extraction rates, they also accelerate production decline and can cause permanent damage to the reservoirs.

In addition to the incremental damage that these techniques can cause, as the water level in the reservoir rises there is the danger that when the water table reaches the level of the horizontal bottle-brush shafts, the reservoir suddenly "dies" with production dropping off rapidly to minimal levels.

This has already happened to reservoirs in Yemen, Syria and Oman where the combination of bottle-brush drilling and aggressive water flooding was used. Oman's Yibal field declined 65% between 1997 and 2001 and by 2004 production had sunk to about 18% of the 1997 level using these techniques.

The extensive water flooding being employed by Saudi Arabia is also putting immense strain on its oil production infrastructure. Because the oil coming to the surface is mixed with water, the pipeline capacity requirements for producing the same volume of oil are rising. It is currently estimated that in the case of the Ghawar field about half of what comes out of the wells is water, with this ratio constantly rising every year. This also requires larger and larger capacities for the very expensive separators that are required to get rid of the water.

The Ghawar field and four other "super-giant "fields (Safaniyah, Hanifa, Khafji and Shuaiba) discovered between 1940 and 1965 produced 90% of Saudi Arabia's oil over the last 50 years. Two of these giant fields appear to have peaked way back in the 1970s.

Thus Saudi Arabia's supposedly limitless extra capacity is tied to the production of just five oilfields, all of them discovered 40 to 60 years ago, some of which are in decline and the largest of them only maintains its production levels by the use of aggressive secondary recovery techniques that can cause catastrophic damage to the reservoirs.

If the Ghawar field dies, the entire world will be invited to its funeral as massive oil shortages and corresponding dramatic price increases wreak havoc with the world's economy.

Speaking at the Association for the Study of Peak Oil (ASPO) conference held in Germany in May 2004, Ali Bakhtiari, Vice President and head of strategic planning of the National Iranian Oil Company (NIOC) and one of the Middle East's most respected authorities on the oil industry, referred to the data about sudden and unexpected declines as the result of bottle-brush drilling and voiced strong doubts about Saudi Arabia's ability to increase production under any circumstances. Referring to the scramble to control Middle East oil, Bakhtiari told the conference:

> *'The crisis is very, very near. World War III has started. It has already affected every single citizen of the Middle East. Soon it will spill over to affect every single citizen of the world…Syria's oil production is in terminal decline. Yemen is following. Major Middle East producers, including Saudi Arabia, will peak soon or have already peaked.'*

For the time being, by using extreme measures, Saudi Arabia may indeed be able to increase the flow of oil by somewhere between one and two million barrels per day for short periods, but at the expense of risking permanent damage to its reservoirs. Its legendary excess capacity is something that it prefers to threaten to use rather than actually put into effect.

The US Energy Intelligence Agency (EIA) in trying to assure the world of the oil industry's capacity to supply the projected levels of demand well into the future, suggests that Saudi Arabia should increase its output to 20 million barrels a day by 2020. On the other hand, a recent internal Saudi Aramco document speaks about a target production capacity of just 10.15 million barrels a day in 2011, approximately the same level as today's production capacity. Thus it seems that the Saudis would be happy if they can simply maintain present production levels, despite their public relations announcements and those of US government agencies.

This is not the rosy picture often painted by energy companies or Saudi princes whose fortunes depend on not only the continued profitability of the oil business but on the viability of the US securities markets in which they have invested massive amounts of their petro-dollars. An appreciation of the fragility of the world oil supply situation could trigger the kind of loss of confidence that collapses stock and even bond markets catastrophically.

A Shaky Situation

All the above analysis ignores deliberate attempts to sabotage production, such as are now evident in Iraq. Should the Saudi government seek to increase production at the expense of damaging its reservoirs there may well be future attacks on the production infrastructure by groups who regard such policies as "selling out" to US/UK interests at the expense of Saudi nationals. Already there is the very disturbing trend of attacks against foreigners working in the kingdom's oil industry. In the summer of 2004, there were fears that many expatriates would not have returned to their jobs following their annual vacations.

The shaky nature of the world's oil supply situation is demonstrated by the comments of Mr. Fatih Birol, Chief Economist of the International Energy Agency (IEA), the world's energy watchdog, in an interview with the BBC at the ASPO conference in May 2004:

> *"For the time being there is no spare capacity. But we expect demand to increase by the fourth quarter (of the year) by three million barrels a day…If Saudi does not increase supply by 3 million barrels a day by the end of the year we will face, how can I say this, it will be very difficult. We will have difficult times."*

However, Mr. Birol admitted that Saudi production was "about flat"; making it highly unlikely that Saudi Arabia could achieve a huge 30% leap in output in just a few months, especially as production from Iraq has become increasingly unpredictable due to the insurgency against the US/UK occupation.

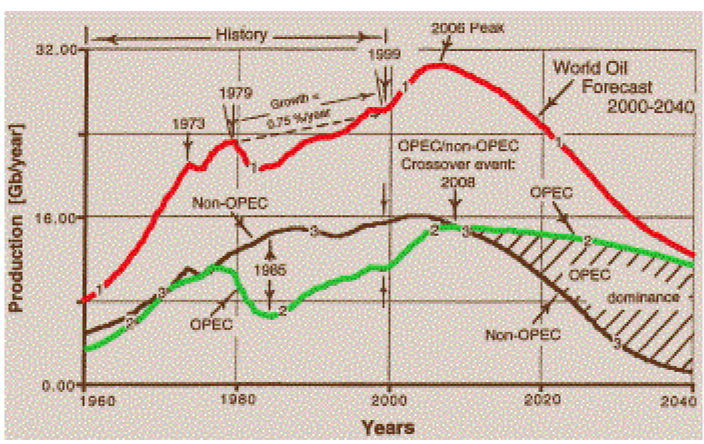
Perhaps even more instructive is the fact that when the BBC's Adam Porter asked delegates at the conference about the likelihood of Saudi Arabia being able to achieve a 30% production increase by the end of 2004, the responses were uniformly negative, with one delegate laughing so hard that he had to hold on to a table for support!

The Saudi saying that "My father rode a camel, I drive a car, my son flies a jet, his son will ride a camel" summarizes the inevitability of the imminent peak and subsequent decline of Saudi Arabian, Middle Eastern and world oil production as a whole.

A Note On OPEC

The supply of oil from the Organization of Oil Exporting Countries (OPEC) producers is expected to exceed that of other producers as early as 2008. The greater significance of OPEC producing 51% of world oil is that it will by then be producing close to 100% of exported oil. By that time, most other countries will be keeping their oil production entirely for their domestic use or they will be refining it and exporting only their surplus refined products.

The major energy companies have long been anticipating this. A fact that can be seen in BP-Amoco's estimate in 2000 that OPEC countries held 77.6% of the world's "proved reserves" and the fact that between 1985-1999 OPEC production grew by an average of 3.46% while Non-OPEC production grew by a mere 0.37%.



Relative production of OPEC & Non-OPEC Producers[11]

Such a scenario will change the relative power of oil exporter versus importer countries, unless other factors such as military domination supersede market considerations.

[11] *The Peak of World Oil Production and the Road to the Olduvai Gorge*, Richard C. Duncan, Ph.D. - Pardee Keynote Symposia, Geological Society of America Summit 2000

Abiotic Oil the Savior?

The commonly accepted theory about how crude oil is formed dates back to 1757 when the Russian scientist Lomonosov theorized that "... 'rock oil' [crude oil, or petroleum] originated as the minute bodies of dead marine and other animals which were buried in the sediments and which, over the passage of a great duration of time under the influence of heat and pressure, transformed into 'rock oil'." The prevailing theory thus holds that petroleum has a biotic or biological origin. The presence of animal and plant fossils in oil bearing formations helped to support this theory.

There is an alternative theory called the Abiotic Theory of Oil Formation that has been developed primarily by Russian and Ukrainian scientists[12] although ironically it was first advanced by the German and French scientists von Humboldt and Gay-Lussac early in the 19th century.

Their theory was that petroleum was a primordial substance formed at great depths within the earth and is unconnected with any biological material associated with the surface of the earth; hence the term abiotic or non-biological origin.

Their theory held that the oil then migrates or seeps up into the reservoirs that are currently drilled to recover oil and natural gas. They explain the presence of fossils as being due to the oil having seeped through layers of fossil material as it rose from the depths of earth's mantle.

The theory was further developed by the Russian scientist Mendeleev in the late 19th century and took its present form in a paper by Kudryavtsev in 1951. It is often referred today as the Russian-Ukrainian Theory of Deep Abiotic Petroleum Origins and it has found some notable support in the United States including the late Professor Thomas Gold[13] of Cornell University and J.F. Kenney of Gas Resources Corporation.

Proponents of the theory have presented evidence that the formation of hydrocarbons heavier than methane (such as petroleum) could not have taken place except at the temperatures and pressures present at very great depths. They have also published findings documenting the artificial production of the range of hydrocarbons found in natural petroleum by subjecting marble, iron oxide and water to temperatures of 2,000°C and 50 kilo-bars pressure.

They also cite evidence of reservoirs that have apparently been partially replenished and the presence of oil in formations that do not show the typical biological fossil profiles and contain very high levels of helium which is considered to be of deep origin. They also contend that the

[12] See "Recent applications of the modern theory of Abiogenic Hydrocarbon origins: Drilling & development of oil & gas fields in the Dnieper-Donets Basin"– V.A. Krayushkin et al

[13] Gold, who was fluent in Russian, was accused by Russian scientists of plagiarizing their work without acknowledging its origin and of introducing errors into the theory, particularly his view that large volumes of methane are being generated in the earth's mantle

hydrocarbon contents in sediments do not contain sufficient organic material to have produced the vast amounts of petroleum found in giant oilfields. Thus they theorize that oil has a non-biological or abiotic origin.

This would imply that there is a virtually inexhaustible supply of oil and natural gas at extreme depths which is being continually formed at the extreme temperatures and pressures found within the earth's mantle and that these hydrocarbons gradually seep upward and replenish the reservoirs that are nearer the earth's surface.

Although the majority of western earth scientists reject this theory as being the major mechanism by which the earth's oil and natural gas deposits are formed, Peak Oil would still occur even if the Abiotic Theory of Oil Formation proves to be sound.

Even proponents of the Abiotic Theory do not suggest that it would be practical to drill down to the depths at which they believe oil is being formed. The deepest well ever drilled is the Kola-SG3 experimental geological borehole at Zapolyarny, Russia which goes to a depth of about 8 miles while the Abiotic Theory suggests that oil formation is taking place at depths of 20 to 150 miles below the earth's surface and at temperatures and pressures that no current drilling technology could handle. Thus oil would still have to be extracted from relatively shallow reservoirs that are being supplied by oil percolating upward from great depths. Therefore extracting oil at a rate greater than it can be replenished by the upward seepage would still result in depleted reservoirs.

According to the calculations of Russian scientists who support the theory, the extraction rates in areas like the Middle East are at least 20% to 30% higher than the rate at which the reservoirs could be replenished by abiotic oil. This means that reservoir levels would still decline as would production regardless of whether the oil is of biological or non-biological origin. Furthermore, the common use of enhanced recovery methods such as pumping water or gas[14] into the reservoirs would seriously hinder abiotic oil from seeping upwards to refill the reservoirs.

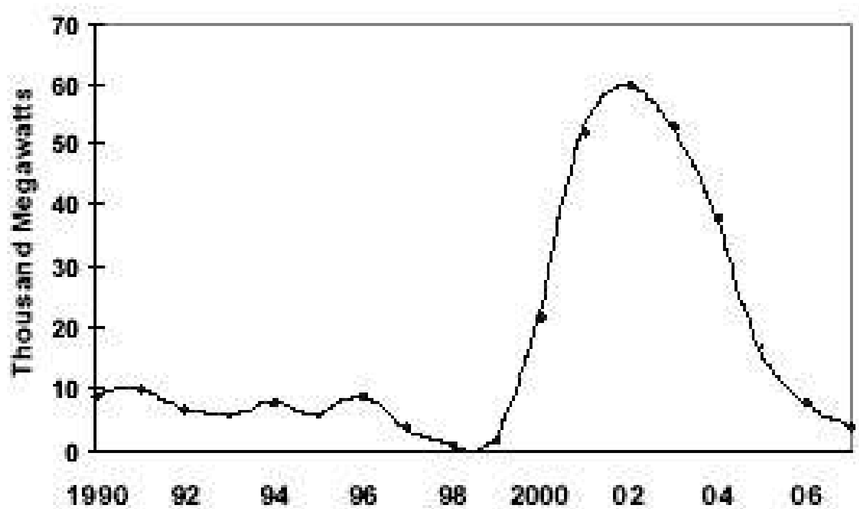
Even if the Abiotic Theory of Oil Formation is correct and if it exists in the quantities suggested by some of its proponents and if it is indeed leaking upward into present reservoirs the effect will only be to delay the onset of Peak Oil. The fact remains that at present extraction rates existing reservoirs are showing declining reserves that inevitably will cause reduced production levels. Therefore the currently high and ever-growing demand for oil would still result in demand outstripping supply in the near future.

[14] Excess natural gas or carbon dioxide is often pumped into wells to increase reservoir pressure and force oil to the wellhead

What About Natural Gas?

Natural Gas and Crude Oil are both hydrocarbons, and are often found together in the same reservoir. Years ago gas was considered the unwelcome relative in the petroleum family, a nuisance and safety hazard with no market value that caused oilmen to utter profanities when they found it instead of the precious black gold. Today, natural gas has come into its own. According to the US Department of Energy, natural gas consumption is projected to rise from 84 trillion cubic feet in 1999 to 162 trillion cubic feet in 2020, driven largely by electricity generation demand.

Due to the greater efficiency of combined-cycle gas turbines compared to coal or oil-fired generation plants, and because gas burns cleaner than either coal or oil, natural gas is viewed as being more attractive for countries interested in reducing their air pollution, including greenhouse gas emissions. The massive shift to natural gas for electricity generation is illustrated by the fact that in the 1990s, US electric utilities ordered a whopping 180,000 Megawatts of gas-fired power plants to be installed by 2005.



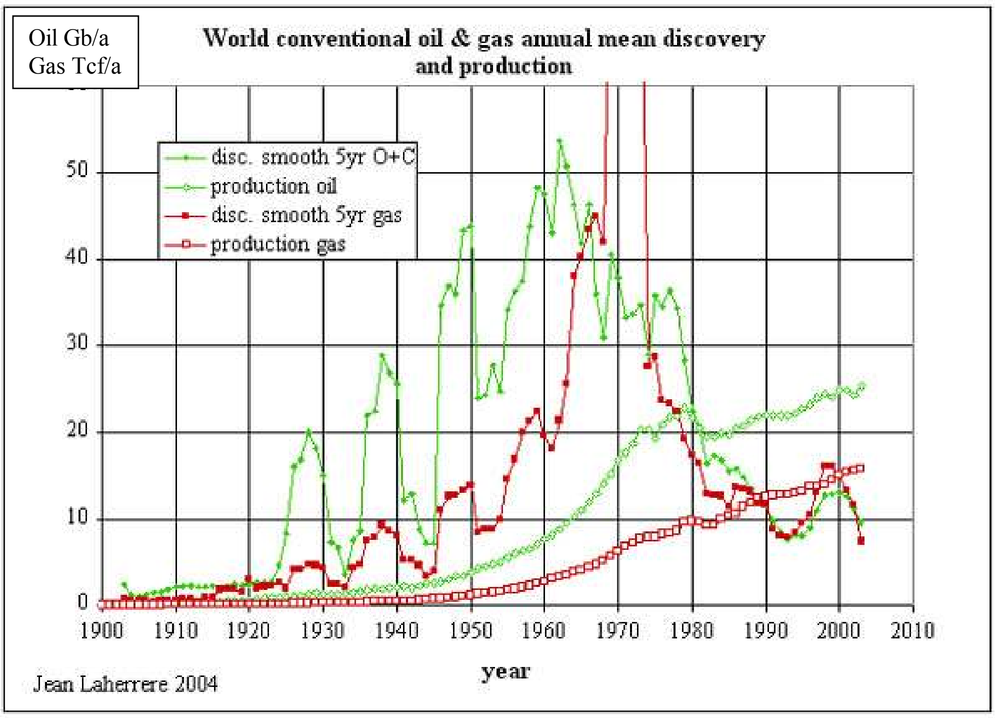
Proposed US Power Plant Additions

Natural gas declines differently from oil. Just as the supply of gas from a stove's gas tank gives little warning of its demise, so too does gas production decline precipitously. Even though oil and gas are usually found in the same places and originate from the same organic matter, natural gas is different from oil by nature. Being a gas as opposed to a liquid, once a well is drilled it takes relatively little effort to pump out the gas. There is initially little tapering off in production and little need to expend more energy driving the gas to the well hole.

A typical example of the accelerated decline rates of gas wells is the fact that a new Texas gas well gives up 75% of its gas in just four years. Natural gas production profiles generally have a rise, a plateau, and then a steep cliff with little warning as the pressure in the well drops and the play peters out. Likewise, natural gas reserves are much more responsive to drilling than are oil reserves. The more wells that are sunk into a gas reservoir, the greater the amount of natural gas extracted, and the quicker the depletion of the reserve.

The Natural Gas Peak

While many people in the industry are aware that oil discoveries peaked in the 1960s, many seem to be ignorant of the fact that natural gas discoveries worldwide peaked in the 1970s. The relationship between world oil and gas discovery and oil and gas production is shown in the graph on the following page in which the units for oil are expressed as Billions of Barrels per annum (GB/a) and for gas are described in measures of Trillions of Cubic feet per annum (Tcf/a).



While the world as a whole should peak in natural gas production some time after Peak Oil, it should be noted that North American natural gas production has already begun to decline. US natural gas production declined 28% in 2003 despite extensive drilling.

Western Europe is now a net importer of natural gas, with most of its future supply expected to come from Russia where conventional wisdom holds that there are large untapped reserves. However, Russia's four largest gas fields are now known to be in decline and given the rapidity with which the production of natural gas can decline in depleted fields, new natural gas reservoirs will have to be quickly brought on line for Russia to meet Western Europe's anticipated demand.

Unlike crude oil, natural gas is not easily transported overseas making the Atlantic LNG[15] plant in Trinidad and Tobago a key component of US energy security. The Liquefied Natural Gas (LNG) exported by special

[15] Atlantic LNG is a consortium headed by British Gas and British Petroleum (BP)

tankers from this facility supplies about 70% of the natural gas demand of the eastern seaboard of the United States. This plant currently uses natural gas from Trinidad and Tobago and is intended to use Venezuelan gas as well in the future as the plant is expanded, thus making the generation of electricity in the eastern United States highly dependent on Caribbean natural gas.

The high rate of extraction demanded by the need to supply the mega US market will likely result in a more rapid decline of the supplier countries' natural gas deposits than originally anticipated. Similarly, the global rate of natural gas depletion will be increased from present levels as many countries convert to natural gas from oil-based fuels in the areas of transportation and electricity generation.

The Ladyfern Example

However, if countries allow excessive natural gas extraction rates due to commercial or political pressure, the result would probably resemble what happened to the Ladyfern deposit in Northern British Columbia.

> "Discovered in 1999, Ladyfern was considered the largest NG discovery in North America. At one time, Ladyfern was thought to contain over one trillion cubic feet of NG, but experience has cut that number to less than half. Ladyfern was also expected to make up fully one quarter of Canada's NG production for some time to come.
>
> "What happened? From a withdrawal rate of 785 Mcf[16]/day the play has now dwindled to 300 Mcf, and will quickly be reduced to a trickle. Only a year ago, this area of British Columbia resembled a gold rush, as NG riggers, helicopters, service crews, and road and pipeline construction crews stampeded the muskeg. Roads that carried 1,000 service vehicles per day one year ago are now lucky to see two dozen trucks.
>
> "What happened to Ladyfern was a result of unbridled, unregulated greed. Government mismanagement allowed competing corporations to overproduce the play, and draw it dry in a fraction of the time that it should have taken. As a result, there are numerous wells dotting the muskeg of British Columbia that are sucking water, and the people of British Columbia are being cheated out of much-needed revenue. Companies that would have made 200% on their investment if properly managed have had to settle for a 20% return."[17]

The error of assuming an inexhaustible supply of oil is now being repeated by producers of natural gas as they rush to cater for consumers looking for a cheap and clean alternative to crude oil. Policies that call for extraction rates that will guarantee a premature decline of their natural gas patrimony are all too often trumpeted as prudent monetization of a country's natural resources, until inevitably the gas begins its steep decline and the customers move on to the next country or region anxious to sell their gas cheaply.

[16] Mcf = Millions of cubic feet; Bcf = Billions of cubic feet, Tcf = Trillions of cubic feet
[17] Natural Gas Crisis by Dale Alan Pfeiffer. © Copyright 2003, From The Wilderness Publications

The Anomaly of Oil Prices

In the 1970s when crude oil rose to $30 per barrel, attempts were made by South Africa and other countries to produce synthetic oil from coal and shale. It was found that it cost $80-$90 to produce an equivalent barrel and that the process consumed a lot of energy. The fact that a product could be priced at one third of its competition and still be termed expensive is a reflection of the fact that the price of oil is not determined by purely economic considerations.

It is noteworthy that nearly 30 years later oil was still selling at about the same level as in the 1970s. Even with inflation and today's improvements in technology, "syn-crude" would only become viable when crude oil prices rise to about $60 per barrel.

The policies of the large energy companies and their governments are among the prime determinants of world oil prices along with the influence being exerted by OPEC and other national producers. The interplay between the major powers and national producers in determining prices can be studied by examining the levels of political, economic and military influence exerted by the United States and the United Kingdom over OPEC's major producers.

The dominant players believe that it is in their best interest to have oil prices remain depressed for as long as possible thereby allowing the large multinational energy corporations to put their houses in order through measures such as mergers, consolidation and diversification. Similarly, governments of powerful developed countries buy more time to implement conservation, develop alternative energy sources, prepare strategic oil reserves and even develop the political and military solutions to effectively appropriate the oil and gas resources of other nations for their own use.

Paradoxically, they are helped by the attitudes of many leaders of oil exporting countries who fear that oil conservation and the development of alternate energy sources will reduce demand for their commodity and cause falling oil prices. At the 16th World Petroleum Congress held in Calgary, Canada in 2000, Rilwanu Lukman, then Secretary General of OPEC, stated: "As a group of fossil fuel exporters, OPEC stands to lose more than most from any proposals that threaten to cut oil consumption".

Such sentiments would have been appropriate if it were not for the fact that crude oil is a depleting commodity of which only a finite amount exists. In the current tight oil supply situation a barrel of oil sold five years from now is almost guaranteed to fetch a higher price, even corrected for inflation, than at present.

The powers that be in major consuming countries would probably prefer not to see too early a worldwide awareness of an imminent plateau of oil production which would likely create overwhelming pressures within producing countries for their governments to limit extraction rates and raise prices. In addition, citizens in developed countries that are reliant on oil and natural gas imports would likely seek to change the policies of their governments and energy corporations in the direction of conservation and alternative energy sources at the expense of the currently dominant auto, oil and gas lobbies.

It is also noteworthy that the differential between petroleum production cost and market price is so great that market price cannot be used as an accurate measure of resource depletion. For example, the variation in the average price of oil between 1998 ($10 per barrel) and 2000 ($24 per barrel) had less to do with depletion of reserves and more to do with an attempt by OPEC to exercise *market discipline*.

At present, one of the most important reasons there seems to be an unending supply of oil is the activity of non-OPEC producers, in particular Russia. Oil production is immensely lucrative. Large amounts of petroleum have been and will continue to be produced outside OPEC at costs that are very low, $5-$10 per barrel, compared to the until recently "officially" desired OPEC price range of $22-$28 per barrel[18]. The opportunity to realize extraordinary profits provides irresistible pressure to produce as much oil as possible…as quickly as possible.

Thus various factors have combined to ensure that oil prices have not yet gone through the roof even as there are indicators that it may soon become a much scarcer commodity. The current $40 to $50 per barrel range is likely to be an indicator of the new "base" price for this essential commodity, though only for a short time as demand continues to drive prices up to new heights[19].

A Reuters article of August 23, 2004 states that OPEC producers are pumping oil at the highest level in over a quarter of a century and quotes Iran's Deputy Oil Minister as saying that OPEC could do no more to control oil prices. He stated, "There is no extra capacity. Those that consume oil, they should decrease demand, that is the only solution. I think prices will remain around $50 a barrel."

But high prices may well turn out to be a good thing. According to Mathew Simmons, energy investment banker and adviser to the Bush II administration, who thinks that oil should be selling for about $180 per barrel:

> *"Oil is far too cheap at the moment…We need to price oil realistically to control its demand…because global production is peaking…If we price oil correctly, it could give us time to find bridge fuels, fuels to fill the gap between an oil economy and a renewable economy. But I don't see that happening."*

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[18] That oil price "standard" virtually died in June 2004 when the Saudi Arabian Oil Minister suggested that $35 a barrel was fair

[19] A Reuters report of August 4, 2004 on crude prices hitting $44 states that "…accelerating global demand has left supplies tightly stretched with little leeway for disruption. Some analysts fear that the relentless rise could take prices above $50 a barrel". The article quoted a manager of international petroleum business at Mitsubishi as saying "OPEC's spare capacity is at a historic low level Even if something that could disrupt oil exports, like the Iraq war and Venezuela's strike, happens again, OPEC can't boost production immediately to offset it this time."

Given that even as Peak Oil arrives there will still be a lot of oil available, the more immediate goal does not have to be a "renewable economy" but rather a hybrid energy economy where the gradual development of alternative energy sources allows nations to reduce demand for oil (and natural gas) by 3% to 5% per year.

This reduction in demand would serve to keep oil prices down to more reasonable levels while allowing continued development and economic growth worldwide. As will be shown later, it is technologically feasible to continue modern economic development despite Peak Oil if an immediate start is made to increase the use of energy alternatives available with today's technology.

Getting the Price Right

It should also be remembered that, historically, producing countries received very little for the crude oil exported from their nations through the international energy companies. For years, governments received as little as 2 - 25 cents per barrel even though the world price was many times these amounts. In 1970, the government of Venezuela asked for an increase in the official price of its crudes from $1.25 to $2.00 per barrel and was threatened with a boycott of its oil[20].

Even after the 1973 oil shock and the large increase in prices, the lion's share of the price of a barrel of oil continued to elude the governments and people of countries exporting this strategic, essential and depleting resource. More recently, President Hugo Chavez introduced a new Venezuelan Hydrocarbon Law that raised the proportion of the price of a barrel of oil going into the national treasury from 16% to 30%.

The opposite impression exists in consumer countries whose populations believe that the producing countries have for many years been unfairly price gouging and are rolling in petrodollar windfalls. An examination of the accounts of the energy companies and the network of traders that dominate the crude oil, refined products and natural gas markets would clearly show that the treasuries of exporting countries do not receive the major part of the market prices paid for their petroleum exports.

To illustrate the unequal relationship between energy companies and producer countries, the case of Trinidad and Tobago which has traditionally been able to obtain better terms than most for its petroleum resources can be briefly examined. The transfer price for natural gas for the first train of the Atlantic LNG plant was just 5% of the then world price and the company also received an eight-year tax holiday.

Even when the price was raised by a factor of 8 for the second train, it was still less than half of the prevailing world price. The result is that the governments of producer countries struggle to obtain the revenues necessary to develop their societies while they are simultaneously blamed by consumers in developed countries who seemingly fail to realize that it is the energy companies that are calling the shots.

[20] The higher price would not have gone directly into the Venezuelan national treasury but would have only raised the base price on which taxes and royalties would have been calculated

Another factor often overlooked is that oil has traditionally been priced in US dollars, a fact that confers tremendous advantages to the United States economy. William Clarke, a California attorney argues[21]:

According to research by Dr. David Spiro[22], in 1974 the Nixon administration negotiated assurances from Saudi Arabia to price oil in dollars only, and invest their surplus oil proceeds in U.S. Treasury Bills. In return the U.S. would protect the Saudi regime … These agreements created the phenomenon known as "petrodollar recycling." In effect, global oil consumption via OPEC provides a healthy subsidy to the U.S. economy… Obviously the E.U. would also like oil priced in euros as well, as this would reduce or eliminate their currency risk for oil purchases.

In 2002, prior to the invasion of Iraq, the Iraqi government had switched from dollars to euros for its oil pricing and neighboring Iran followed suit shortly thereafter and converted half of its Central Bank assets to euros. The US bond and securities markets are already under pressure due to an annual national deficit of about $450 billion per year and a national debt of over $7 trillion. Should other oil producing countries switch to euros as their standard currency for oil transactions, Clarke says:

…(T)he oil-consuming countries would have to sell their US dollar holdings and buy Euros instead. This would have the dramatic effect of causing a crash in the value of the US dollar on world markets (estimated at between 20-40%) *and produce massive inflation. The consequence of that would be a run on the markets and a flight of bond and security holders out of the US dollar and into other currencies.*

The above analysis adds another dimension to the issue of oil pricing since, given its vested interest in keeping the dollar as the standard oil transaction settlement currency, the United States is obliged to pressure oil producers to stay with the dollar and not migrate to the euro. Thus, although Venezuela has not reneged on its supply contracts to the United States, President Chavez's stated intention of changing Venezuela's oil settlement currency to the euro or a combination of dollars and euros must certainly not be favorably viewed in Washington.

[21] William Clark, "Revisited-The Real Reasons for the Upcoming War in Iraq: A Macroeconomic and Geostrategic Analysis of the Unspoken Truth."
[22] See Spiro, David E., The Hidden Hand of American Hegemony: Petrodollar Recycling and International Markets, Cornell University Press (1999)

Oil and Natural Gas Consumption

Worldwide about 2.5 billion barrels of oil are consumed every month, with some significant variation depending on the season, consumer confidence and economic growth rates. Consumption varies not only in accordance with the level of development but also with the patterns of consumption in various countries and regions.

After the oil price shocks of the 1970s, Europe became much more conscious of the fact that its dependence on imported oil was a major vulnerability. Today, Western Europe with a population slightly larger than the United States and with a comparable standard of development and material quality of life uses about half the oil and natural gas of the US.

Many Americans still buy gas-guzzling cars, trucks and SUVs in record quantities (up to 46% of the private fleet), live in energy inefficient homes and employ a suburban planning model incorporating little mass transit – an arrangement that is highly dependent on abundant oil and natural gas.

Of an estimated 127 million commuters in the United Sates, 74% drive to work alone, with sales of SUVs having remained generally strong as gas prices rose, although in June 2004, there were some indications that rising gas prices may have finally started adversely affecting SUV and pickup truck sales in the United States.

Extra-heavy vehicles like the Hummer H1 (7154 lbs), H2 (6400 lbs) and H3 (5850 lbs) [23] are not even included in SUV statistics because their voracious gas consumption would skew the average mileage estimates of the category downward. An independent investigation by US journalists found that the Ford Excursion really only gets just 3.7 miles per gallon. Interestingly, only 1 in 8 drivers of 4X4s has ever taken their vehicle off-road and such vehicles also represent a grave danger to other road users[24].

Even though the US has less than 5% of the world's population it uses about 25% of the oil and natural gas produced worldwide. Despite having the technology to generate much of its energy from renewable sources the United States still gets 86% of its energy from oil and natural gas, 8% from nuclear energy, less than 1% from geothermal, wind and solar combined and 2% from hydroelectric plants. A promising 3.3% comes from bio-fuels, but it should be remembered that much of that is currently dependent on a system of mechanized farming that is highly reliant on oil and natural gas.

For most countries, the US represents the ultimate target when setting development and lifestyle goals. This can have the unfortunate effect of causing a mimicking of US energy consumption patterns that would be unsustainable if adopted worldwide.

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[23] Civilian version of the US military Humvee, which has replaced the Jeep
[24] The US Insurance Institute for Highway Safety found that the occupants of a vehicle hit by one these heavy 4x4 vehicles are 27 times more likely to be killed than the occupants of a vehicle hit by a normal car

Energy-intensive manufacturing fuels most of the economic growth of countries that are rapidly industrializing, such as the Asian Tigers. Data from the International Energy Agency (IEA) shows that the average oil-importing developing country uses more than twice the energy to produce a unit of economic output than developed countries. For example, India uses more than two and a half times the energy of the average developed country to produce a unit of GDP; while on the other hand Japan is highly energy efficient in its manufacturing processes.

Thus developing countries not only face increased demand for energy due to rising standards of living but their continued economic growth demands a reliable and affordable energy supply. Even with the relatively modest development goals being pursued by various countries, a sharp increase in energy demand is expected over the next few years with the majority of the energy growth currently projected to come from increased consumption of oil and natural gas.

The Oil-Food Connection

Most people are aware of the fact that oil and natural gas are important elements in the mechanization of modern agriculture and the food processing industry. What is less obvious but of extreme importance is the role of petroleum-based fertilizers and pesticides in increasing crop yields.

The impression that one gets from reading the literature is that newly developed strains of such staple crops as wheat, rice, corn and soybean produce vastly greater yields than the less bountiful traditional seed-stock. To complete the picture, these more abundant yields are produced by highly mechanized methods of plowing, planting, harvesting and processing to produce a veritable green revolution.

In reality, a great deal of the credit for the increased yields lies in the fact that petroleum-based fertilizers are being used to supplement the energy of the sun by making up for the nutrients removed from the soil by intensive agriculture. In the distant past farmers simply moved on when soil became depleted or when they were willing to be patient, practiced crop rotation. For example, farmers in the American Mid-West would plant an alfalfa crop every few years and plow most of it back into the soil[25].

Today mono-culture[26] rules and petroleum-based fertilizers are used to supplement the natural nitrogen fixation process that is at the heart of plant growth. In essence, the major reason for increased yields is that the energy in petroleum is being converted to energy that can be consumed as food.

As one author puts it, "The energy for the Green Revolution was provided by fossil fuels in the form of fertilizers (natural gas), pesticides (oil), and hydrocarbon fueled irrigation."[27]

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[25] The biblical injunction in Book of Leviticus to let the land lie fallow every 7th year probably served the same purpose of allowing soil rejuvenation

[26] The continuous planting of a single crop on a given plot of land

[27] "The Oil We Eat" - Dale Allen Pfeiffer – From the Wilderness Publications

If petroleum is cheap then this is an “economical” method of boosting food production. In a post Peak Oil scenario with an end to Cheap Oil and Natural Gas an inevitable consequence will be an end to Cheap Food based on the current petroleum-to-food cycle at the foundation of “modern” agriculture. It is estimated that it currently takes about 10 calories of energy from fossil fuels to bring 1 calorie of food to the American consumer, making the food production industry a prime candidate to feel the strongly negative effects of Peak Oil.

Alternatives to Oil & Gas for Transportation

World trade and domestic commerce in most countries both rely heavily on the efficient movement of raw materials and finished goods from source to factory or processing facility and thence to market. Mechanized agriculture is also largely dependent on the use of oil-based transportation fuels.

Furthermore, the buildings and other amenities that characterize modern development all require the use of oil-based transportation fuels for the trucks, cranes, ships and aircraft essential to the construction industry. For example, it is estimated that it takes the equivalent of 6,500 gallons of gasoline to build a single-family home in the United States. Thus, in any examination of the possible impact of the scarcity of oil and to a lesser extent natural gas on various societies, the effect on transportation must be given intense scrutiny.

One well-researched estimate of global transportation stock in 2001 shows[28]:

- Automobiles, globally: 722 million
- Automobiles, USA: 132 million
- Trucks (all types, in USA): 1.5 million
- Buses: (all types, in USA): more than 654,000
- Locomotives: (USA) 26,000
- World aircraft fleet: 11,000 aircraft more than 100 passengers. All 11,000 designed for oil-based fuel[29].
- World shipping: 85,000 ships in the world.
- Decked fishing boats in the world: 1.2 million

Natural gas can be used as a replacement for oil as a transportation fuel in a limited number of transportation applications, although with considerable attendant conversion costs. However, this will serve to accelerate the eventual production decline of natural gas, especially as it has also come to be viewed as the preferred "clean" fuel for electricity generation.

If the normally touted alternatives of Hydrogen and Non-conventional Oil were indeed ready to replace oil and natural gas as transportation fuels the outlook would not be so grave. But as will be later demonstrated, some government and industry leaders have been the fostering the mistaken notion that hydrogen and advances in technology with respect to utilizing heavy/non-conventional oil sources will easily make up any shortfall in the supply of oil and natural gas as transportation fuels. This is far from the truth.

In an ideal world; governments, civil society and individuals would take prompt action to implement a comprehensive program involving a combination of mandatory greater energy efficiency, conservation and increased use of renewable fuels including gasohol and biodiesel. The use of such alternatives could reduce

[28] *Running On Empty* – www.oilcrash.com
[29] Two Brazilian companies are experimenting with alcohol-powered aircraft

demand for oil and natural gas significantly and thus allow for more the time to create a sustainable worldwide transportation model.

However, current worldwide attitudes show that most people and governments lack either the foresight or the will to effectively tackle the problems posed by the present unsustainable transportation paradigm.

Non-conventional Oil

Non-conventional oil is a term used to include very heavy crudes, bitumen, shale oil and tar sands (oil sand). Whereas conventional oil is recovered via drilling down into the reservoir, tar sands are normally exploited using conventional mining methods involving the removal of the earth and rock (over-burden) above the deposits, then excavating the sands and transporting it by truck or train for processing.

Tar sands are a mixture of bitumen, clay, sand and water and once extracted from their deposits it is mixed with hot water and agitated causing the bitumen to melt and rise to the surface where it is skimmed off. Because it is so thick it must be first be chemically split ('cracked') or mixed with a lighter oil before it can be pumped via pipeline.

The following is a description of the process of deriving shale oil:

> *"Instead of the oil (actually, it's not oil, it's kerogen, a pre-cursor to oil which can be refined into something we can use) being held in porous rock, it's tightly locked into the shale. It has to be strip mined, so first you must remove the overburden (the land above it) and put it somewhere. Then you can blast it or dig it out. Then you have to crush the shale, put it into a retort and heat it to over 500 degrees centigrade. This then releases the kerogen as a gas, which can be distilled back to liquid kerogen. The kerogen can then be refined into oil and then into gasoline etc. For each barrel of oil, you must mine a ton of shale. After you have heated the shale up, it expands by 30% - 50%, and will no longer fit back into the hole from which it came. And the heating and refining releases heaps of greenhouse gases. We would need to mine and process about 250 million tonnes of shale each year for each one percent of oil that we tried to replace. This is not on, even discounting the moonscape it would make of the mine sites."*[30]

Even a casual perusal of the foregoing process raises the question of the energy input required to produce oil from shale. In Alberta, Canada it takes the energy equivalent of two barrels of oil to produce three barrels of this non-conventional oil as compared with the energy equivalent of 1 barrel of oil being used to produce 5 to 10 barrels of conventional oil. The process also consumes large volumes of fresh water and damages the environment.

In the case of Alberta shale oil, the energy sources used in the production process are natural gas for the heating of the tar sands and oil-based fuels for the extensive excavation, transport and lifting involved.

[30] "Did you know Oil is running out?" Charlie Richardson, Sydney, Australia

Venezuela has the world's largest deposits of heavy oil and tar sands in its Orinoco region. Only a small fraction of the heavy Orinoco oil can be removed using conventional methods and the crude has a very low API index in the range 9 to 11 as compared to light crudes whose API ratings would be 30 or above[31]. Conoco and state-owned PDVSA[32] have a joint enterprise called Petrozuata to upgrade the heavy crudes into a lighter synthetic crude which is more suitable for refining.

The heavy crude has to be blended with lighter crudes prior to being pumped via pipelines to the refinery. In order to recover more of the crude, large quantities of steam are continuously injected into the reservoirs to breakdown or "crack" the crude over a period of several years. Refining this very heavy crude yields a lower proportion of gasoline and diesel and requires quite an expensive and specialized refinery.

Hydrogen

One of the biggest falsehoods being promoted is that hydrogen can easily be substituted for oil and natural gas as a transportation fuel. It has often been pointed out that a virtually inexhaustible supply of water exists from which hydrogen can be derived. However, the reaction that converts water to hydrogen and oxygen[33] requires a substantial energy investment per unit of water[34]. *This energy investment is required by elementary principles of chemistry and can never be reduced.*

1.3 Kilo-Watt Hour of electricity is required to produce hydrogen with an energy value of 1 Kilo-Watt Hour.

Hydrogen from electrolysis is therefore an energy "carrier" not a "source" of energy like oil.

The other major method for hydrogen production is by the treatment of methane with steam that produces carbon monoxide as a by-product[35]. On contact with air, this carbon monoxide becomes carbon dioxide (CO_2), the main greenhouse gas offender. The production of the feedstock methanol from natural gas or coal causes a net energy loss of 32% to 44%. Then the steam treatment process required to procure the hydrogen results in a further 35% energy loss. So that just as with production via the electrolysis of water the hydrogen produced is only an inefficient carrier of energy.

What is often further overlooked in this formula is the source of the energy required to produce the steam, which if it comes from the burning of fossil fuels provides a disadvantage as opposed to directly burning the fossil fuel. The planet would still not have escaped the production of carbon dioxide and other greenhouse gases. The generation of this pollution would simply be transferred to the hydrogen production plants.

The only real alternative would be to get the energy from solar. wind or nuclear power. However, following this procedure would not only be expensive in terms of the capital costs, especially for nuclear

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[31] *Degrees API Gravity* = (141.5/Specific Gravity at 60 Deg. F) – 131.5 with lighter crudes having higher API numbers

[32] Petroleos de Venezuela S.A.

[33] $2H_2O$ (water) + energy = $2H_2$ (hydrogen gas) + O_2 (oxygen gas)

[34] 286 Kilo Joule per mole

[35] Following the formula: CH_4 (methane gas) + H_2O (water)+ energy > $3H_2$(hydrogen gas) + CO (carbon monoxide gas)

power plants but the hydrogen production process would still result in the above-mentioned severe energy loss.

Storage is perhaps the greatest problem with using hydrogen as a transportation fuel due, among other things, to the size of the fuel tanks. In gaseous form, a volume of 238,000 litres[36] of hydrogen gas is necessary to replace the energy capacity of 20 gallons of gasoline.

So far, demonstrations of hydrogen-powered cars have depended upon compressed hydrogen. Because of its low density, compressed hydrogen will not give a car as useful a range as gasoline. Moreover, a compressed hydrogen fuel tank would be at risk of developing pressure leaks either through accidents or through normal wear, and such leaks could result in explosions.

If the hydrogen is liquefied, this will give it a density of 0.07 grams per cubic centimeter. At this density, it would require four times the volume of gasoline for a given amount of energy. Thus, a 15-gallon gas tank would equate to a 60-gallon tank of liquefied hydrogen. Beyond this, there are the difficulties of storing liquid hydrogen. *Liquid hydrogen is cold enough to freeze air*. In test vehicles, accidents have occurred from pressure build-ups resulting from plugged valves.

Additionally, there are the energy costs of liquefying the hydrogen and refrigerating it so that it remains in a liquid state. No authoritative studies have been done on the energy costs here, but they are sure to further decrease the Energy Return on Energy Invested (EROEI) of hydrogen fuel.

Because hydrogen is the simplest chemical element, it will leak from any container, no matter how strong or how well insulated. For this reason, research shows that hydrogen in storage tanks will always tend to evaporate, at a rate of at least 1.7 percent per day. Scientists studying global climate change warn that such leakage will severely damage the ozone layer.

Hydrogen is also very reactive. When hydrogen gas comes into contact with metal surfaces it decomposes into hydrogen atoms, which are so very small that they can penetrate the metal's molecules. This causes structural changes that make the metal brittle

Another option is the use of powdered metals to store the hydrogen in the form of metal hydrides. In this case, the storage volume would be little more than the volume of the metals themselves. Moreover, stored in this form, hydrogen would be far less reactive. However, the weight of the metals will make the storage tank very heavy.

Fuel cell technology has all the problems indicated above of its fuel source, hydrogen. Some experimentation with direct conversion of ethanol to hydrogen may appear promising, but it should be remembered that in the US it currently takes about 71% more energy to produce a gallon of ethanol than the

[36] At normal atmospheric pressure

energy contained in a gallon of ethanol, making ethanol at best a highly inefficient energy carrier unless more efficient means of making ethanol are adopted such as the Brazilian sugarcane process.

Just as we convert the energy in oil, gas, coal and wind into electricity and transmit it to various locations for our convenient use, so too hydrogen is only useful as a means of transforming energy from a source such as electricity into a more convenient form. In the process some energy is inevitably lost and many difficulties have to be overcome before hydrogen can become a safe, convenient and efficient energy carrier. Even then hydrogen would still not replace oil and natural gas which are true energy sources as opposed to hydrogen which is a mere carrier of energy.

To quote one commentator:

> *Seeing one car run on a Fuel Cell or Hydrogen Gas does not make it a solution for anything, especially if you invest more energy in the Hydrogen than you get from burning it or if you make more Greenhouse Gas at the Hydrogen factory or if you can't afford to ship or store it*

A Note On Biomass

Biodiesel and ethanol are usually derived from organic material and thus strictly speaking come under the generic heading of biomass derived energy sources along with that proportion of methanol that is produced from organic material, usually by wood distillation. However, these three substitute fuels will be treated separately (biodiesel, ethanol and methanol) and in a later section sources that are more typically thought of as biomass such as wood, charcoal and bagasse will be examined.

Biodiesel

In May 2004, premium gasoline sold for about $5 per gallon in Germany while biodiesel sold for 90 cents per gallon. Biodiesel is a vegetable oil or animal fat based fuel and can be processed from a variety of commonly available virgin edible and inedible oils as well as from waste oil such as from the fryers of fast food outlets.

Technically speaking, biodiesel is the name for a variety of ester-based oxygenated fuels made from vegetable oils or animal fats. The process for making biodiesel is simple and requires only the source vegetable or animal oil, lye and methanol (wood alcohol) with the useful by-product glycerin[37] being the major residue.

The concept of using vegetable oil as a fuel dates back more than 100 years when Dr. Rudolf Diesel demonstrated his engine using peanut oil[38] as fuel. The visionary Dr. Diesel said:

> *"The diesel engine can be fed with vegetable oils and would help considerably in the development of agriculture of the countries which use it…The use of vegetable*

[37] Glycerin also called glycerine is a commercial product whose major component is glycerol. It has over 1,500 uses including the manufacture of soap, cosmetics, toiletries, drugs and food products.

[38] Peanut oil was one of the over 300 products derived from peanuts by George Washington Carver, the former slave.

oils for engine fuels may seem insignificant today. But such oils may become in course of time as important as petroleum and the coal tar products of the present time."

Diesel engines can thus use vegetable oils (with some limitations), biodiesel made from vegetable or animal oils, standard petrodiesel[39] or a combination of these fuels. The diesel engine's adaptability to various fuels has even been exploited by enterprising Venezuelans who have been known to run the light Santa Barbara and Anauco Wax crude oils in diesel engines by employing an additional fuel filter.

Biodiesel is thus a useful alternative fuel source or recycling mechanism that can delay oil depletion by providing an at least partial substitute for standard petrodiesel. Countries such as India have successfully experimented with a variety of indigenous plants (Hemp, Honge, Pongam, Jatropha) to make biodiesel for use in factories, small generating plants and even trains.

However, it must be noted that there are currently oil and natural gas inputs in the production of the vegetable or animal oils as well as an energy requirement in the processing of the biodiesel, usually provided by oil and/or natural gas.

Biodiesel is more environment-friendly than petrodiesel and was also the first alternative fuel to have successfully completed the health effects testing requirements of the US Clean Air Act Amendments of 1990. Biodiesel produces less smoke, carbon dioxide, carbon monoxide and sulfur oxides than petrodiesel and the lower levels of nitrogen oxides it produces can be safely removed by catalytic converters that are damaged by petrodiesel.

It should be noted that diesel engines with their higher compression ratios are more fuel-efficient than spark ignition gasoline engines and due to their higher fuel efficiency produce less carbon dioxide per mile.

With the pending uncertainties regarding the availability of crude oil-based fuels it might be wise, especially in developing countries, to purchase diesel engines in preference to gasoline engines and to develop a robust biodiesel industry or to develop a plant-based ethanol industry to substitute for gasoline.

Ethanol

Ethanol or Ethyl Alcohol is plant derived alcohol (most often from corn in the US) and is usually used as a fuel in gasohol, a mixture of gasoline and alcohol. In the United States, ethanol is not currently a realistic substitute fuel since it takes about 71% more energy to make a gallon of ethanol than the energy that can be recovered from the gallon of ethanol.

Ethanol production in the US is made possible by generous subsidies that help to influence the Mid-West farming vote. In addition, ethanol producers are generous contributors to the election campaigns of many congressmen and senators. Thus ethanol in the US is more public relations than energy savior.

[39] Oil industry terminology for diesel produced by distillation from crude oil.

However, in Brazil where ethanol is produced from sugarcane rather than from corn as in the United States, ethanol is a very economical substitute for gasoline. In Brazil, the cost of ethanol over the entire cycle of production, including farming, transportation and distribution is about 63 cents per gallon, which is substantially lower than current world prices for gasoline. About 23 million vehicles in Brazil use gasohol, which in Brazil consists of a mixture of gasoline and between 20% to 26% of anhydrous ethanol (i.e. water-free alcohol), with more than two million vehicles running on ethanol only (with 5% water content).

The production process burns bagasse, one of the sugarcane waste products, and uses the heat to run low-pressure turbines with enough excess electricity being generated to sell 100 Mega-Watts to the power utilities. It is estimated that with the use of more efficient high pressure turbines and other improvements, more than 1,000 Mega-Watts of electricity will be generated as a by-product of the processing of sugarcane into ethanol. India is now attempting to follow Brazil's example, but the large number of diesel engines in that country perhaps makes biodiesel a greater priority for India than ethanol.

Tropical and sub-tropical economies would do well to follow the lead of Brazil in taking advantage of the greater efficiency of solar energy conversion of tropical plants like sugarcane over temperate corn and wheat in serving as a source for the production of ethanol. Besides producing enough ethanol to power millions of its own vehicles, Brazil currently exports about 650 million liters of sugarcane ethanol and projects that it can raise that figure to more than 4 billion liters over the next ten years.

Methanol

Methanol or Methyl Alcohol or Wood Alcohol was originally made by a process of wood distillation, but today is mostly produced from natural gas and coal. Like ethanol it can be mixed with gasoline to produce gasohol fuel, but it does not mix as well as ethanol with gasoline and additives often must be used to produce a stable mixture. It has a major safety disadvantage in comparison with ethanol because its fumes are toxic.

In the case of methanol derived from natural gas being used as a fuel, it should be pointed out that it is more efficient to simply burn the natural gas directly since the methanol produced from natural gas loses between 32% and 44% of the energy value of the natural gas used to produce it, depending on the manufacturing process.

Because methanol can be transported by slightly modified petroleum products tankers it is much easier to transport than natural gas, which has to be transported by pipeline or using special Liquefied Natural Gas tankers that are banned from some ports due to the risk of explosions. However, methanol can be effective in the production of biodiesel and can be produced by virtually every country using the wood distillation process.

Methanol is currently used in vast quantities for the manufacture of a vast range of compounds including dyes, paints, plywood, resins for the production of plastics, drugs, perfumes, acetic acid, adhesives and automotive anti-freezes. These other industrial uses may make it too valuable to be used as a substitute fuel where it would require special handling due to its toxicity.

Biogas

Biogas is the name for any flammable gas generated from biological material. It is normally produced by allowing animal or plant wastes to degenerate in the absence of oxygen and is usually about 70% methane while natural gas is almost 100% methane. India leads the world in biogas research and has over 2,500 plants in operation most of which use cow dung as the main input. A cow normally produces about 50 pounds of dung per day with the energy potential to run 5 small gas powered refrigerators.

Biogas generators can range from the highly sophisticated to simple designs that non-technical people can build and maintain. Human wastes are used to generate biogas at a sewage plant in Los Angeles that runs twenty four 5,000 horsepower engines. Many farmers also use biogas generated from their animal and plant wastes to satisfy their energy needs while producing compost as a useful fertilizer by-product.

The process basically involves placing biodegradable material in a sealed container and allowing bacteria to decompose it thereby producing biogas and leaving a residue that is often suitable for use as fertilizer. An advantage of using plant and particularly animal waste is that it prevents the methane (CH_4) which forms during the process of natural decay from entering the atmosphere where it acts as a greenhouse gas and contributes to global warming

Alternatives to Oil & Gas for Electricity and Other Uses

No other form of energy defines modern life like electricity. It is easier to imagine a "modern" world without gasoline and diesel than without electricity. Peak Oil and the attendant Peak Natural Gas phenomena represent a grave threat to modern civilization with its great dependence on electricity. Without oil and gas being available at reasonable prices most countries would be unable to generate sufficient electricity for their current needs, to say nothing of the needs of countries that need to greatly increase their electricity consumption in order to develop their societies.

There are now about two billion people who directly consume very little or no electricity and who have no chance of joining the modern world without access to an adequate supply of this vital form of energy.

Electricity generation and associated heating and cooling represent the bulk of world energy demand besides transportation. Electricity can also figure into transportation, especially via mass transit. Some have also proposed that nuclear or hydro-electric plants could be used to produce the electricity for the hydrolysis of water to produce hydrogen for vehicular transportation.

The problems of the use of hydrogen as a transportation fuel have been dealt with in the previous chapter and it has the same limitations if it is proposed as a substitute for oil in other areas; the main concern being that it is an energy carrier that requires more energy to produce it than can be obtained by burning it.

Nuclear power plants generally cost about $3 billion or more, making nuclear power an option only for the wealthiest countries. Disposing of the nuclear waste generated is very expensive and demands extremely careful handling and stringent security measures to prevent potential disaster well into the distant future.

For example the plutonium from a breeder type reactor has a contamination half-life of 24,000 years. It is also estimated that the world's uranium reserves would only last about 25 years if an attempt is made to aggressively replace oil and natural gas with nuclear power for electricity generation.

In the United States the nuclear power industry has received over $140 billion in subsidies over the last 50 years and yet no utility has ordered a new nuclear power plant in the last 25 years for reasons including the hazards involved as well as a lack of economic competitiveness compared to other methods of generating electricity.

Wind Power

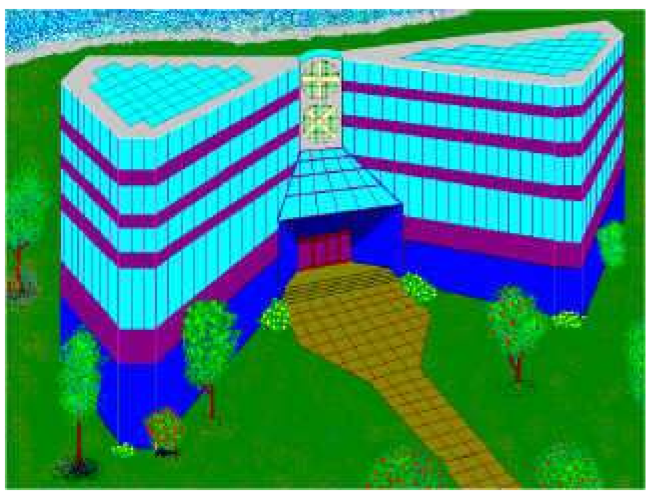
Wind power is clean and renewable and can be usefully included in the energy mix for a country, community or individual under the right conditions. Following teething problems in the 1970s and 1980s, the industry has matured over the last few decades with over 10,000 mega-watts of wind power electricity currently being generated in Europe alone.

Industrial scale wind turbines now rival oil and gas fired turbines in terms of cost-effective generation of electricity. It is estimated that the United States could generate 20% of its electricity on 1% of its land area and on that 1% of land only 5% would actually be used for wind generation with the remaining 95% being available for farming or ranching.

An aggressive wind power electricity generation program could meet the needs of 10 million US homes by 2010 thereby saving not just oil and natural gas but 100 million metric tons a year in carbon dioxide (CO_2) emissions. Alas, there is no indication that the American public or government is so inclined.

Besides the wind farm concept that many are now familiar with, wind power generation can actually be quite efficient if integrated into building design, where the shape of the building channels the wind into the blades thereby raising the wind speeds and efficiency of the wind turbine.

A doubling of wind speed can increase wind power generation by a factor of eight. A 10 foot (3 meter) diameter wind turbine integrated into a suitably located and designed building that has an average wind speed at the turbine's blades of 20 mph (32 kph) can generate 5,000 Kilo-Watt hours per month, with a cost per Kilo-Watt hour of 2 to 3 cents over a 20 year lifecycle, including the flywheel batteries and other ancillary equipment needed to complete the installation.



If integrated with a solar panel electricity generation system, the wind/solar combination can provide all of a modern building's power needs but at a considerable initial capital cost. However, wind power can also be utilized using fairly simple designs to provide mechanical power and even small amounts of electricity at a cost that even less developed countries can afford.

The energy intensive manufacturing industries of the rapidly industrializing countries have the technology to install or even manufacture wind power equipment, thus insulating themselves from rising oil prices and resultant inflated electricity costs that would cripple their industrial capacities.

Solar Power

It is estimated that the earth receives about 180,000 Tera-Watts (i.e. 180,000,000,000,000,000 Watts) of energy from the sun every year, which is about 100 times the energy in our proven petroleum and coal reserves and about 15,000 times our commercial energy consumption. In the world's major deserts at around latitude 30 degrees every square meter receives up to 8 Kilo-Watt Hours of energy per day. There is thus tremendous potential for directly converting solar energy to other more useful forms of energy in our quest for a sustainable, energy-rich, materially-developed global lifestyle.

Harvesting energy from the sun can be accomplished using a range of methodologies with widely varying degrees of technological sophistication. An example of low-tech solar energy use would be the simple flat plate collector used in many domestic water heaters, which can provide 50% to 100% of a family's hot water requirements depending on location, demand and other factors.

The efficiency of the solar energy collection process can be increased by the concentrating of solar power via lenses or reflectors, and can be used as the basis of a more efficient domestic or commercial water heater system.

The CSP or Concentrating Solar Power methodology has been scaled up in a system that generates about 300 Mega-Watts in California's Mojave Desert. The CSP methodology can also be used in so-called Stirling Dishes where a series of concave parabolic mirrors is used to concentrate solar energy on a Stirling heat engine which drives an alternator yielding a typical output of 20 to 30 Kilo-Watts. Most developing countries have the capability of manufacturing Stirling Dishes and other CSP devices to generate electricity from solar power.

There are also solar cookers and ovens that can be cheaply manufactured to substitute for other fuel sources and there is the ingenious use of reverse solar cooling where items can be cooled to very low temperatures at night using designs similar to those used to collect solar energy for heating during the day[40].

High-tech solar energy systems often use photo-voltaic materials that directly convert light to electricity. The high degree of purity of the semiconductor materials like silicon that are required to make photo-voltaic cells is similar to that required for making expensive computer chips, which drives up the price of the raw material. The manufacture of such materials also requires technology that is beyond most developing countries and that are often prohibitively expensive for widespread use even in developed countries.

Rapid worldwide proliferation of photo-voltaic solar electricity generation will probably not come until advances in the field raise the efficiency of conversion from around the current 15% while incorporating the use of cheaper materials. In developed economies, photo-voltaics are already feasible for powering homes that are more than a kilometer from existing power lines, a condition that describes much of the undeveloped world where however, the potential consumers cannot currently afford photo-voltaic technology.

[40] A black object left out in the open at night will cool as it radiates heat out to space, which is cold.

Many of the less developed countries that are projected to increase their demand for petroleum products lie in the tropical regions that receive more than twice the amount of energy from the sun per square meter than temperate climes.

Solar energy can be directly harnessed for a range of activities which currently require oil and natural gas, from the drying of crops to the generation of electricity, the pumping of water and other uses. Thus solar energy suggests itself as a primary method for providing the energy needed for development without increasing the demand for petroleum.

Less developed countries should immediately begin implementing Concentrating Solar Power (CSP) technologies for electricity generation as opposed to photo-voltaics that only the most wealthy and technologically advanced countries can currently deploy. In the special case of oil-producing countries that have desert regions, the investment in large photo-voltaic solar farms may be feasible, thereby freeing more petroleum for export and providing those countries with a source of electricity when the oil runs out.

Biomass

Biomass is organic material which has stored energy from the sun and includes trees, plants, animals and their by-products. Thus wood, sawdust, straw, dung, sugarcane, bagasse and charcoal are all biomass energy sources along with ethanol, methanol and biodiesel; the petroleum-substitute fuels that may be derived from biomass materials and which have been treated in separate sections of this text.

First it is necessary to clarify the confusion that sometimes surrounds coal and charcoal, two totally different substances. Coal is a combustible rock containing more than 50% by weight of carbon and is a fossil fuel like petroleum. It was formed by the combined effect of bacterial decay, compaction, heat, and time on plant remains similar to those in peat, most coal being fossil peat. Peat itself being an unconsolidated deposit of plant remains from a water-saturated environment such as a bog. Peat burns freely when dry.

Coal is burned for electricity generation, heating and smelting; in the process producing considerable amounts of carbon dioxide and other undesirable airborne pollutants such as the sulfur oxides and dense smoke containing considerable particulate matter (soot).

Charcoal is usually produced by subjecting wood or wood residues to high temperatures (600°C) under conditions where there is insufficient oxygen to allow normal burning. Traditionally, wood is stacked in a pit, the fire started and then the pit is covered with earth and left for some time to allow the transformation that is technically known as pyrolysis i.e. the breakdown of the wood's organic compounds under the influence of high temperatures. Modern methods involve heating the wood in sealed steel vessels.

The resulting charcoal burns without the smoke and dangerous flames of the original wood at temperatures that are high enough to smelt metals and was used for this purpose as far back as the bronze and iron ages.

Significantly, charcoal is still used in modern smelting in Brazil, Russia and other countries. Like coal, charcoal produces carbon dioxide, the main greenhouse gas, as well as methane if the burning process is not very efficient but not the sulfur oxides that cause acid rain when coal is burned.

Wood-based oil and gas can also be obtained by a similar process as that used to produce charcoal but by using higher temperatures. The resulting oil and gas have about half the energy value of their petroleum derived equivalents and charcoal is also obtained as a by-product of this process.

Such methods were used in Europe during World War II to generate oil and gas fuels for heating, lighting and public transportation. A promising field may lie in using Concentrating Solar Power (CSP) technology to provide the heat to derive oil, gas and charcoal from wood; a sort of acceleration of the natural process that supposedly gave us fossil fuels.

A major concern in using biomass as a source of renewable energy has been the deforestation that can result. Although there have been actual but highly sensationalized instances of deforestation due to harvesting of wood for fuel; scientific studies have shown that most deforestation results from conversion of forest land for agriculture and the housing of expanding populations. (Lefevre *et al.*, 1997; FAO, 1999)

Due to the fact that tropical climates receive the sun’s energy at more than twice the rate of temperate climates, biomass can be more efficiently generated from plants in the tropics, especially where there is an adequate supply of water.

Even the growing of hardwoods is more efficient in the tropics where tropical hardwood trees can mature in one third the time required by those grown in colder climes. Since the majority of less developed countries are in the tropics, there is an even greater potential for the use of biomass energy as a replacement for petroleum in the crafting of sustainable national development plans for such nations.

Implementing the Required Paradigm Shift

Once it is accepted that the current way of doing things cannot continue because of the imminent arrival of Peak Oil then it follows that nations, communities and individuals must come up with viable and sustainable plans for their future success.

In making the suggestions contained in this chapter, it is assumed that modern man will not simply accept a drastic reduction in standard of living and the possible chaotic collapse of today's energy-rich, technologically-advanced society. The modern integrated global economy produces tremendous amounts of goods and services upon which mankind has come to depend and it would be logical to use all the means at the world's disposal to avert the disastrous collapse threatened by Peak Oil.

Many movies have been made about nations being galvanized into effective collective action in the face of a meteor or comet that is threatening to strike the earth. Peak Oil will be similarly devastating if it is not properly addressed.

This text has not dwelt on some of the possible doom and gloom scenarios that can result from Peak Oil. There are many experts who feel that there will be catastrophic consequences resulting from governments and individuals waiting too long to face the reality of Peak Oil. They believe that a great "die-off"[41] will result in which hundreds of millions or even billions of human beings will perish as a result of the scarcities that will follow upon the at least partial collapse of modern technological society.

The chaos that could possibly follow Peak Oil has been forecasted by former British Energy Minister Michael Meacher to be, "The sharpest and perhaps the most violent dislocation (of society) in recent history."

Although prevailing attitudes make it unlikely, the horrors threatened by Peak Oil could be theoretically avoided by relatively straightforward measures that can be adopted to gradually reduce our dependence on oil and natural gas while simultaneously increasing the energy we derive from renewable sources.

If consumption of crude oil is reduced by 3% to 5% per year then any drastic decline in production can be pushed back by several years. Such a rate of reduction in oil consumption can be readily accomplished by a combination of increased energy efficiency and conservation, including better use of mass transit as well as energy diversification with particular emphasis on biofuels, wind and solar energy.

Energy Efficiency and Conservation

Transportation is a key area for action in the quest for energy conservation and diversification. It has often been said that the train is a car's best friend. The flexibility provided by cars and trucks in moving people and goods to a wide variety of destinations for business or pleasure needs to be retained.

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[41] e.g. www.dieoff.org and www.oilcrash.com

What is neither necessary nor desirable is the movement of people on their daily commute to and from work by the inefficient means of lightly loaded cars and trucks. The vast majority of cars, SUVs and pickup trucks on the I-95 highway leading into Miami at the rush hour have only the driver in the vehicle, a pattern repeated across the US and too often all around the world.

Most mass transit systems require only about 20% of the fuel of the vehicular traffic they replace. If the standard, major commute routes are efficiently covered by mass transit, then individuals who need to travel on non-standard commute routes can still continue to do so while society as a whole still achieves an overall reduction in fuel consumption. Thus a more efficient approach to commuting can result in large overall savings in fuel expended and have the beneficial side-effects of reducing emissions and the need for further highway construction, a capital cost better invested in developing renewable energy sources.

Governments should push manufacturers to produce more fuel-efficient vehicles and consumers can exercise their right to reject fuel guzzling cars and trucks. It would help greatly if the US government were to impose a purchase 50% tax [42]on any vehicle not meeting a tough, but realizable minimum mileage standard e.g. 35 miles per gallon for cars and 30 miles per gallon for SUVs and pickups; with the extra-heavy SUVs and "light trucks" like the Hummer being forced to get at least 25 miles per gallon. Other countries would certainly follow the lead of such a US initiative.

Gas-electric hybrids should be promoted and manufacturers should be encouraged to come up with kits that can be used to retrofit standard gasoline vehicles so that existing engines can be converted to hybrids. Electric hybrid technology can also be applied to diesel vehicles which have the great advantage of being able to consume a wide range of fuel from vegetable oil to standard petrodiesel[43].

It is estimated that the energy saved within the United States by due to the difference in energy standards for refrigerators in 2001 and the 1974 standards result in an energy saving that is almost equivalent to the that nation's hydroelectric output and that a further 30% energy reduction would be relatively to achieve.

Fortune Magazine reports that Staples, an office supplies chain, saved $6.5 million over 2 years through optimization of heating, lighting and air-conditioning and chemical giant DuPont avoided $2 billion in energy costs over the past decade through energy efficiency.

Promoting New Energy Sources

The production of biodiesel, ethanol and plant-based methanol should be promoted worldwide. With developing countries in particular needing to master these technologies.

In the case of biodiesel, the basic ingredients of vegetable or even animal oil, methanol and lye can be manufactured in even relatively backward economies. The use of biodiesel would directly reduce demand

[42] From January 2005 France will impose a green tax of up to 3,500 Euros on purchasers of new gas-guzzling vehicles with energy efficient and less polluting vehicles attracting a rebate.
[43] Oil industry terminology for diesel produced by distillation from crude oil

for standard petroleum-based diesel and can be a source of energy security for countries that have difficulty finding the hard currency to pay for petroleum fuel imports.

Developing countries have to look no further than Brazil to grasp the enormous potential for substituting plant-based ethanol for gasoline.

Countries should also focus on developing wind and solar energy for electricity generation and replacing the use of hydrocarbon fuels as the energy source in certain manufacturing environments e.g. solar heating can replace the use of natural gas in some food processing applications. Coastlines, in the case of island nations especially the windward coasts, and higher elevations worldwide[44] have excellent potential for the harnessing of wind power.

Domestic water heaters should as far as possible be solar. Electric and gas heaters should be punitively taxed with zero taxes on all solar and wind power equipment for at least 5-10 years. The goal should be to reduce or at least avoid increasing the oil and natural gas burned to produce electricity.

Renewable energy must be considered a primary area of study by universities and technical schools and they should be given substantial grants for renewable energy research and development. In this regard there is no need to re-invent the wheel and countries should begin by mastering existing renewable energy technology. The legal framework should be liberalized for homeowners and developers wishing to incorporate renewable sources in their electricity supply mix.

Producing countries should strive to conserve hydrocarbons for later (and more profitable) sale as the scarcity intensifies. The economic wisdom of such current policies as converting natural gas either directly or via electricity to steel and aluminum in smelters should be challenged; especially when the energy for such industries could be much more sensibly supplied by hydroelectric power or biomass sources such as Russia's use of fast-growing eucalyptus to produce charcoal for some of their smelters.

More efficient pumps should be used for land oil production. The technologies involved in the secondary recovery of crude oil should be further optimized. In general, the longer producers take to sell their hydrocarbons the better will be the price and such countries also need time to make the necessary domestic adjustments to the imminent reality of more scarce and costly oil and natural gas.

Getting People Involved

The concerns of environmental activists and people residing near energy facilities should be used to apply pressure on multinationals pushing for maximum extraction rates at the expense of the environment. Excessive extraction rates should be seen as being contrary to the long-term interests of producing countries which should be husbanding their depleting hydrocarbon resources so that future citizens can also benefit from their petroleum patrimony.

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[44] At a height of 100 meters (330 feet) wind speeds of about 10 meters per second or 22 miles per hour are normal

Such activism by citizens of producing countries could thereby provide a natural counterweight against the often unrestrained desire of governments and energy companies to satisfy all requests made of them as energy suppliers, even when it would be more prudent to ration the sale of these depleting resources.

Large energy corporations have in the past and will in the future exert pressure through their governments and by way of personal inducements to government officials and technocrats to obtain access to oil and natural gas on terms that are overly advantageous to themselves. Inevitably this is at the expense of the valid concerns of citizens of producing countries.

The major issue of transparency must be addressed in terms of the relationship between governments of hydrocarbon-exporting countries and energy companies, especially in the case of governments of developing countries that deal with large multinational energy corporations.

Royalty and tax regimes should be subject to informed public debate with all relevant facts being made available to interested nationals. In too many instances worldwide, government officials and technocrats as well as senior executives in state energy companies have been personally enriched at the expense of the wider society via corrupt deals with international energy companies.

The recent dramatic rise in oil prices has in many cases not brought correspondingly large increases in state revenues in oil exporting countries. This is due to royalty and tax rules that allow non-state, foreign entities to enjoy windfalls as prices rise and to enjoy tax write-offs when prices fall.

There must be equity in the sharing of risks and benefits between the state and the international energy corporations. They are both essential partners in the development of the hydrocarbon resources and only an enlightened citizenry with guaranteed access to the facts surrounding the arrangements being entered into in their names can ensure that the sharing of the pie is equitable.

Food Production

As previously discussed, modern mechanized farming is highly dependent on the availability of cheap oil and natural gas. In a post Peak Oil environment agricultural production based on this model will decline and/or be significantly more costly. Many countries now dependent on the US and Canadian breadbaskets for much of their domestic food supply will therefore be faced with steeply rising prices for this most essential of commodities.

Countries should therefore strive to increase the proportion of their food requirements produced locally. Agriculture should be made a priority with studies on alternatives to conventional hydrocarbon-based nitrogen fertilizers and pesticides. Cuba, for example, feeds itself using organic fertilizers and organic farmers in the US and India have developed non-petroleum-based pesticides and farming methods that can substantially reduce normal insecticide use.

Fish harvests should be increased and fish consumption promoted to partially replace meat. The supply of meat in many countries is currently largely imported from countries such as the United States, Canada and Australia that use energy intensive methods of production that are guaranteed to produce massive price increases for meat as oil and natural gas prices climb in a post Peak Oil world. Fishing fleets should include wind powered and biogas[45] electrical generators and even sails to reduce fuel consumption

Home gardens should be strongly encouraged. Over 60% of the UK's fresh vegetables are produced in home and kitchen gardens under far less favorable weather conditions than obtain in many other countries. Cuba also produces about 60% of its vegetables from urban gardens and using organic agricultural methods.

Where possible, regional food imports should replace imports from distant lands, shipping from which will become increasingly expensive as fuel prices rise and there is the further possibility that shipping lanes may be impeded by political/military instability in other regions.

Energy Downstream Industries

Scarcity will increase the leverage that governments of oil and natural gas producing countries can exert in selectively getting downstream hydrocarbon industries located in their backyards, thereby providing their citizens with the opportunity to benefit from some of the value added and technology transfer involved. Many petroleum producers need to widen their technological base beyond oil and gas exploration and production activity. Hosting downstream industries can assist in the upgrade of their society's technical knowledge that will be needed to sustain their development as their petroleum resources decline.

Social Engineering & Planning

Populations must be prepared for the necessary transformation in habits, expectations and even tastes. National debate on the **POPS** discourse should be carefully managed. For one thing, pressure from a public concerned about the implications of Peak Oil on their future will and should influence the negotiations that the governments of hydrocarbon exporting countries must engage in with consumer governments and international corporations.

The transformation required of ordinary citizens is radical and cannot be accomplished overnight. Locating people's homes at considerable distance from their workplaces must be discouraged as should excessive decentralization of production units. In countries around the world millions of people engage in excessive commuting between their homes and workplaces and in the process needlessly burn the equivalent of millions of barrels of oil. Such factors must be considered in national planning especially in developing countries whose economies cannot afford such waste.

[45] From fish guts and other discarded wastes

In cases where such inefficient commuting arrangements cannot feasibly be addressed by relocation, mass transit must be introduced into the commuting mix; perhaps funded by capital currently intended for road and highway expansion.

Telecommunications

As physical transportation becomes more expensive, tele-commuting, tele-medicine, electronic government, e-commerce and other telecom related applications will become more important. Adequate funding provided for telecommunications research at universities and technical institutes along with increased funding for secondary school level and consumer education on telecommunications has the potential to yield substantial benefits in the new environment where transportation energy costs will be much higher.

Global Security and Other Implications

Sixty percent of the world's recoverable oil is in an area of about 90,000 square kilometers, about one quarter the size of Germany, in a "golden" triangle running from Mosul in northern Iraq, to the Straits of Hormuz, to an oilfield in Saudi Arabia 75 miles in from the coast, just west of Qatar, then back to Mosul. A significant part of the rest of the world's recoverable oil lies in other Middle Eastern countries.

Given that the United States is the largest consumer of oil and is projected to need 7.7 million barrels per day more oil by 2020 than it did in 2000, which is equivalent to the oil currently consumed by the 2.5 billion people of China and India combined, it must inevitably seek to tighten its control of Middle Eastern oil[46].

[46] Chapter 8 of the report of US Vice-President Cheney's Energy Task Force projects an increase of US oil consumption between 2000 and 2020 of 7.7 million barrels per day, all of which is to be sourced in the Middle East.

The fact that the overwhelming majority of US military forces deployed in recent times have been to that region confirms its intentions. Incidentally, the tiny Gulf state of Qatar where the United States has located its Central Command Headquarters has more natural gas than North and South America combined. It should also be noted that by 2007, the United Kingdom, the major strategic partner of the US, will itself be a net importer of both oil and natural gas.

There will be the temptation for certain interest groups in the United States and its primary ally, the United Kingdom, to demonize Arabs (and by extension Muslims) in order to provide the emotional justification for the massive military offensive and occupation necessary to achieve effective dominance of Middle Eastern Oil.

The intellectual façade for this already exists in the popular Clash of Civilizations rationale being promoted by people like Harvard professor Samuel Huntington, while the reactions of some Muslim extremists seem intended to make such a clash a self-fulfilling prophecy.

US/UK Dominance

It would be helpful to quote, at some length, the words of Dr. Colin Campbell[47] in his analysis of how the United States is approaching its preparations for Peak Oil in his article **Middle East Oil – Reality and Illusions** that appeared in The Association for the Study of Peak Oil and Gas (ASPO) Newsletter of June 2004:

> *A year ago, it invaded a Middle East country, which was thought to have substantial oil reserves, on pretexts since found to be invalid. It has also built up a monumental level of foreign debt, backed by paper collateral built on the assumption of perpetual economic growth.*
>
> *Now at last, the financial community begins to wake up to the impending decline of oil from natural depletion. It is a devastating realisation for which there is no ready solution. Given the central role of oil in the world economy, a shortfall in supply can only spell serious and lasting economic recession. Every day, oil prices touch new ceilings.*
>
> *…The image-makers counter this dreadful reality with pictures of crazed Muslim fanatics bent on terrorism. They try to conjure up fears of Middle East countries holding the world to ransom by restricting essential oil supply, implicitly assuming they have it to supply. It has always been good politics for governments to invent enemies so as to deflect blame for failed policies from their own shoulders.*
>
> *… The Energy Information Agency (EIA), an arm of the US Department of Energy.. claims that Saudi Arabia's production can more than double over the next two decades, rising from 10.5 Mb/d*

[47] Dr. Colin Campbell, Former Exploration Geologist for Texaco, Chief Geologist for Ecuador, and Founder of the Association for the Study of Peak Oil and Gas

today to 22 Mb/d by 2025, while Iraq's can rise from 2.5 Mb/d to 6.6 Mb/d over the same period. OPEC's total supply is accordingly forecast to rise from 27 Mb/d to 56 Mb/d. World demand is depicted as growing from 81 Mb/d in 2004 to 121 Mb/d, implying a return to economic prosperity.

In other words, it is a picture of a cloudless sky save only for that lurking Muslim fanatic on the horizon. With such a rosy prospect before us, are we not therefore fully entitled to prevent, if necessary by pre-emptive strikes, any risk that someone might for example blow up the oil terminal at Ras Tanura in Arabia. Would it not be wise to use the bridgehead of Iraq to take control of the Saudi oilfields, depicting it as a constructive gesture for benefit of that country and its trusty rulers? ...

We live in a world of imagery, delivered continuously by the television screen with its well-crafted juxtapositions and selected commentary. Scenes of mobs in dusty towns fluctuate with well-armed soldiers in flak jackets to the backdrop of automatic fire and explosions. Acts of heroism against a treacherous enemy become the daily diet of the masses... Occasionally, the words of a mysterious robed figure, reported to be hiding in Afghanistan, are released to add a sinister overtone and strengthen our resolve against the imputed enemy.

Unfortunately for those who champion such thinking, oil and natural gas production and export facilities are extremely vulnerable to sabotage. Resistance movements of the type now evident in Iraq are likely to increase. Attacks on production, pumping and pipeline facilities will likely become more frequent and more devastating as the indigenous people come to the clear realization that, rhetoric notwithstanding, a primary object of these military interventions is the extraction of the region's petroleum resources on terms disadvantageous to themselves as producers.

The net effect may be that US/UK plans for dominating the supply of Middle East petroleum resources by military means may not proceed as smoothly as currently envisaged by their planners.

The Sabotage Factor

In June 2004 Iraqi oil exports declined to almost zero due to multiple attacks on pipelines and pumping facilities[48].

Fortunately, this aspect of the production and export infrastructure is fairly quickly and easily repaired. However, should powers external to the Middle East continue to pursue primarily military means to secure their vital energy interests, the insurgents' attacks will likely escalate to include tank farms and shipping terminals. Such attacks would cause much longer delays before the damaged facilities can be rebuilt and brought back into operation, with potentially massive negative impact on world oil supply and pricing.

[48] International Herald Tribune June 16, 2004 "Saboteurs blasted a key pipeline Wednesday for the second time in as many days, halting all oil exports from Iraq"

Recent history is instructive in that prior to the US/UK invasion of Iraq in March 2003, the industry pundits had projected that oil would soon drop to about $20 per barrel as the United States gained control of Iraqi oil after removing Saddam's regime. The reality has been otherwise.

In the period 1999-2001 Iraq managed to produce 2.5 million barrels per day. This dropped to 1.3 million barrels per day in 2003. The nominal production capacity in 2004 is officially 2.3 millions barrels per day but the reality is that with current levels of sabotage it is unlikely that even the 1.3 millions barrels per day level of 2003 will be achieved.

A more rational approach to securing reliable petroleum supplies from the region would be for the US and UK to seek an acceptable accommodation or *modus vivendi* with Middle Eastern producers, who themselves want to sell their oil, refined products and natural gas to satisfy their domestic needs and to fund the social and economic development of their societies. Pressure toward representative government and other aspects of democratization can be applied short of direct military intervention.

Groups like Al-Qaeda are a direct threat to the region's rulers and even to the majority of the Islamic opposition groups that favor representative government rather than the mosaic of dictators, kings and military strongmen that have long ruled with the acquiescence of the major powers. The United States and the United Kingdom could make common cause with such elements to rid the region of the terror networks rather than use external aggression that will only serve to unite disparate groups, including nationalists and other more moderate elements who have little in common with the extremists, against a common external enemy, as has been witnessed in Iraq.

The governments of the petroleum producing countries are best positioned to secure the oil and natural gas production facilities in the region, especially with the invited help of the developed countries through the provision of the technologies necessary to monitor their production facilities and to contain insurgencies and criminal activity.

Higher Prices are Structural

The fact is that oil and natural gas prices are going to rise under the pressure of Peak Oil scarcity. This is a global issue and cannot truthfully be blamed on the actions of Middle East producers who have generally cooperated in keeping down oil prices.

It makes more sense for the developed countries to work with the producing countries to ensure a smooth flow of oil and natural gas rather than to demonize the governments of oil exporting countries or to unfairly blame the producer countries for the price rise and market instability. Such fundamentally unfair characterizations could then be deceptively used to provoke resentment in the populations of the developed countries to justify military intervention.

Wars can have unpredictable results and the stakes are extremely high when the area that produces a significant proportion of the world's most strategically vital commodity is deliberately made into a war zone.

On the domestic level, even governments of oil and gas producing states will not be able to completely isolate their citizens from rising world prices for energy, food and other products as post Peak Oil scarcity kicks in.

More vulnerable citizens may not be able to purchase life's essentials with a commensurate rise in need-driven criminal activity that could potentially escalate to crisis levels; perhaps providing a justification for foreign intervention in the case of the kidnapping of foreigners and other crimes that may be associated with failed states.

Buying power may well decline across the board and relieving the pressure on workers in petroleum exporting countries by allowing an upward indexation of earnings based on the hopefully increased national revenue from energy exports has the potential to be inflationary.

The government of a hydrocarbon energy exporting country that puts effective measures in place to handle the post Peak Oil world would likely enjoy the grateful support of its population for a long time. Such entrenchment in democratic states may require a different relationship with the parliamentary opposition, especially since the incumbent government should try to avoid the opposition being used to subvert the ruling party as an agent of foreign governments or energy corporations seeking a more subservient caretaker of the nation's hydrocarbon resources. Factions within the ruling party could be similarly exploited.

The United States and Canada

Much of the previous section involved the United States as the reigning global superpower but briefly, the US and Canada are world leaders in terms of having the type of energy-rich, technologically developed society that other nations try to emulate and their actions can have a great influence on how the world tackles Peak Oil. By simply adopting the kinds of conservation and energy efficiency measures common in Western Europe, the United States could significantly reduce demand for petroleum, thereby postponing the era of scarcity that will follow Peak Oil.

Because it has world-leading technology, the US can stimulate its economy by taking the lead in providing the products and services that will be required by the more diverse energy mix that must replace over-reliance on petroleum. The manufacturing of technologically advanced renewable energy generating equipment like wind and solar electricity generators could even help reverse the present trend toward job losses to cheaper labor markets.

The US and Canada already have the wind, solar, bio-fuel and other biomass technologies that can complement oil and natural gas and if they fail to develop these resources and to encourage other nations to do likewise, we may be condemned to endemic instability worldwide as the US pursues energy security (along with the UK and willing coalition partners) by primarily military means.

Citizens of the US have the choice of influencing their governments to take a sensible approach to Peak Oil or to pay the high price of pursuing the fantasy of an inexhaustible supply of cheap oil obtained by the ever increasing application of military power.

To once again quote Dr. Colin Campbell:

> *"The USA has the exceptional position as the largest and a growing importer. US imports deny somebody else access to oil... Tax on gasoline is lower in the USA than in other countries by a large factor. So the US could easily curb its excess...The worst thing the US can do is press OPEC to increase production, which will simply make the peak higher and the decline steeper. It is just digging itself into a bigger hole, morality apart."*

The Middle East

The situation in the Middle East is directly tied to that in the United States, the region's biggest customer for petroleum and the world's major superpower. Because the region holds the largest share of the world's recoverable oil it is likely to have access to oil even when other parts of the world are in short supply. However, the economies of these countries are generally under-developed and their level of technology outside the oil and gas industry leaves much to be desired.

Conventional military forces in the Arab countries are weak and have been defeated on several occasions by Israeli and American-led forces. Thus, the Arab countries as well as Iran are all incapable of repelling powerful invaders intent on seizing their resources. On the other hand, recent events in Iraq have demonstrated that an easy invasion can be followed by a bloody occupation and extensive sabotage of oil production facilities.

Unlike Iraq where citizens were accustomed to owning and bearing arms, the people in many other countries in the region have little access to weapons because their governments fear rebellion against autocratic or dictatorial rule. Such countries may find themselves targeted for occupation as oil supplies dwindle. These governments may seek to raise citizen militias geared toward resistance to occupation as a means of dissuading potential aggressors. However, such a policy would force them to provide representative government and meaningful participation to their citizens, since such militias are highly destabilizing elements within undemocratic countries.

Petro-dollar earnings allow most countries in the region to invest in alternative energy sources with the Middle East being one of the only parts of the developing world that can afford the multi-billion dollar price tag for a nuclear plant. Geo-political realities largely rule out the nuclear power option[49], but the region has extremely strong solar power potential and their large foreign exchange earnings mean that they can afford expensive photo-voltaics along with the technologically less challenging Concentrating of Solar Power (CSP) technology.

In 1950 Saudi Arabia had no highways and most of its modern infrastructure has been built by foreigners, leaving the country lacking in the human resources needed to sustain and improve the current level of development. Other countries in the region find themselves in similar circumstances. It is essential that they invest in the education of their populations and in the development of renewable energy sources in order to build a productive economy capable of sustaining them when their oil production inevitably declines.

Europe including Russia

Western Europe and Russia are perhaps the best-positioned regions with respect to the challenges of Peak Oil. These countries have longstanding energy conservation programs and alternative energy sources that currently generate substantial proportions of their energy needs. They also possess both the technological capacity and financial wherewithal to pursue energy diversification.

The countries of Eastern Europe have longstanding links with the Russian economy and are currently being increasingly integrated within the Western European economy. As such they may be able to ride the coattails of their more developed neighbors. Like so many other development issues, Peak Oil is very much a North-South issue.

The United Kingdom is somewhat of an anomaly with regard to Peak Oil. Although it is does not currently share the massive dependence of the United States on imported oil and natural gas, it has aligned itself with the US policy of using military force to ensure control of Middle East petroleum in keeping with its "Special Relationship" with Washington.

It is projected that the foreseeable energy needs of the United Kingdom (which, as has been previously indicated, will be a net importer of oil and natural gas by 2007) could probably be addressed through a relatively painless combination of increased conservation and greater use of renewables. There is a strong possibility that the reaction of the British electorate to the problems associated with the invasion and occupation of Iraq may make future British governments less adventurous in this regard.

Latin America and the Caribbean

Given the above analysis of strategic moves being made to control Middle Eastern oil supplies, it can be concluded that the control of oil and natural gas in the southern part of the western hemisphere is certainly not being ignored. The United States and the United Kingdom policy will surely seek to ensure that

[49] The United States and other countries fear that nuclear power plants will be used to develop nuclear weapons

petroleum exporters such as Venezuela, Colombia and Trinidad and Tobago[50] are reliable suppliers of oil and natural gas well into the foreseeable future.

To achieve this objective, the methods to be employed could range from the messy option of direct intervention, to the possible but still undesirable support for military coups to the preferable and *probably already in play* approach of supporting opposition parties that are deemed to be open to external control. This may be seen as being necessary in order to enable the major powers to remove from power through the democratically elected process governments that seem to place national interests on a par with or even above their obligations to Washington and London.

Latin American and Caribbean producers would probably be wise to provide the United States with all the necessary assurances that they will remain reliable hydrocarbon providers while simultaneously seeking to secure room to maneuver to limit extraction rates to levels consistent with optimizing returns from this vital diminishing national resource.

In particular, the assurances given should aim at providing a disincentive to the funding and support by foreign powers of opposition parties and other groups intent on removing legally elected governments. Such a relationship with the United States should have the reciprocal benefit of placing regional producers under the umbrella of American protection from any overly ambitious regional usurpers.

Venezuela, with nearly two thirds of South America's proven oil reserves, its current high level of hydrocarbon production that is set to rise even further and the massive, as yet largely untapped, Orinoco heavy oil deposits is the largest prize outside of the Middle East.

The Chavez government is however currently regarded as an unreliable supplier of US energy requirements. That government or any of its successors that follows the present path will likely be the subject of various types of overt and covert pressures that could easily result in instability that would have the potential of spilling over to its neighbors. Given the current tight global oil supply situation, attempts to remove the Chavez regime by unconstitutional means may result in the disruption of Venezuela's oil exports and further upward pressure on oil prices.

[50] Recent oil discoveries offshore Trinidad and Tobago will cause that country's production to rise over the next few years. This will have no effect on global trends as the reservoirs are small and the contribution to world production insignificant.

Maneuvers such as the recent attempt by Barbados to finagle hydrocarbon exploitation rights from Trinidad and Tobago under the pretext of gaining access to flying fish will be repeated wherever hydrocarbon deposits lie close to terrestrial or maritime boundaries; as evidenced by the ongoing maritime dispute between Guyana and Suriname over a potentially oil-rich area off their Atlantic coasts.

Regional politics will probably be greatly impacted by Peak Oil in other ways. If, for example, Trinidad and Tobago makes proper provisions for Peak Oil and other Caribbean countries do not, there will be a tendency for their citizens to flood that country for survival reasons.

Free movement of Caribbean nationals or even just professionals would have to be reviewed under such conditions, despite the treaty commitments of regional governments to integration under the Caribbean Community (CARICOM) Single Market and Economy initiative. The same considerations would apply to Latin America where Peak Oil could jeopardize current attempts at regional integration.

Food security will also become a critical issue and must be a priority in national planning. Even in a country like Venezuela, with huge agricultural potential, less than half of the food consumed by non-elite Venezuelans is produced locally. A shortage or even a massive price rise with respect to imported food could be disastrous for those countries in the region that are currently importing the majority of their food.

In this regard, it should be noted that despite having democratic constitutions, the tendency of some Latin American countries has been toward oligarchy, with a wide disparity between the haves and have-nots and the majority of their populations living at or close to poverty levels. As a result, a significant proportion of the food consumed by the poorer classes has often had to be locally produced, many imported products being out of the economic reach of the majority.

The domestic production of a large proportion of a country's food supply can be turned into a definite advantage in a post Peak Oil environment where the prices of food produced in countries such as the United

States and Canada, which make use of highly mechanized processes and hydrocarbon-based fertilizers and pesticides, will rise sharply along with freight costs affected by higher fuel prices.

The examples of Brazil in terms of the development of substitute fuels and of the politically troublesome Cuba in terms of energy conservation and organic agriculture can also be followed by other Latin American countries who all have the technological and industrial capacity to implement various sustainable energy programs.

With few exceptions, borders are well-defined and established. This renders the prospect of resource wars less probable, but the likelihood of some countries lagging behind others in making timely adjustments to Peak Oil will strain regional relationships in the area of immigration and the smuggling of fuel. On the other hand, fierce nationalism and the presence of large numbers of Hispanics in the United States will make direct military intervention to achieve direct dominance of petroleum reserves unattractive.

Asia

Countries such as China and India have large populations and are in the process of rapid development which calls for a sharp growth in the consumption of energy. Under present circumstances this means more oil and natural gas.

These countries will certainly be tempted to use their military and economic power to help secure their energy needs. Japan, a developed country, with heavy dependence on imported hydrocarbon energy sources has a powerful economy, strong military[51] and enviable technology; all of which it may bring to bear to ensure that its national energy import needs are met.

Additionally, China and India, both nuclear-armed and together comprising some 2.5 billion people, could decide to rely heavily on their large coal deposits to supplement energy needs, thereby causing a vast intensification of greenhouse gas emissions. This is unless they decide to use such expensive carbon sequestration techniques as burying their carbon dioxide (CO_2) in disused oil fields, abandoned mines, salt caverns or the ocean depths[52]. Biological sequestration such as increased forestation would likely be unable to cope with the greenhouse gases from a massive increase in the burning of coal.

Most Asian countries are sufficiently developed to make use of the currently available technologies required for energy diversification. They also have the climatic conditions to efficiently generate biomass, as well as advantageous conditions for directly capturing solar energy. However, with its large population, issues of food security will loom large in determining whether Asia can thrive under the conditions that will obtain once oil production peaks and then becomes both scarce and expensive.

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[51] $45 Billion in Fiscal Year 2004 and consistently in the top 5 countries in terms of military spending in recent years

[52] There is strong evidence that the oceans are already absorbing vast amounts of carbon dioxide from the atmosphere producing carbonic acid that is destroying coral, plankton and shellfish. Marine carbon sequestration will make matters worse.

Without the energy to fuel its industries or cheap food to sustain its populations, Asia may find that its carrying capacity is substantially less than its current population. It is therefore one of the regions that needs to swiftly take the initiative in preparing for Peak Oil.

A potentially mutually beneficial area of South – South cooperation could involve Asian countries partnering with African states that possess tremendous biomass potential to produce such fuels as sugarcane ethanol. In the process of clearing the land for such ventures the wood and other plant material being removed could be processed into wood oil and gas as well as charcoal. Such projects would have the additional advantage of providing excess electricity generation as part of the ethanol production process as obtains in the sugarcane ethanol industries of Brazil and India.

Africa

North Africa and to a lesser extent West Africa with its land and offshore petroleum deposits will be affected by the scramble to secure oil and natural gas as Peak Oil threatens to end the era of abundant cheap energy.

Much of Africa is poorly placed in any competition for an increasingly scarce and expensive resource. This is due to the depressed and underdeveloped state of many of its national economies. Yet with its potential for the development of biomass, hydroelectric, wind and solar energy sources, its proven petroleum reserves and other mineral resources; failure to meet the challenge of sustainable development will largely be a failure of African and international politics and will.

The economies of countries such as Egypt, South Africa, Nigeria and Kenya can serve as centers of transformation toward a more diverse and sustainable energy model. However, the outlook is less than hopeful with so many regional conflicts, the depredations of HIV/AIDS, drought and undeveloped human resources.

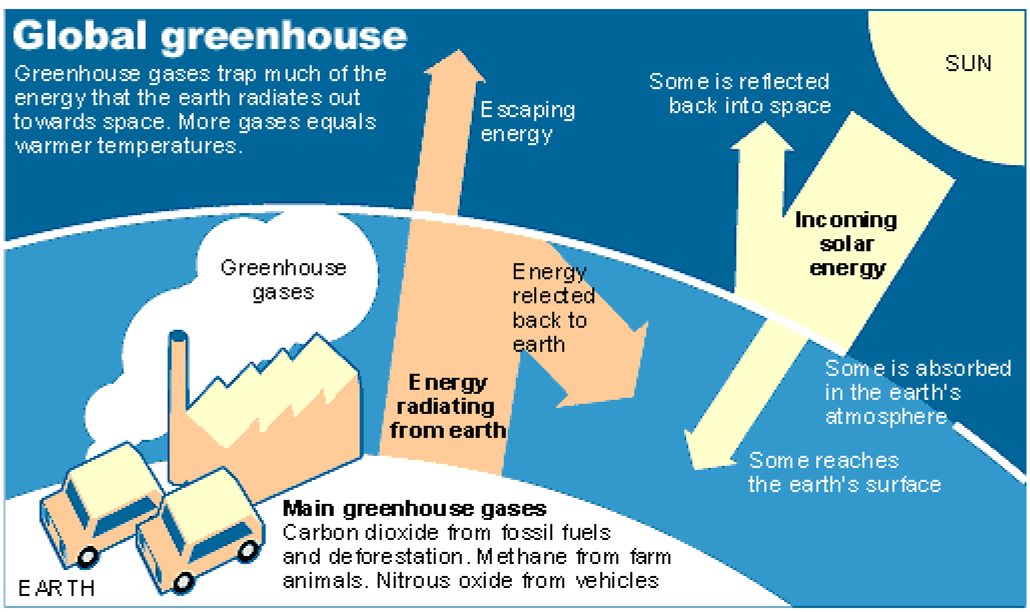
There is also room for hope in that many of Africa's most urgent problems have relatively cheap and simple remedies. For example, in many drought-stricken regions there is the potential to provide water from wells that can be drilled and equipped with solar or wind driven pumps for less than $5,000. Such modest standalone applications of appropriate technology have the potential to transform these countries, enabling their populations to contribute to the creation of wealth that will fuel the growth of the global economy.

Africa's biomass potential also beckons investors from other continents that have the technology and capital resources to invest in projects that would address their energy needs while providing African countries with opportunities to develop. *(See suggested sugarcane ethanol project in the Asia section on page ##)*

Peak Oil and Climate Change

Recently a Pentagon report dealing with the possible effects of sudden climate change was leaked to Fortune magazine and then to the UK Observer. The report was commissioned by Andrew Marshall, head of the Office of Net Assessment that is responsible for weighing risks to US national security. According to the Observer's February 22, 2004 article, the report warns that competition for food, water and energy supplies will pose a vastly greater threat to global stability than terrorism[53].

Briefly, the major mechanism involved is global warming. The major factor in global warming is so-called greenhouse gases of which carbon dioxide (CO_2) is the main culprit. Carbon dioxide (CO_2) is produced when organic and fossil fuels such as coal, wood and petroleum-based fuels are burned. These gases allow heat from the sun to enter the atmosphere but restrict heat from leaving the earth through the atmosphere thereby causing the earth to get warmer in a similar manner to how the glass in a greenhouse traps heat and makes it warmer. The following graphic illustrates the process of global warming through the greenhouse gas effect.



This warming of the atmosphere causes polar ice to melt and upsets our climate's equilibrium. The way it works is that normally cold, dense artic water sinks into the ocean's depths and sets up a convection cycle that eventually causes warm tropical water to flow north to replace it. This circulation loop, called the Thermohaline Conveyer or simply the Ocean Conveyer or Atlantic Conveyer, is what brings the warm Gulf Stream north thereby keeping North America and, even more so, Europe warmer than they would otherwise be. The warm water surrenders heat to the atmosphere and the prevailing winds carry that warm, moist air generating rain and moderating winter temperatures.

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[53] The full report or an executive summary may be downloaded at http://www.ems.org/climate/pentagon_climate_change.html

As temperatures rise and ice in the artic region melts, ocean salt water is diluted with fresh water. The cold artic water that is diluted by the melting ice becomes less saline and less dense and so does not sink, slowing or even shutting down the Ocean Conveyer and thus the warm water stops flowing northward.

This is the mechanism dramatized in the climate change blockbuster movie *The Day After Tomorrow*. Although the changes portrayed in the movie are unlikely to occur with the rapidity shown, it is also true that once the Ocean Conveyer shuts down or slows significantly all our current climate models become obsolete and the possibility of dramatic, abrupt climate change would be a distinct possibility. In an apparent paradox, global warming is likely to cause colder temperatures in the northern temperate regions with higher temperatures in the tropical regions.

The Pentagon report referred to above, which was prepared by conservative scientists, speculated that if global warming and its attendant melting of polar ice continues unchecked, by 2010-2020 the United Kingdom could experience Siberia-like weather and hundreds of millions of people would be forced to flee widespread flooding in tropical coastal areas, with corresponding mega-droughts in other areas.

As copies of the report made its way to other news agencies, it emerged that Peak Oil also figured into the analysis as evidenced by the following quote "… **global demand for oil will grow by 66% in the next 30 years but it's unclear where the supply will come from**. Clean water is similarly constrained in many areas around the world. With 815 million people receiving insufficient sustenance world wide, some would say that as a globe, we're living well above our carrying capacity[54]…" The report further projected that shortages of drinking water, food and fuel could result in military conflicts…so-called "resource wars".

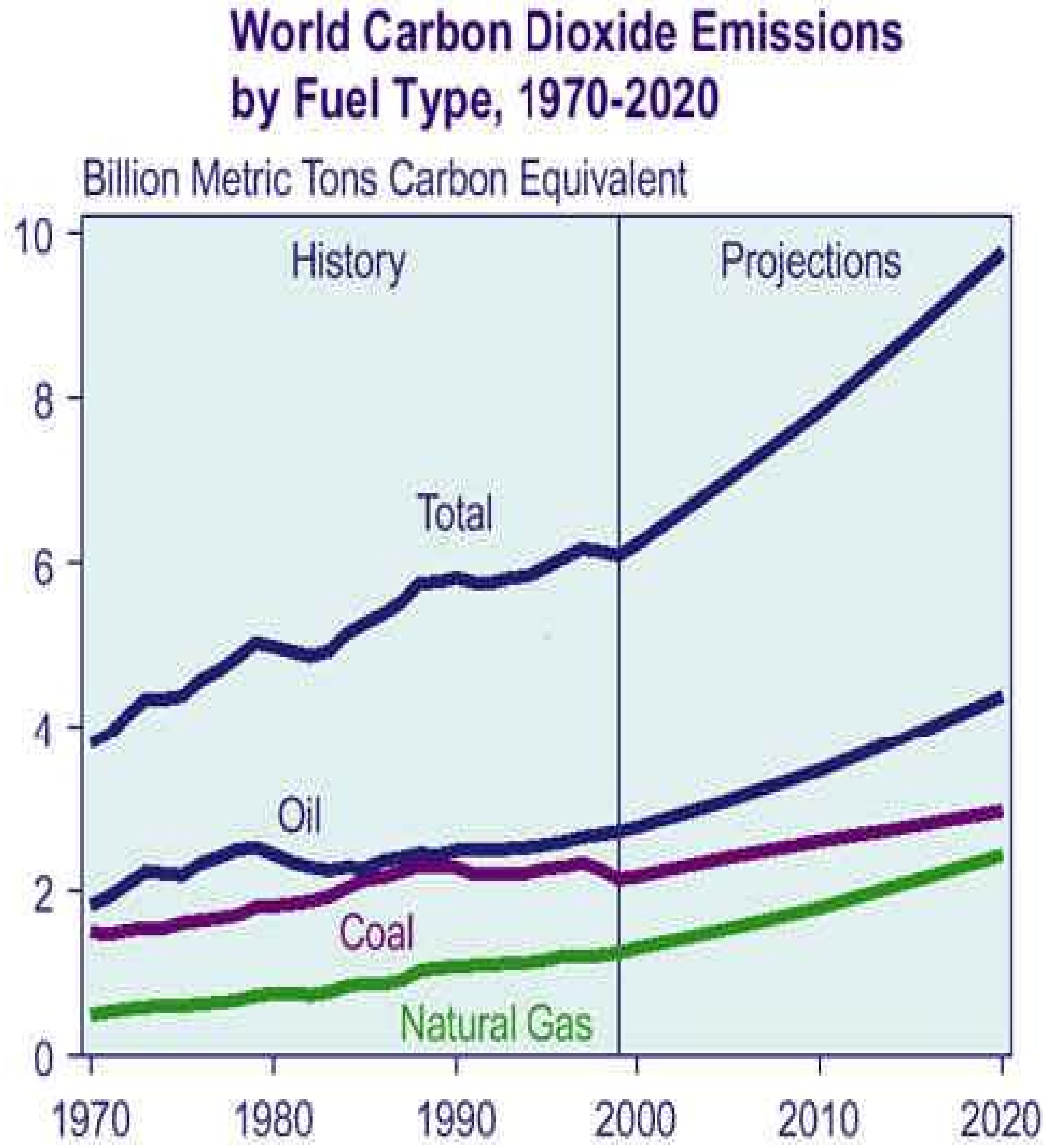
No Tree-Hugger Fantasy

Examination of Greenland ice cores that allow the documentation of changes in climate over the last 15,000 years indicates that this has happened before. About 8,200 years ago the conveyer stopped due to melting ice sheets in North America causing a mini-ice age lasting about 100 years. Thus, global warming may cause all kinds of extreme weather including cycles of flooding and drought, increased hurricane activity and freezing temperatures in Europe and North America as nature attempts to re-freeze the polar regions.

For those who think that global warming is just a bunch of sensationalism from tree-hugging environmentalists it would be instructive to read the article "Meltdown" in the February 14, 2004 edition of the British publication, The Guardian. Vast areas of permafrost have melted; roads, houses and even sections of forest have buckled and sometimes disappeared as the permafrost melts; spring comes a week earlier now in Alaska and areas that previously froze in October now freeze in late December. A look at the

[54] The implication is that many millions may die as population is adjusted downward to match "carrying capacity"

world's historical and projected generation of carbon dioxide emissions gives little cause for hope that the present global warming trends can be reversed without drastic action.



It is clear that energy demand in the developed northern hemisphere would increase more sharply than currently projected if harsher winters become the norm. But it should be noted that even without the possible disruption of climate change, the coming hydrocarbon energy crunch is set to cause tremendous disruption and is understandably being planned for by various agencies of the major powers.

Conclusion

Since the start of the Industrial Revolution, economic development has been based on the availability of cheap and convenient sources of energy. Starting with the latter part of the 19th century, crude oil has been the convenient, versatile, readily available and cheap fuel source driving the remarkable material advances of the modern world. Natural gas once flared as a by-product of oil production also came along to complement crude oil and the hydrocarbon twins have been the quiet foundation of modern prosperity.

Today the world must come to the realization that our industrial and post-industrial way of life is based on a depleting resource whose production is peaking. People everywhere will have to change how they do things if the planet is to overcome the reality of an end to cheap oil.

It remains to be seen whether powerful countries use their military and economic muscle to ensure that their people have the lion's share of the available oil and natural gas or whether the world cooperates in energy diversification and conservation. In addition, whether greenhouse gas emissions from the burning of fossil fuels are limited by binding international treaties or whether the present free-for-all with respect to emissions continues will determine what a post Peak Oil world will look like.

One fact that looms large is that providing the high levels of energy required to sustain growth and development will require the use of a wide range of technologies, making education and especially technical education a prerequisite for a successful future.

It is theoretically possible, but currently unlikely, that through the wise use of today's technology the international community could implement improvements in energy efficiency and effective conservation in concert with a combination of oil, natural gas, coal, biomass, ethanol, methanol, biodiesel, wind power, solar energy and other technologies to synergistically replace our current over-reliance on oil and natural gas.

Many of the technologies involved are not very sophisticated. However, such technological know-how is often not sufficiently widespread worldwide, with an extreme shortfall in many less developed countries. Even with the necessary political will, this technological deficit would still have to be overcome.

The fact remains that something must be done. Even if the world fails to be preemptive in dealing with the looming crisis, the reality of peaking and subsequently declining oil production will demand action of some kind.

As usual, it is up to mankind to make choices about our future. Many of the required measures can only be implemented by governments or at least with government support. However, it is the ordinary citizens who will have to live with the consequences of the actions taken or avoided by those in authority.

People of the world owe it to themselves and future generations to learn about the impact of Peak Oil and to be vigilant in monitoring government policies and initiatives for dealing with the imminent oil and natural gas energy crunch. The actions of energy corporations also need to be scrutinized to ensure that there is the requisite balance between maximizing shareholder value and responsibility in husbanding the essential commodities of oil and natural gas to achieve the greater good of mankind now and in the foreseeable future.

It is unlikely that all the world's governments will respond effectively to the looming crisis, but this only makes it even more urgent for those nations, communities and individuals who recognize Peak Oil as having a fundamental influence on their future to act swiftly and resolutely to prepare for the changed circumstances that will result when Cheap Oil runs out…**IN THE NEAR FUTURE!**

Interesting Quotations

"The Saudis are out of capacity. That's my opinion ... They have no infrastructure or extra pipes or gas, oil, and water separators [very expensive large globes used to separate what comes out of a water injection well]. They have very heavy oil which, through a conventional refinery, produces asphalt. We don't need asphalt. We need gasoline. It takes a complex refinery to make gasoline and it only takes seven to 10 years to build one."
Matt Simmons, Simmons & Co, a leading independent oil analyst (from Michael C Ruppert, Peak Oil Revisited) Quoted in "No pleasant surprises in new oil order" Asia Times July 10, 2004

"It now appears that world oil production, about 80 million barrels a day, will soon peak. In fact, conventional oil production has already peaked and is declining... Without the unconventional oil from tar sands, liquefied natural gas and other deposits, world production would have peaked several years ago."

From "*After the Oil Runs Out"* by James Jordan and James R. Powell in the Washington Post – June 6, 2004
"According to Saudi Aramco, the kingdom's proven reserves are estimated at 257.5 billion barrels. But analysts in Dubai prefer to cling to Aramco's former executive vice president Sadad al-Hussayni who, in articles appearing in the Oil & Gas Journal, insists proven reserves amount to only 130 billion barrels."

From "Oil's Slippery Slope" – Asia Times – August 24, 2004

For the first time in the history of the modern oil industry, global demand continues to rise faster than the world's capacity to produce more crude. That's very different than the last major "oil shocks" of the 1970s, which were the result of a decision by the newly-formed Organization of Petroleum Countries to withhold supplies to drive up prices.
"We have an incredibly tight oil market," said Daniel Yergin, chairman of Cambridge Energy Research Associates. "And that means the market is vulnerable to any kind of shock or semi-shock because there is hardly any give in the supply."

From "How High Will Oil Prices Go?" – MSNBC – September 27, 2004

"Every generation has its taboo, and ours is this: that the resource upon which our lives have been built is running out. We don't talk about it because we cannot imagine it. This is a civilisation in denial. Oil itself won't disappear, but extracting what remains is becoming ever more difficult and expensive... No one with expertise in the field is in any doubt that the global production of oil will peak before long. The only question is how long."

From "Bottom of the Barrel" - The Guardian – December 2, 2003

"In a few years, the global production of conventional oil will fall, while the global demand continues to rise. The resulting shock of this structural oil famine is inevitable, so great are the dependency of our economies on cheap oil and, related to the first, our inability to wean ourselves from this dependency in a short period of time.
We can hope to soften the shock, but only if its imminence immediately becomes the unique reference point for a general mobilization of our societies, with, as a consequence, drastic consequences in every sector. The alternative is chaos…rationing will come from the market through the coming rise in oil prices, and then be propagated by inflation, with the shock reaching every sector."

From "Toward the Petro-Apocalypse" – Yves Cochet former French Land and Environment Minister in Le Monde (Paris) – March 31, 2004

Glossary

- A great start is to use an internet search engine like www.google.com and enter the words **Peak Oil**
- www.peakoil.com - Website devoted to exploring the issue of hydrocarbon depletion
- www.peakoil.net - Website of the Association for the Study of Peak Oil & gas
- www.peakoil.org - Another good Peak Oil Website
- www.dieoff.org Website devoted to post Peak Oil scenarios
- www.fromthewilderness.com - Wilderness Publications website, a good source for Peak Oil information
- www.oilcrash.com Lays out the Peak Oil problem and offers survivalist solutions
- "The Party's Over: Oil, War and the Fate of Industrial Societies" (New Society, 2003) by Richard Heinberg
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