Oil Future and War Now: A Grim Earth Sciences' Point of View.

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Abstract

Worldwide per-capita oil consumption is closely correlated with the standard of living. In developing nations like China and India increasing prosperity therefore requires increased per-capita oil consumption. However, oil is a finite resource whose production globally is about to begin to decline irreversibly. Consequently the growing demand for oil is leading to a growing global conflict in which the Gulf War, the 9/11 attack, and the war in Iraq are just the first three skirmishes. These skirmishes pale in comparison with the looming potential conflict over oil with China.

Prosperous countries among them the United States, Canada, and Japan enjoy average high incomes than less prosperous countries, like China and India resulting in much more oil use. With the embracing of industrialization and urbanization among other factors in developing countries, increasing prosperity has led to increased oil consumption, as the countries strive to improve their people's lives. Doing so, however seems to require more available energy per capita, which in today's technology means oil. In contrast no prosperous nation falls below the poverty datum line; all of the obvious outliers are less-prosperous nations that, because of a surfeit of oil resources, can use much more oil than they could afford at import.

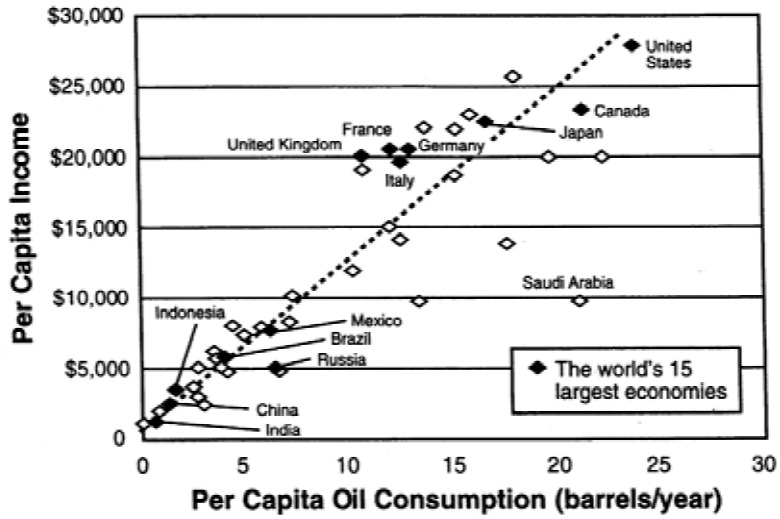

Figure 1 Energy consumption as an indicator of the wealth of nations (Illustration by Armando Izquierdo, after Economides & Oligney, *The Color of Oil*, 2000: Fig 1).

Michael Economides and Ronald Oligney (2000) point out that there is a relationship between per-capita oil consumption and per-capita income in which the curve on Figure 1, tells us what's needed to bring up the economy of developing nations like China, India, and Indonesia. To achieve this, according to this argument, these nations have to climb up the standard of living slope as indicated by the broken line. Thus, increase the oil available to them or simply increase the standard of living. Egonomides and Oligney (2000) take a positive point of view considering the standard of living. In other words, this implies: China and India needs to buy my oil, use my oil and the standard of living will increase.

	bbls/year	bbls/person/year
World	26x10**9	4.4
USA	6.3x10**9	24.0
China	1.5x10**9	1.2
India	0.86x10**9	0.9

Figure 2

The current world's oil consumption stands at over 30 billion barrels per year (Figure 2). In the United States, on average, a person burns about 25 barrels of oil per year, while each person in China burns about 1.3 barrels of oil per year. India burns less than a barrel per person per year, less than the world average consumption of about 5 barrels per capita per year.

What if?		
	Added bbl/year	**Added %/yr**
Bring China + India to		
world average now	8.3x10**9	32%
$^1/_4$ of US consumption now	11.5x10**9	44%
$^1/_3$ of US consumption now	15.8x10**9	61%
$^1/_2$ of US consumption now	25x10**9	96%
the whole world to		
$^1/_4$ of US consumption level now	13x10**9	50%
$^1/_3$ of US consumption level now	18x10**9	75%
$^1/_2$ of US consumption level now	26x10**9	100%
US consumption level now	52x10**9	200%

Figure 3.

Figure 3 shows what it would mean for China and India to climb up this slope of standard of living. For example, to bring China and India to the world average today would require an increase of between 30 - 35% in production per year worldwide, and to one-quarter or one-third of the United States consumption level would require a 50% increase in oil production. Moreover, to bring the world to about one-quarter of the United States consumption level now, that's about six barrels per person per year would require 50% increase in oil production. If the whole world would be burning oil the way the United States do, production has to be tripled or double again what we are currently producing and consuming.

Many economists don't believe there is anything particularly exciting about these huge numbers of future demand. As reflected by The John Hopkins University's Steve H. Hanke (1996) statement:

> "*The world oil shortage is a fiction that most people accept as fact. They repeat endlessly that there is only so much of the stuff. So every barrel used today means less for the future and, by definition, the scarcity must increase. That's the common wisdom, and the common wisdom is bunk. In fact, no mineral, including oil, will ever be exhausted."*

This is not an unusual point of view among economists grounded in a very simple ideology or religion; that supply-and-demand will take care of certain life events and in this case, prevent future oil shortages. This asserts that in case of a growing demand for oil even if it is difficult to deliver it: prices will rise, and so obvious those who look for oil and produces it will do a better job - work harder; find the oil and produces it faster. In addition, alternative energy will be introduced and so there is no problem.

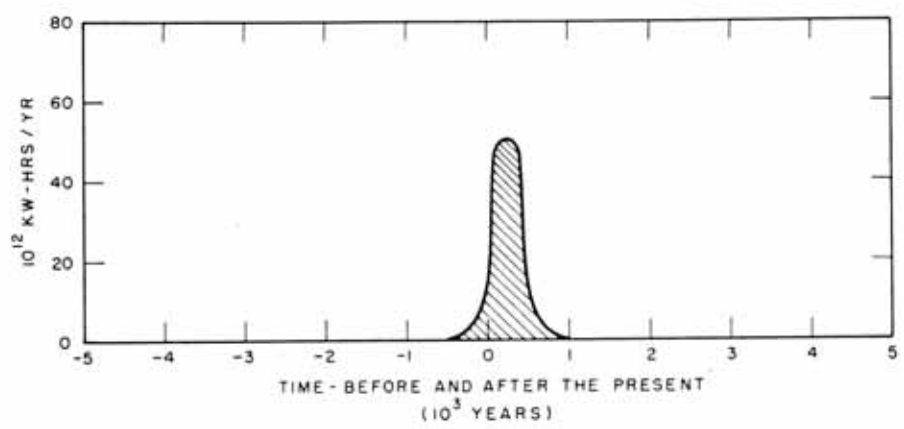

Figure 4 Total World production of Fossil Fuels in Time Perspective (After M. K. Hubbert, 1956: Fig 54)

Contrary, in 1956, M. King Hubbert published report for the National Academy of Sciences, analyzes the question of the finiteness of oil. Hubbert makes a point that the use of oil as energy source would be transient stage in human history. We know that the amount of oil in the earth is finite, and the rate of

which geological kitchen is producing oil today is so small, so we have fossil oil – and if we take a time scale measured in thousands of years, as indicated in Figure 4. He pointed out that there is going to be an oil era which already started late in the 19th century and will last into the future but not forever. For the first approximation lets think in terms of epoxy, which has weight, height and an area under the curve (Figure 4). The height is the maximum production rate that we will have if we think in terms of oil. The weight give us a measure of how much the amount of time involved in this process. The timing will tell us when it will begin to be turned down, as production will begin to decline.

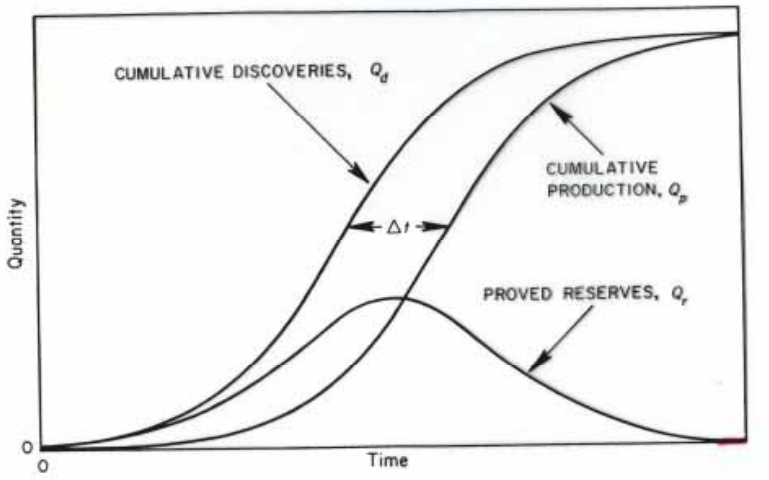

Figure 5 The diagram show cumulative discoveries, cumulative production, and proved reserves in a full oil production cycle. The time gap is shown by the area between the cumulative discoveries curve and cumulative production curve (from Hubbert, 1962: Fig 22; 196: Figure 8.9).

Hubbert suggested cumulative production for Q_d (Cumulative Discoveries) which start late in the 19th century at zero and then grew exponentially until we begin to see the edge of the oil reserve on earth (Figure 5). The discovery rate will slow down and will eventually become flat. Further, he suggested cumulative production would follow discovery. Hubbert took the difference between two curves - these are cumulative reserves at any given time. So what is the peak of oil reserves or what is the discovery? What is the area under the proven reserves curve, which is the total oil to be recovered and what is the time scale of all this?

In fact, Hubbert felt that production history in the lower 48 states until the year 1954 was sufficient to fit the simple logistic equation curve to make a prediction about the future oil production in the lower 48 states. He met with resistance as making predictions in sciences is involved with difficulties, uncertainties and usually have a lot to derive. Following the logistic equation known to ignore almost everything that economists and politicians expect to influence businesses, he made a prediction based on three variables: an estimate of the total oil and gas that can be recovered (Q_∞), the starting time for oil production (T_0), and a time factor (C), which he could determine using the production data available to 1954.

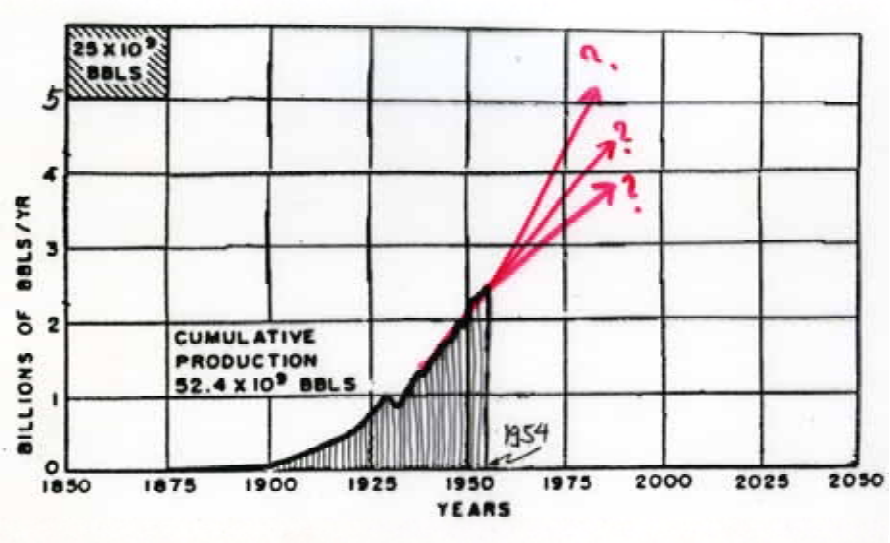

Figure 6 Lower 48 US crude oil life cycle based on assumed ultimate recovery of 150 and 200 billion barrels. (From Hubbert, 1956)

At the time, a debate among oil companies and government agencies was over how explosively that production would grow in the United States. The red lines in Figure 6 indicate the different models for the growth of the exponential production for the lower 48 states to the future. Would growth be exponential? Except for Hubbert and a few others who knew it was a finite resource, this was not a very safe way to extrapolate the future.

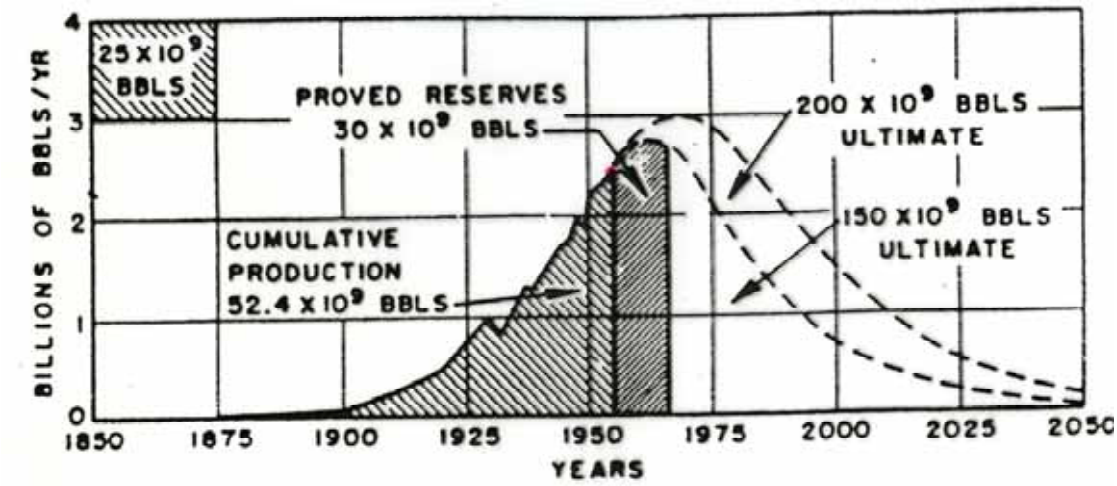

Figure 7 Complete cycles of the lower 48 US crude oil based on assumed ultimate recovery of 150 and 200 billion barrels up to the year 2050 (After Hubbert, 1956).

In 1956, while most people said the United States was growing exponentially, Hubbert argued that this was only temporary that within a decade or so depending on what we assume is the total recoverable oil in the lower 48 states - production will peak and then begin to decline (Figure 7). If we assume we are going to recover 150 billion barrels in the lower 48 states production will peak at the year 1960 at the level of 2.8 billion barrels per year. On the other hand, if we assume that ultimate recoverable oil is 200 billion barrels, production will peak in the year 1971 at the level of about three billion barrels per year. What's remarkable is that, in his 1956 report he pointed out that the occurrence of the peak when it happens it is fairly insensitive to how much recoverable oil area is. His explanation was that: as soon as we find oil, we will find ways to burn it. If we find a lot of oil we are going to find ways to burn it faster by the nature of the businesses set up, and it doesn't matter how much oil there is. If you double it from 150 to 300 billion barrels per year, we will gain only five to six years for the lower 48 states.

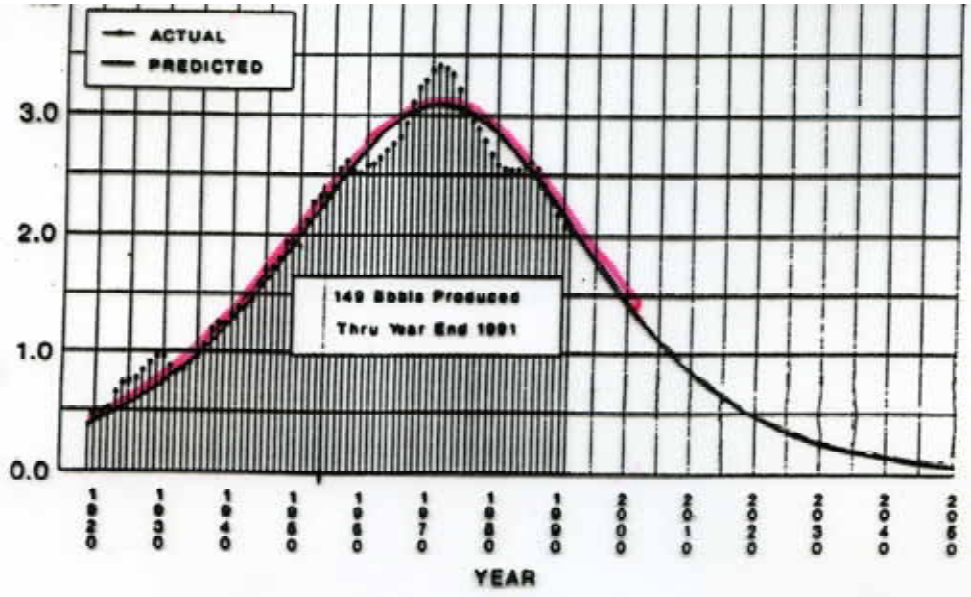

Figure 8. Assumed oil consumption and production from year 1920 to 2060. (after Smith & Lidsky, *TLE*, Nov 1993)

In a paper published by *Leading Edge*, Smith and Lidsky (1993) made an effort to compare Hubbert's prediction, shown in red line with four decades of actual production in the lower 48 states, shown in black (Figure 8). The kind of agreement is stunning and completely unparalleled in earth sciences; Hubbert predicted the production peak year correctly. Actually, he predicted a peak and production peak in 1971. According to this particular curve, his prediction implied about 3.2 billion barrels of oil per year peak production. Almost close to the actual number of 3.5 billion barrels per year. Significantly, the decline really happened pretty much following the curve.

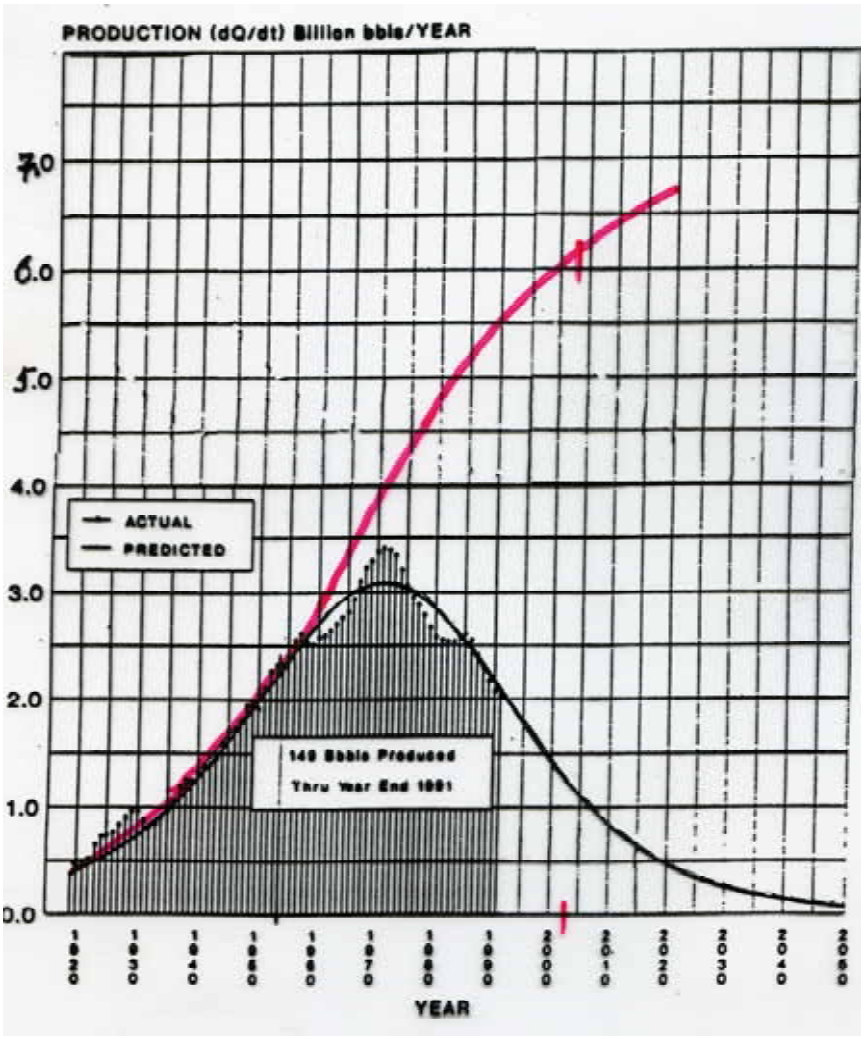

Figure 9 History of the Lower 48 crude oil life cycle as of 1991 (ultimate = 189 billion bbl).

Figure 9 shows the approximate history of oil consumption in the United States up to the present, in which a huge gap developed. The reason is that we went to produce a difference elsewhere. In 1971, this turn around didn't really have a lot of impact because we assumed the world is plenty with oil. Today, we are importing 60% of the oil we are using and it's growing at the rate of 3% per year and with the exception of a blink between 1973 and 1976 this has received relatively modest attention. This gap between what we produce in the United States and what we use, simply because for a long time about 20 years we really assume the world has so much oil, it's finite to the US. It seemed it was not a big deal if you look at the world as a whole.

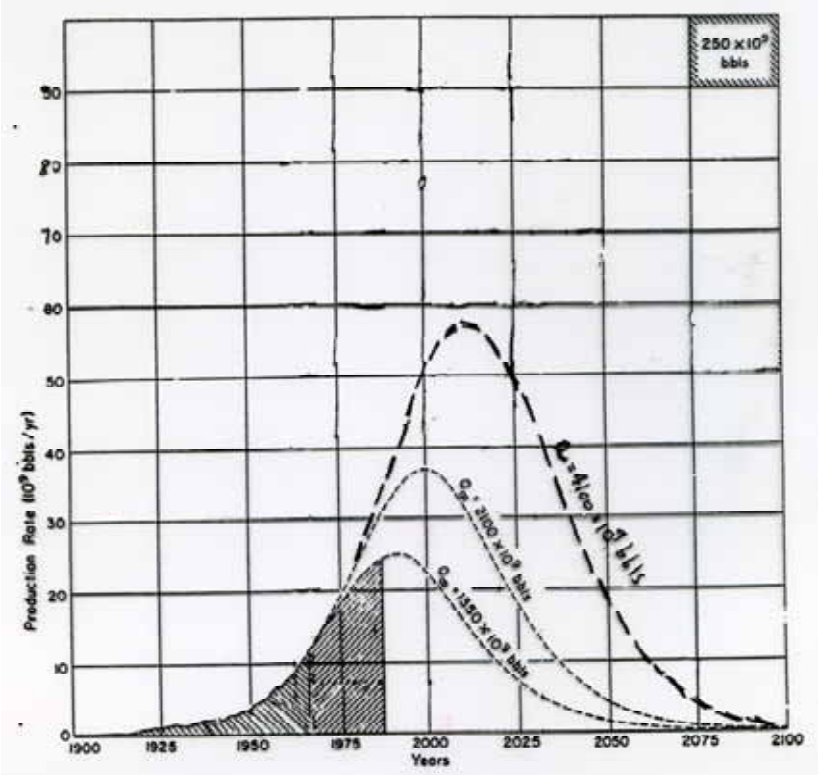

Figure 10. Complete cycles of world crude-oil production for two values of Q_X.

Hubbert in his report has also done the same kind of exercise for the world as a whole. He figured the same logic should apply to the earth as a whole. Can we make some kind of estimate of when will oil production actually peak? The numbers were a little less certain because the geology of the oil provinces in the world was not as well known in the 1960s, so Figure 10 shows three bell-shaped curves predicting future production, assuming three different values for the earth's recoverable oil. The lowest curve is assuming that the area under the curve – the total recoverable is 1.3 trillion barrels. The second curve is 2.1 trillion barrels. The third curve assumes 4.1 trillion barrels of oil ultimately recoverable, and what will the curve look like. Again, if this is correct: the shift and the peak in terms of time is not that great. The lowest curve - the peak is around the year 1990. The second lowest curve - the peak is about now. Even if we take the third highest estimate, the peak according to this kind of calculation will be around 20 to 25 years, a very narrow window. Hubbert has gone under enormous criticism because while oil product is growing in the world he affirmed its depletion before long. In addition, the logistic equation has no real theoretical basis. At this point it is not really the issue. The real issue is, is the amount of oil finite enough for us to begin to wonder or worry or think about. At what point are we going to feel the finiteness of this resource? So, whether the logistic equation is fancy equation, it becomes secondary.

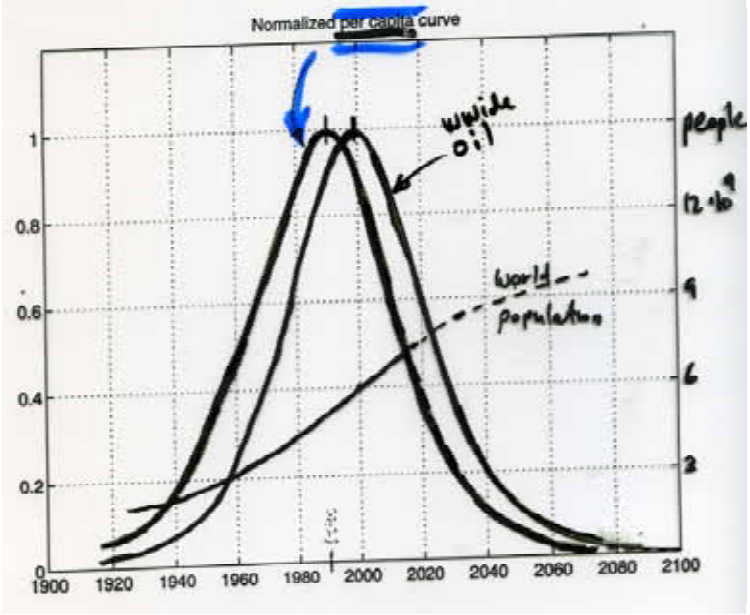

Figure 11.

Another thing Hubbert mentioned in his report, what I have just calculated here, if you take his middle curve, and divide it with the world population (Figure 11). He made this prediction in 1960, the world population at that time was about 11.3 billion. Today it has doubled. So per-capita the peak has shifted backwards by about a decade. Therefore, whenever the peak in global consumption occurs, the peak of oil produced or used occurs ten years before that.

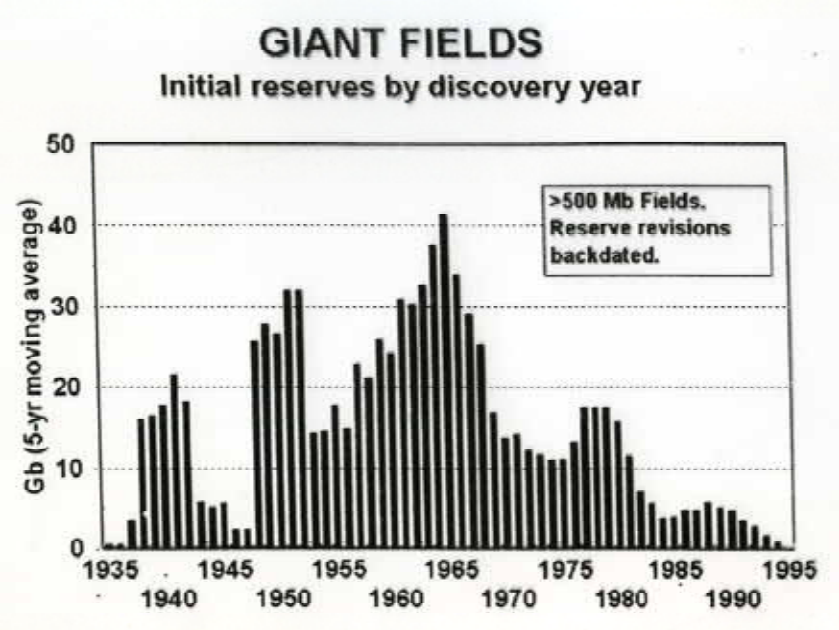

Figure 12 The rate of initial reserve discovery per year in billions of barrels of mega-fields.

The aspect of this interpretation is corroborated by the number of oil mega-fields that have been discovered as a function of time as indicated in between 85% and 90% of all the oil on earth comes from around 120 mega-fields; all produce a tiny fraction. As Figure 12 shows there is no question that worldwide there has been a tremendous decline in discovery of new mega-fields. Secondly, since 1975, or earlier than that, the rate of discovery of the largest field has drastically declined. Clearly we are policing a lot of oil that has already been discovered, and are unable to replenish what we are burning. This compelling data shows we cannot keep up finding mega-fields at the rate which we consume oil. Finding mega-fields was never a market force issue since oil companies try to find mega-field; it's not that they stop working on them, because the value is enormous. That we are unable to find enough mega-fields to replenish what we use is a fact since oil is a fossil thing that was generated in the geological kitchen.

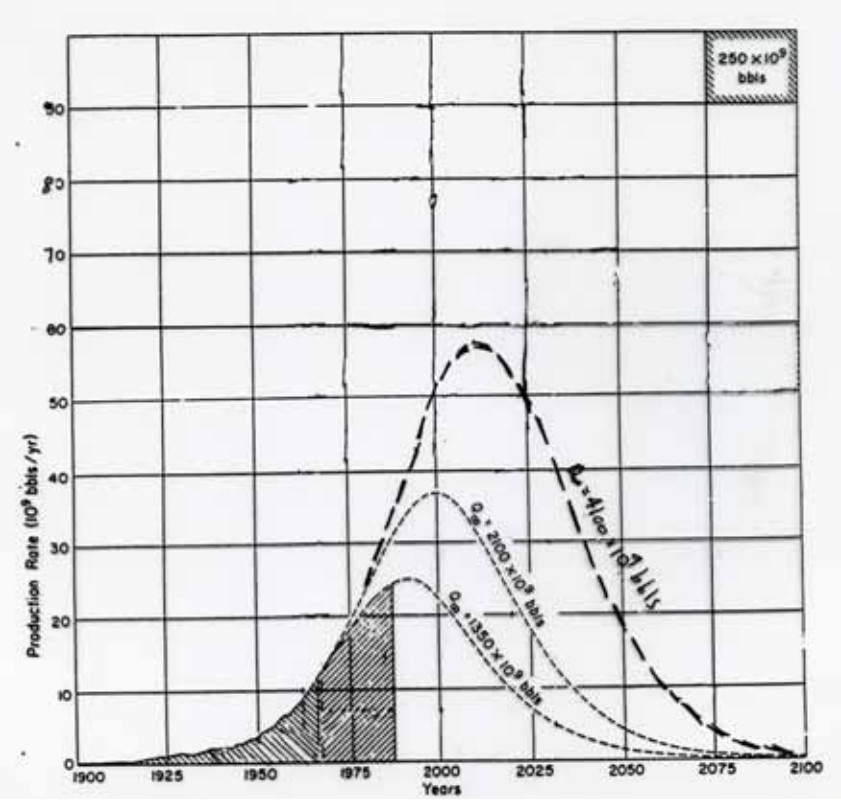

Figure 13.
Complete cycles of world crude-oil production for two values of Q_X.

If this is correct (Figure 13), Hubbert's curves imply that if the world is to try a repeat of what the United States did 30 years ago, the world is not going to suddenly give up on anything. In order to accommodate a growing gap like that into the future, in red are some possible numbers in which the peak will be around the year 2025 or so. Thereafter, they will be a growing negative discrepancy between what we would want to use and what will be available unless something happen. The gap projected is likely to have more economic, political, and military consequences than the gap when it developed just for the United States.

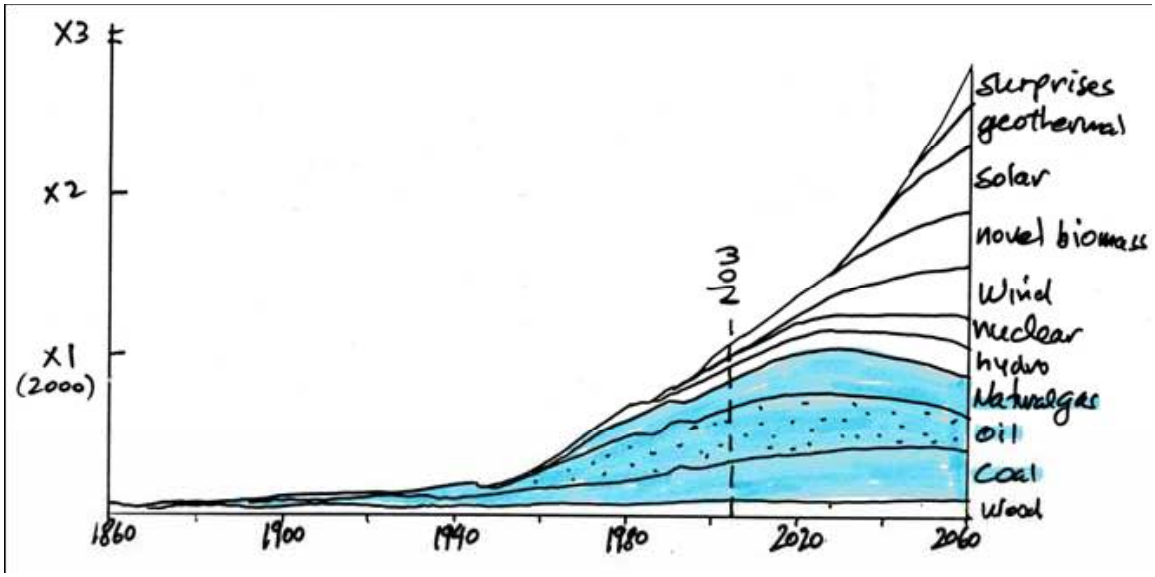

Figure 14 Blue line highlights the energy production from metro-gas, oil, and coal. The scale on the left is total one global energy consumption at present, thus, one unit in the year 2000.

According to the projection shown in Figure 14, by the year 2060, three times energy is needed if we think of the world that we are developing the way we want it to go. In this case, oil and gas will decline and will make up like 70-75% of the energy consumed back to date, less than a third. The difference between what will be needed in 50 years from now has to come from other sources of energy. That's a huge challenge for technology, development and investment; a short time to develop alternative resources at the rate of these grounds. The question is how we are going to do it at the rate of this decline.

In addition, on how to develop alternative resources, we have become aware, (we have known this for a long time), but suddenly it has come to the forefront that there is so much at stake. Two-thirds of all the oil on earth is found in the Persian Gulf. It is a geological unfairness, but petroleum is distributed completely heterogeneously. Earth scientists believe the collision of Arabia with Asia made the area a good oil factory, but other collision systems, like India with Asia, have not produced much oil. The difference then lies in the rates of collision, sediment accumulation, and organic matter production, and that organic matter must be trapped rapidly, so it doesn't oxidize before it gets buried deeply enough to be heated and converted to oil. But however, many other regions that looked promising have disappointed, and most of the world's oil remains in the Persian Gulf.

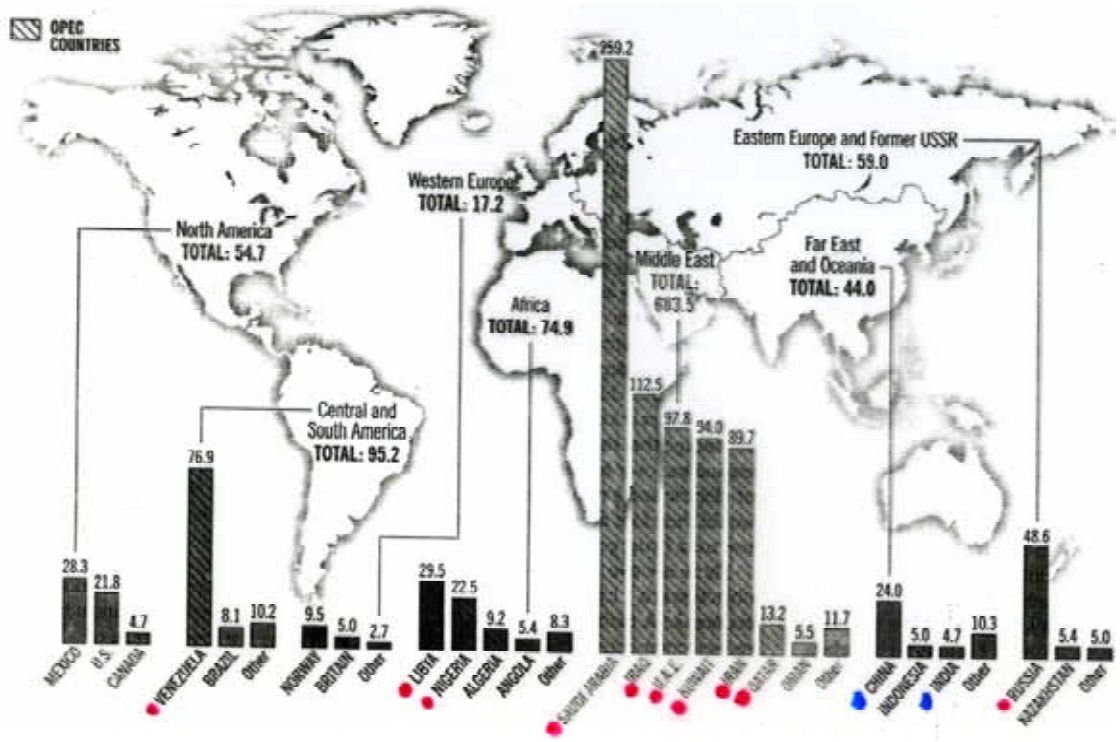

Figure 15. Map of some of the large oil producing nations in the world.

As can be seen in Figure 15, Saudi Arabia still has the largest chunk oil reserves. To some extend Venezuela, Mexico, Nigeria and China still has major reserves. Mexico is close to using everything it could receive internally, while the US is already importing a lot. Canada is probably at the point it would not be able to export. Russia within a few years will be struggling to use internally most of what they need. China, the most populous country in the world, is already importing 40% of the oil they could consume.

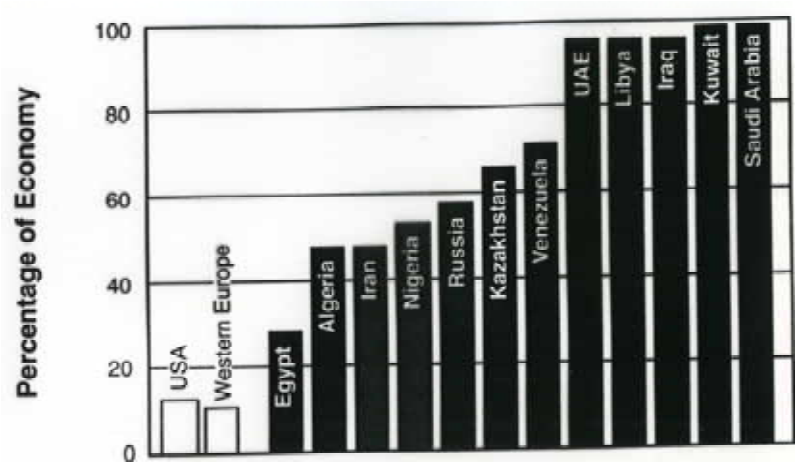

Figure 16. Percentage of economy for selected oil-producing nations (Illustration by Armando Izquierdo, after Economides & Oligney, *The Color of Oil*, 2000: Fig 2)

So really when the developing economies of the world looks to the rest of the world to import oil, its that they have to look at the Persian Gulf as the main area of interest (Figure 16).

This is really not such a big surprise but this is what we haven't paid really much attention: national and international security have become so tightly connected not only to oil but also to the geography of oil. In 1999 during Bill Clinton's administration, a statement from the annual report by the National Security Council to the White House simply stated:

> *The United States will continue to have vital interest in ensuring access to foreign oil supplies. We must continue to be mindful of the need for regional stability and security in key producing areas to ensure our access to, and the free flow of, these resource*s.

However, there may have similar statements or policies declared before, but it's becoming more and more crucial. This is mindful of the fact that because now we have depended on oil elsewhere. It's a mild statement, but has tremendous political and military and national security consequences. The statement is not partisan. Not for Bush or Clinton. Not Republicans or Democrats. It's the policy of the US. It's the program we are in.

Already, the beginning of conflict over oil is sliding into a military issue. In fact, the first major conflict of recent times was the Gulf War over Kuwait. The United States did send a huge military expedition of about 500,000 soldiers to liberate Kuwait, when there were other troubled countries, politically or geographically closer to our hearts? The reason behind was to "protect the access and the free flow of oil" from Kuwait to the free world.

As mentioned earlier on, political scientist Michael T. Klare describes the 9/11 attack as the second skirmish in the oil conflict shortly after September 11, 2001. He addresses the question of why Bin Laden attacked the United States. Why did the attack took place? It is an absurd assumption that the United States will be turned into an Islamic Republic. Therefore, what was the point of this attack? Is it sheer madness or fanaticism, or is there something else behind it? Quoting Klare extensively, he writes,

> *"There are many ways to view the conflict between the United States and Osama bin Laden's terror network: as a contest between Western liberalism and Eastern fanaticism, as suggested by many pundits in the United States; as a struggle between the defenders and the enemies of authentic Islam, as suggested by many in the Muslim world; and as a predictable backlash against American villainy abroad, as suggested by some on the left.*
>
> *But while useful in assessing some dimensions of the conflict, these cultural and political analyses obscure a fundamental reality: that this war, like most of the wars that preceded it, is firmly rooted in geopolitical competition.*

> *The geopolitical dimensions of the war are somewhat hard to discern because the initial fighting is taking place in Afghanistan, a place of little intrinsic interest to the United States, and because our principal adversary, bin Laden, has no apparent interest in material concerns. But this is deceptive, because the true center of the conflict is Saudi Arabia, not Afghanistan (or Palestine), and because bin Laden's ultimate objectives include the imposition of a new Saudi government, which in turn would control the single most valuable geopolitical prize on the face of the earth: Saudi Arabia's vast oil deposits, representing one-fourth of the world's known petroleum reserves."*

The royal family in Saudi Arabia owns the resource there. They are extremely vulnerable, because they are small, and not particularly loved by everyone. We have been protecting them since it has been part of the US policy to ensure stability in the free flow of oil. In fact, we have been protecting the royal family since the WWII or even earlier. Bin Laden, according to Klare, basically send a message to the royal family that your protectors are vulnerable we can attack them in their business center, the World Trade Center which is the largest and we can even attack the at their military headquarters which is the Pentagon. According to this view, this was what the attack was all about.

The third skirmish in the oil conflict is occurring now. Regardless of whether most leaders in the world have seen M. King Hubbard's curves and understood the geology, they do understand that there is a growing stress about oil in the world. As the supply of oil begins to decline, the pressure within each country to safeguard its own access to the remaining oil increases tremendously. The US government recognizes the need to safeguard the flow of oil into the country. For the 21st century, in my own view, the global conflict over oil has already started. The US policy will continue to ensure that the access to vital sources and the free flow of the so fundamental resource, oil, is promoted by the stability and security of key producing areas. Thus, the interest with Iraq is simply to ensure the stability and security of oil production and the flow of oil to the US. In other words, this is an oil war. Of course, we are in Iraq now. I don't think there was a meaning in the White House that they have to say we have to go to Iraq or put our heads in the oil producing countries. The US does not have a rule over oil producing countries, however, the 1999 statement to the National Security Council is still valid today.

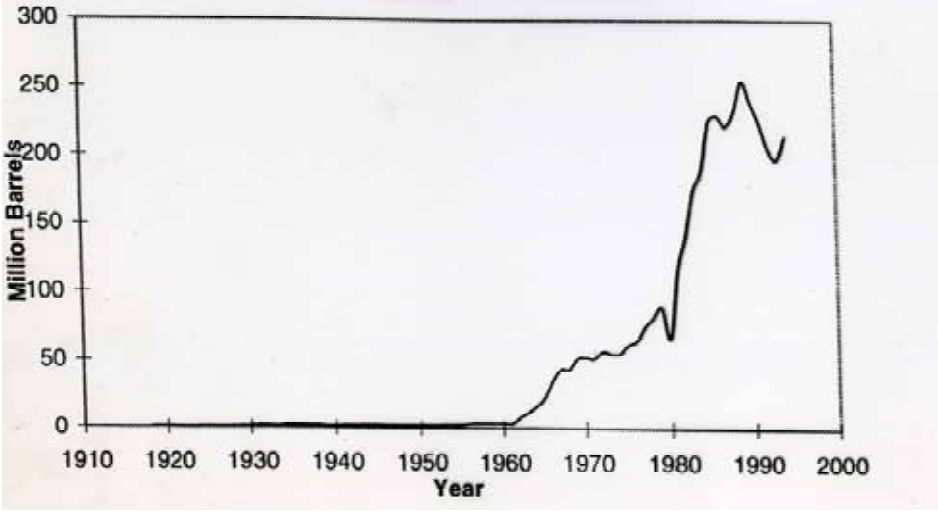

Figure 17. Oil production in million barrels per year (India).

Unfortunately, the shortfall cannot be made up from within these growing nations. For example, in India, where the first real discovery of oil in was around 1962, oil production gained momentum, and is now already declining with their national production waning before they really enter the petroleum era (Figure 17).

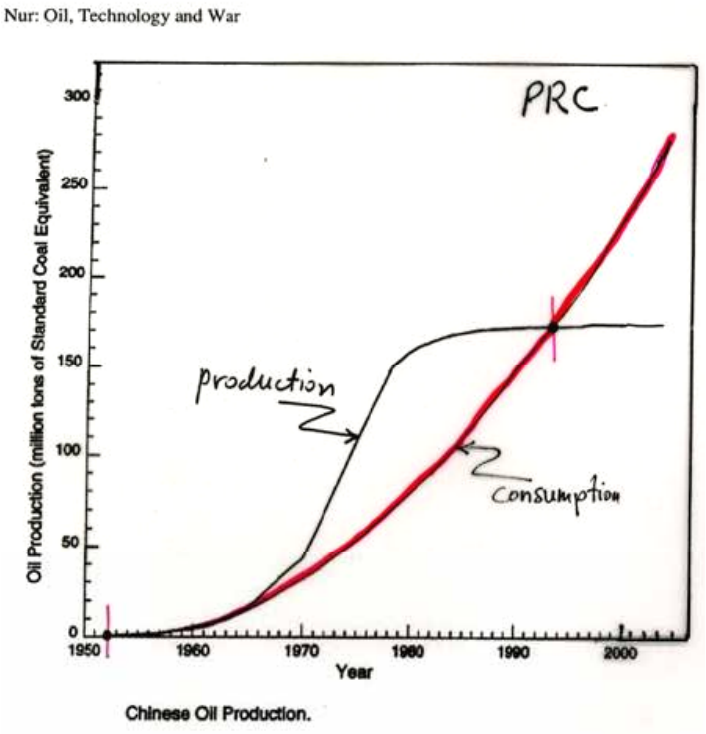

Figure 18. China's oil production and consumption level from the period between 1950 to present.

China's story is even more disturbing. With Daqing, China's top oilfield, discovered in 1959, the prospects looked terrific for the first two decades. Between 1950 and 1970 oil production in China looked terrific really the reminiscent of the US oil production in the lower 48 states before the 1960s. In addition, China became one of the world's major oil producers, with the year 1978's output at 100 million tons. In fact, a report published by its ministry of energy in 1979, predicted that with its large territory and increased exploration, China would be the next Saudi Arabia, a major exporter of oil to the world. Shortly after the report, production leveled off in China. Figure 18 shows the history of China's oil production and consumption in a period of 23 years (from the year 1980 to 2003) according to EIA. In fact, the geological history of the continental areas of China has not allowed for fast burial of hydrocarbons, with the result that the country harbors relatively little oil. For the last 30 years, despite prodigious efforts toward exploration and production, China's annual oil production has remained steady at around 3.2 billion barrels.

Until 1993, China was an oil exporter, the basis for its economic optimism but for the first time, the country became a net importer of oil responding to the explosive growing demand for oil, as it became to emerge as an industrialized country with an explosive productivity and increasing standard of living. Worse, the rate at which China import is growing exponentially with oil imports nearly doubled in January 2003, contributing to the country's first monthly trade deficit since 1996.

This should be again, a source of tremendous concern to us. In the immediate aftermath of the 9/11 attacks, Zhu Xingshan, deputy director of China's Economic Center of Energy Research Institute affirmed:

> *"Today China imports one third of its annual oil demand (in contrast, the US imports about 50 percent) but a most conservative estimation tells that by 2020 China's oil imports will be half of its total oil demand. The September 11 attacks in the US have provided a pretext for the US to enter Central Asia. This will be of far-reaching significance to China's strategy for oil supply in the future. We should see to it that good preparations be made against all possibilities and eventualities since things stay not all that clear in today's world."*

The demand is growing exponentially. The competition of where the oil is going to come from is growing exponentially. The competition is going to be worse. One can imagine the Chinese Oil National Council echoing the same sentiment:

> "~~*The United States*~~ *China* [own emphasis] *will continue to have vital interest in ensuring access to foreign oil supplies. We must continue to be mindful of the need for regional stability and security in key producing areas to ensure our access to, and the free flow of, these resources."*

In reference to the Persian Gulf area, we have a conflict of interest with China, and India is going to follow close. It doesn't have to lead to war but it could. This is the point where economist and political scientist will say this is ridiculous; first of all pre-market forces will take care of the situation, China will find way to pay more, we will find a way to pay more, we will explore better, we will find more oil on the other side. If we ask them, "how do you know?" They will say, "I don't know. You don't know either. History really supports the notion that every time we get into a stressful economic situation where national and economic securities involved there is evidence that market forces will take care of it."

As stated in Quincy Wright's *A Study of War* published at the end of the WWII,

> "*The integration or the disintegration of a political group may equally endanger the peace. Integration may arouse the anxiety both of neighbors and of minorities. Disintegration may encourage the aggression of neighbors and the revolt of minorities. Maintenance of the status quo may, however, be no less dangerous in a dynamic society with changing foreign contacts and domestic interests. Every society is continually on the brink of conflict. It must continually adapt its organization and its policy to changing conditions of internal opinion and external pressure. If changes intended to effect such adaptation are too great or too little, too rapid or too slow, to the right when they should be to the left, to the center when they should be to the periphery, trouble may be expected. The problem of adapting to the family of nations, internally heterogeneous and externally alone, to rapidly changing conditions of technology and opinion has presented extraordinary difficulties*."

This statement is probably not accurate today or relevant as it was 60 years ago.

These are some of the summaries of not really trusting some of the market forces too much: As a point of view, the World War II was already in part about oil. The main reason Germany went to the east was oil. China had the resource. Hitler and his fellows concerned with Germany's high population figures and increasing standard of living felt they needed more space to have more resources. As in this historical quotation,

> *"After more than eighteen months of unrelenting effort and extraordinary costs in human and material resources, the tide of battle turned, and the Germans were finally on the defensive in Russia. In a midnight phone call, Field Marshal Erich von Manstein begged Hitler to transfer the German forces in the Caucasus to his command in order to help the embattled Sixth Army at Stalingrad.*
>
> *Hitler refused. 'It's a question of the possession of Baku, Field Marshal,' the dictator said. 'Unless we get the Baku oil, the war is*

> *lost.' Hitler then proceeded to deliver a lesson on the central importance oil had assumed in warfare."*

Even more important, why did Japan attack Pearl Harbor? The main reason was oil. Japan had panicked. Oil had become central when Churchill converted the British navy from coal-burning ships to oil-burning ships that could go faster and further. With no actual control of any source of oil and depending on the United States-California actually-for their supply, Japan looked around and saw that Sumatra, already pretty productive under the Dutch, was in their own backyard. However, with the realization, only the Pacific fleet in Honolulu could stop the Japanese from maintaining a chain of tankers from Sumatra to Tokyo Bay. In fact, when Japan invaded China – a lot of complaints emerged in the US, this eventually led to a beginning of an oil embargo trying to put pressure on Japan to back off. And it led to a meeting in Tokyo, which took place towards the end of the 1930s. In a statement, the Prime Minister of Japan said,

> *"Two years from now we will have no petroleum for military use. Ships will stop moving. When I think about the strengthening of American defenses in the Southwest Pacific, the expansion of the American fleet, the unfinished China Incident and so on, I see no end to difficulties. . . . I fear that we would become a third-class nation after two or three years if we just sat tight."*

For those who hope or believe that market forces are known take care of situations like that, that is not what happened in World War II, which was partly related to oil. Japan to attack the US, oil played an extremely surprisingly major role, otherwise there was really no deep-rooted conflict between the US and Japan. The Japanese could have kept buying oil if they behaved themselves, buy oil at the world market, but they decided not to do it. They decided to lower the Pacific fleet and have free access and ensure access and free flow of oil from Indonesia to Tokyo Bay.

So the point of trying to put this together is that, we are beginning to see the end of it. It's like a middle life crisis: at the age of 40 or 45, we still have a few decades to live and we begin to realize that there is an end to this. That seems what we are facing. The real question is when does panic set? Do we have to wait until we don't have any oil in the world or when we use up 70% of it? Given this, some of us, some nations, some governments will begin to behave like panicky just around the peak period because not many governments will allow this to slide along way because they will try to be active about it. So what can we do about it?

Geographically, this is a farfetched possibility of China's quest to ensure the stability of the "free flow of oil" from the Middle East considering the distance between Berlin and Baku; Tokyo and Sumatra; China and the Middle East (Figure 19). The stress may slide into a military conflict.

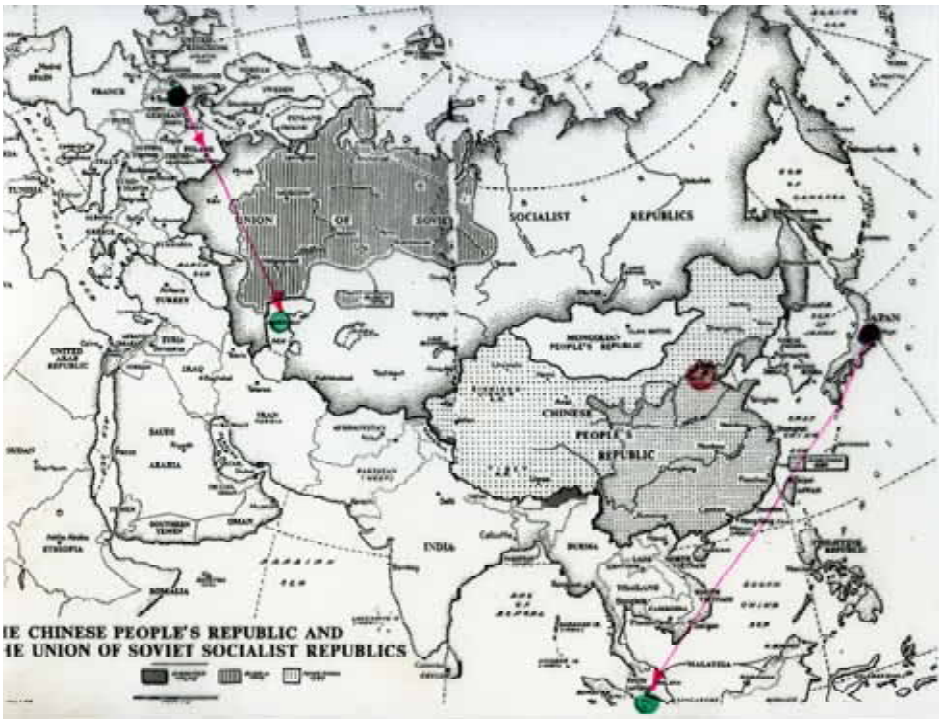

Figure 19.

Richard Smalley of Rice University, Nobel Prize winner in Chemistry, has given some perspective to the problem.

> *"As we gear up for war in the Middle East and watch oil prices soar," he says, it is easy to understand that energy is a big issue. We have to somehow wean ourselves of our dependence on oil, and the sooner the better. What is less well known is the incredible magnitude of the worldwide energy challenge that is before us. The problem is not just oil. Somehow, within the next few decades, we must find a new energy source that can provide a minimum of 10 terawatts of clean power on a sustainable basis, and do this cheaply. To do this with nuclear fission would require no less than 10,000 breeder reactors. Assuming we don't get it all from nuclear fission, where is that 10 terawatts of new power going to come from? Who will make the necessary scientific and engineering breakthroughs? Can it be cheap enough to bring 10 billion people, world population at that time, to a reasonable standard of living? Can it be done soon enough to avoid the hard economic times, terrorism, war, human suffering, that will otherwise occur as we fight over the dwindling oil and gas reserves on the planet? Energy may very well be the single most critical challenge facing humanity in this century."*

No one knows for certain the outcome of the war in Iraq and what will follow for

the world. The dilemma is where will the conflict next boil over. In this new situation of conflicts significantly after the September 11 attacks marked with the ongoing unrest in the Middle East, it is hard to define how the world is going to divide equitably the oil pool that is so important and is shrinking every year. How will it be rationally shared among both the nations that use it now and those that hope to increase their use in the future?

Compared to the coming oil crisis, global warming a slow emerging problem with a time constant of a century or more, received tremendous attention, commitment and significant funding. The oil problem emerging ten times faster, on the scale of a decade or two has already led to conflicts, and it is much more dangerous, at least in the short term.

The point is that, as insurmountable as this problem sounds, there is at least one thing we as scientists can do that is to stand firm on the issue we fundamentally believe and create awareness of the foreseeable crisis. Most people sense that there is an energy problem looming, but they think we don't know exactly what it is. Actually, it is pretty clear and imminent. America's role as a leader and the living standards for its future generations is molded by inventions and innovations. The real goal is to shore up all stakeholders interest and support to face the challenges soberly and invest in education and the development of viable energy technologies. Perhaps the rational and smooth transition from fossil fuels could avert conflicts in the world's geopolitical climate. In other words the time to act is now.

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