Oil Peak vs. Oil Panic: Revisiting M.K. Hubbert

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Geophysics Department
Stanford University
Oil Peak vs. Oil Panic: Revisiting MKHubbert

Abstract

Worldwide, per-capita oil consumption is closely correlated with 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. This is a source of increasing panic for consumers. Consequently the growing demand for oil is leading to bargaining local skirmishes between producers and consumers of which the Gulf war, the 9/11 attacks, and the war in Iraq are just the most recent ones and are being closely followed by Iran and Venezuela. These skirmishes pale in comparison with the looming panic that could lead to a global conflict among major consumers (specifically the US and China) when they must compete for dwindling oil reserves in the future.
Projected World Energy Supplies

World Energy Demand

- Natural Gas
- Crude Oil
- Coal
- Nuclear Electric
- Solar Wind
- Geothermal
- Hydroelectric

New Technologies

Decommissioning Fossil Fuels

Billion Barrels of Oil Equivalent per Year (GBOE)

1900 1920 1940 1960 1980 2000 2020 2040 2060 2080 2100

Edwards, AAPG 8/97
Production history of 8 giant or super-giant oilfields

Ref: Matthew R. Simmons, *Twilight in the Desert*, 2005
Figure 54. Total World Production of Fossil Fuels in Time Perspective
Figure 5.3 Estimated human population from A.D. 1 to the present. Different symbols represent estimates from different sources. SOURCE OF DATA: Appendix 2
HOW MANY PEOPLE CAN THE EARTH SUPPORT?

Estimated human population from A.D. 1
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.
The big question: What rules the oil business?

Demand (market forces) or
Supply (limited resource availability)?
* Demand means that market forces take care of any problem.

* Resource availability means political panic at some point in time.
## Current Consumption

<table>
<thead>
<tr>
<th></th>
<th>bbls/year</th>
<th>bbls/person/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>$3.3 \times 10^9$</td>
<td>4.6</td>
</tr>
<tr>
<td>USA</td>
<td>$7.5 \times 10^9$</td>
<td>24.0</td>
</tr>
<tr>
<td>China</td>
<td>$1.9 \times 10^9$</td>
<td>1.5</td>
</tr>
<tr>
<td>India</td>
<td>$1.1 \times 10^9$</td>
<td>1.1</td>
</tr>
</tbody>
</table>
## What if?

<table>
<thead>
<tr>
<th>bring China + India pp to</th>
<th>Added bbl/year</th>
<th>Added %/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>world average now</td>
<td>8.3x10**9</td>
<td>32%</td>
</tr>
<tr>
<td>1/4 of US consumption now</td>
<td>11.5x10**9</td>
<td>44%</td>
</tr>
<tr>
<td>1/3 of US consumption now</td>
<td>15.8x10**9</td>
<td>61%</td>
</tr>
<tr>
<td>1/2 of US consumption now</td>
<td>25.0x10**9</td>
<td>96%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>the whole world pp to</th>
<th>Added bbl/year</th>
<th>Added %/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 of US consumption level now</td>
<td>13x10**9</td>
<td>50%</td>
</tr>
<tr>
<td>1/3 of US consumption level now</td>
<td>18x10**9</td>
<td>75%</td>
</tr>
<tr>
<td>1/2 of US consumption level now</td>
<td>26x10**9</td>
<td>100%</td>
</tr>
<tr>
<td>US consumption level now</td>
<td>52x10**9</td>
<td>200%</td>
</tr>
</tbody>
</table>
Figure 54. Total World Production of Fossil Fuels in Time Perspective

Width?
Height?
When peaked?

M. K. Hubbert
1956
FIGURE 8.9
Generalized form of curves of cumulative discoveries, cumulative production, and proved reserves for a petroleum component during a full cycle of production. $\Delta t$ indicates the time lapse between discovery and production. (From Hubbert, 1962, Figure 22, p. 55.)
Figure 1. Lower 48 US crude oil life cycle based on assumed ultimate recovery of 150 and 200 billion bbl. Reprinted from *Nuclear energy and the fossil fuels*, Hubbert, 1956.
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PRODUCTION (dQ/dt) Billion bbls/YEAR

CONSUMPTION

PRODUCTION

148 Billion Produced
Thru Year End 1991

Lower 48 crude oil life cycle as of 1991 (ultimate = 189 billion bbl).
FIGURE 8.23
Complete cycles of world crude-oil production for two values of $Q_x$. 

Production Rate ($10^9$ bbls/yr)
Complete cycles of world crude-oil production for two values of $Q_z$. 
Complete cycles of world crude-oil production for two values of $Q_x$. 

- 80 PERCENT (64 YEARS) 
- 80 PERCENT (58 YEARS)
FIGURE 8.10
Relations between rate of production ($dQ_p/dt$), rate of proved discovery ($dQ_d/dt$) and rate of increase of proved reserves ($dQ_r/dt$) during a full cycle of petroleum production (From Hubbert, 1962, Figure 24, p. 56.)
Pressure on Supply: Major oil discoveries are behind us… but in a high energy price environment E&P is no longer commercially independent business
We found the most oil during the 1960s; production follows discoveries; technology hasn't helped much.

Pressure on Supply: Major oil discoveries are behind us... but in a high energy price environment E&P is no longer commercially independent business.
<table>
<thead>
<tr>
<th>Buyer</th>
<th>Acquired</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP</td>
<td>Amoco, Arco</td>
</tr>
<tr>
<td>Chevron</td>
<td>Gulf Oil, Texaco, Unocal</td>
</tr>
<tr>
<td>Exxon</td>
<td>Mobil</td>
</tr>
<tr>
<td>Phillips/Conoco</td>
<td>Conoco/Phillips</td>
</tr>
<tr>
<td>Total</td>
<td>Elf</td>
</tr>
<tr>
<td>Statoil</td>
<td>Saga</td>
</tr>
<tr>
<td>Repsol</td>
<td>YPF</td>
</tr>
</tbody>
</table>
Should we panic? - of course not.

Are we panicking? - yes, we definitely are.
As the National Security Council observed in the White House's 1999 annual report on U.S. security policy, "the United States will continue to have a vital interest in ensuring access to foreign oil supplies." Therefore, the report concluded, "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."
The first 3 skirmishes:

- Kuwait in 1991
- The 9/11 attacks
- The war in Iraq
The first skirmish:
Kuwait, 1991
The 2nd skirmish:

USA, 2001
November 5, 2001

The Geopolitics of War

by MICHAEL T. KLARE

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 3rd skirmish:

Iraq, 2003
The third skirmish: Iraq

Months before the attacks of 9/11 the White House was already considering toppling Saddam, and ... was ... studying Iraq's oil fields ... Dick Cheney was pivotal both in advancing the administration's plans for regime change in Iraq and in formulating U.S. energy policy.

(Specifically) ... a map was studied.... in the spring of 2001 by (a Cheney task force) of White House and a select group of oil company executives meeting in secret. It ... show(s) ... Iraq's ... southwest ... neatly divided ... into nine "Exploration Blocks."

A National Security Council directive, dated February 2001, instructing NSC staff to co-operate fully with the task force ... that ... would be considering the "melding" of two policy areas: "the review of operational policies towards rogue states" and "actions regarding the capture of new and existing oil and gas fields."

From Linda McQuaig, 2004
The next emerging oil skirmishes:

Iran
Venezuela
I call these local skirmishes because they are ‘bargaining’ conflicts between oil consumers and producers.

The real big problem are the emerging global conflicts among consumers who must compete for the same dwindling crucial resources.
Chinese Oil Production.
Chinese Oil Production.
[The Peoples Daily, 21/9/2001]

US September 11 Attacks Impact on China's Oil Security

According to Zhu Xingshan, deputy director of China’s Economic Center of Energy Research Institute

“... 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."
As the National Security Council observed in the White House's 1999 annual report on U.S. security policy, "the United States will continue to have a vital interest in ensuring access to foreign oil supplies." Therefore, the report concluded, "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."
OIL IN WW-II

Germany

• Desperate drive to Baku for Caspian sea oil
• Drive through North Africa to the Middle East oil fields

Japan

• Attack Pearl Harbor, trigger WWII in the Pacific
When the Panic Moment?
"As we gear up for war in the Middle East and watch oil prices soar, it is easy to understand that energy is a big issue. We have to somehow wean ourselves off 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 (TW) 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 TW 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 to a reasonable standard of living? Can it be done soon enough to avoid the hard economic times, terrorism, war and 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."

Nobel Laureate Richard Smalley is University Professor, Gene and Norman Hackerman Professor of Chemistry, and Professor of Physics and Astronomy at Rice University.
Conclusions

1. The petroleum decline problem is independent of Hubbert’s model.

2. The notion that market forces will take care of the looming petroleum shortages is a belief based on ideology and hope. The finiteness of recoverable petroleum reserves is fact.

3. To gradually replace fossil energy with alternatives on the scale of tens of billion barrels/year will require several decades and trillions of dollars.

4. A different approach to our national energy security policy will become growingly crucial to avoid future wars. Using force to secure stable global sources and free flow of oil will not work in the long run.
End of Main Talk
THE FAMILY OF NATIONS

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 the family of nations, internally heterogeneous and externally alone, to rapidly changing conditions of technology and opinion has presented extraordinary difficulties.
The future isn’t what it used to be.

“There is no likelihood man can ever tap the power of the atom.”

Robert Millikan, Nobel Prize in Physics, 1923

[after TRW Inc, 1985]
Evolution of World Oil and Gas Resources

(excludes USA and Canada)

Source: IHSE IRIS21 / PEPS 2005
People Control the Growth of Nonhuman Populations

Figure 3.1 Estimated population of Egypt, 664 B.C.-A.D. 1966. Source: Hollingsworth (1969, p. 311, Fig. 5)
Pressure on Supply: Major oil discoveries are behind us… but in a high energy price environment E&P is no longer commercially independent business.
Human affairs in time perspective

TIME (THOUSANDS OF YEARS)

[ M. K. Hubbert, 1956]
# The Size of the World’s Oil Business

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Payment to producers @ $50/bl</td>
<td>$1.6 \cdot 10^{12}/yr</td>
</tr>
<tr>
<td>2</td>
<td>Payment at the pump @ $2.6/gallon</td>
<td>$3.4 \cdot 10^{12}/yr</td>
</tr>
<tr>
<td>3</td>
<td>Actual cost of gasoline/price in Europe @ $5.2/gallon</td>
<td>$6.8 \cdot 10^{12}/yr</td>
</tr>
</tbody>
</table>

Adding Natural Gas:

Multiply by x 1.5  

$2.4 - $10 \cdot 10^{12}/yr$
GERMANY IN WWII

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.
JAPAN IN WWII:

The two Japanese tankers had continued to sit in the harbor near Los Angeles since midsummer, waiting to pick up contracted supplies of oil. In the first part of November, they finally weighed anchor and sailed away, with no oil aboard. Now, no one could doubt the absoluteness of the oil embargo. With winter almost at hand in Tokyo, the Japanese authorities retaliated by cutting off all supplies of heating oil to the American and British embassies.

"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."

"From the records available it is clear that this time-oil factor hovered over the conference table like a demon," one historian later wrote. "A decision for war was considered the most readily available means of exorcising it."21
Although many economists and political scientists tend to dismiss the significance of Hubbert's thinking about the finiteness of recoverable oil as well as the consequent implications, it appears that without careful management these conflicts could turn into wars much bigger than in Kuwait in 1991 or in Iraq in 2003. It is therefore imperative for us as earth scientist to try to educate the public and our leaders about the basic geological reality of finite fossil energy resources, and the serious consequences of this fact.
Conclusions

1. The petroleum decline problem is independent of Hubbert’s model.

2. The notion that market forces will take care of the looming petroleum shortages is a belief based on ideology and hope. The finiteness of recoverable petroleum reserves is fact.

3. To gradually replace fossil energy with alternatives on the scale of tens of billion barrels/year will require several decades and trillions of dollars.

4. The emerging conflict is not between consumers and producers but among competing major consumers. Because of that a totally different approach to our national energy security policy will become growingly crucial to avoid future global conflicts. Using force to secure stable global sources and free flow of oil will not work in the long run.
As worldwide greenhouse-gas emissions climb, so will global temperature and sea level.

{Technology Review, March 2005}
- Petroleum related fraction of selected economies
### PROCESS ENERGY CONSUMED PER NET ENERGY (COMBUSTION HEAT VALUE) OF FUEL PRODUCED

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Feedstock</th>
<th>Fuel Production</th>
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<tbody>
<tr>
<td>Gasoline</td>
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</tr>
<tr>
<td>Diesel</td>
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<td>Fuel oil</td>
<td>Oil</td>
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<td>Compressed natural gas</td>
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<tr>
<td>Nuclear</td>
<td>Uranium</td>
<td>0.0349</td>
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<tr>
<td>Methanol</td>
<td>Natural gas</td>
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<tr>
<td>Methanol</td>
<td>Coal</td>
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<tr>
<td>Methanol</td>
<td>Wood</td>
<td>2.0212</td>
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<td>Synthetic compressed gas</td>
<td>Wood</td>
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<td>Ethanol</td>
<td>Wood/grass</td>
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<tr>
<td>Ethanol</td>
<td>Corn</td>
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<tr>
<td>Biodiesel</td>
<td>Soy</td>
<td>0.4380</td>
</tr>
<tr>
<td>Hydrogen by electrolysis</td>
<td>Water</td>
<td>1.6500</td>
</tr>
<tr>
<td>Hydrogen by reforming</td>
<td>Natural gas</td>
<td>1.6000</td>
</tr>
<tr>
<td>Hydrogen by reforming</td>
<td>Gasoline</td>
<td>1.6000</td>
</tr>
</tbody>
</table>
Conclusion:

• M.K. Hubbert’s model - why does it (roughly speaking) work?

• The consumers burn the oil while the producers burn the money.

• Oil peak vs oil panic.

• Conflict between consumers and producers vs conflict among consumers.
Figure 13.1 Production Profiles for Eight Giant or Super-Giant Oilfields

SOURCE: Simmons & Company International
Oil and War:
Oil Peak vs. Oil Panic

Prof. Amos Nur
Geophysics Department
Stanford University
GIANT FIELDS

Initial reserves by discovery year

>500 Mb Fields.
Reserve revisions backdated.
What is in it for Israel?

1. R & D opportunities in future
   - Energy technology
   - Hydrogen production
   - Gas hydrates
   - Desalination technology

2. Thinking about oil related national security and international conflicts issue.
## What if?

<table>
<thead>
<tr>
<th>added bbl/year</th>
<th>added %/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bringing China + India to</strong></td>
<td></td>
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<td>world average now</td>
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<td>$25 \times 10^9$</td>
</tr>
<tr>
<td><strong>The whole world to</strong></td>
<td></td>
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<td>$52 \times 10^9$</td>
</tr>
</tbody>
</table>
“On Predicting”

How do you want it – the crystal mumbo-jumbo or statistical probability?  [Harris, 1992]
CRUDE REALITY

In millions of barrels per day

U.S. petroleum consumption*

U.S. crude oil production

Proposed ANWR oil production

*Includes oil imports as well as U.S. crude and natural gas liquids
November 5, 2001

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Siberian Pipeline Project Fuels Rivalries Between China, Japan

By Peter Wonacott

BEIJING—As Chinese crude-oil imports break records, China is scrambling to salvage a multibillion-dollar pipeline project with Russia that promises a steady supply from rich Siberian oil fields just beyond its borders.

The problem: Japan wants the same pipeline for similar reasons.
As the National Security Council observed in the White House’s 1999 annual report on U.S. security policy, “the United States will continue to have a vital interest in ensuring access to foreign oil supplies.” Therefore, the report concluded, “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.”
Figure 2. Lower 48 crude oil life cycle as of 1991 (ultimate - 189 billion bbl).
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"the United States 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."
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Filling the Tanks

China’s top crude-oil suppliers for the first eight months of 2003

<table>
<thead>
<tr>
<th>Country</th>
<th>Imports, in millions of metric tons</th>
<th>Percent change from same period of 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saudi Arabia</td>
<td>9.48</td>
<td>+34.0%</td>
</tr>
<tr>
<td>Iran</td>
<td>8.48</td>
<td>+11.6%</td>
</tr>
<tr>
<td>Angola</td>
<td>6.64</td>
<td>+116.8%</td>
</tr>
<tr>
<td>Oman</td>
<td>5.37</td>
<td>+15.6%</td>
</tr>
<tr>
<td>Yemen</td>
<td>4.06</td>
<td>+265.0%</td>
</tr>
<tr>
<td>Sudan</td>
<td>3.81</td>
<td>-18.3%</td>
</tr>
<tr>
<td>Russia</td>
<td>3.07</td>
<td>+80.2%</td>
</tr>
</tbody>
</table>

Total imports: 57.42 million metric tons
Statoil CEO resigns amid bribe inquiry

...The company wants to increase output abroad to prepare for an expected drop in Norwegian oil reserves...
JAPAN IN WWII:

"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."

"From the records available it is clear that this time-oil factor hovered over the conference table like a demon," one historian later wrote. "A decision for war was considered the most readily available means of exorcising it."21
For China, Iraq adds to unease over oil

By Keith Bradsher

The New York Times

TANGUI, China: If everything goes according to plan, this grimy industrial port and offshore oil-drilling base in northeastern China will someday have rows of giant oil storage tanks.

But for now, these are only plans. With war being waged once again in the Gulf, China, the world's largest economy without a strategic petroleum reserve, is waiting and hoping that armies, subterfuges and terrorists will do little to disrupt the imports on which its booming economy increasingly depends.

China now imports a third of its oil. With most of the imports coming from the Gulf, the lack of reserves has become a source of national concern.

The new leaders who took over China's top government jobs at the National People's Congress last week and this week want to improve China's energy security, a Chinese policymaker said in an interview in Beijing this week. "I believe the new government will pay a lot of attention to energy issues," he said.

China's oil imports nearly doubled in January, contributing to the country's first monthly trade deficit since 1996. It is not entirely clear where the oil went, given China's limited storage capacity. Western experts say that at least some oil is probably aboard aging tankers moored near Chinese ports.

As a result, China could probably withstand at least a very short interruption, said Norio Ebara, an Asian energy specialist at the International Energy Agency in Paris. "They purchased a lot of oil in the last few months, so there's no need to purchase now," he said.

China has also been buying stakes in large oil fields outside the Mideast in the hope of diversifying its sources of supply. Two Chinese state-owned companies, CNOOC Ltd and Sinopec Corp, each agreed earlier this month to buy 8.33 percent stakes in the North Caspian Sea project in eastern Kazakhstan, which includes one of the world's largest oil fields outside the Mideast.

China opposed American military action against Iraq, although it was not outspoken in doing so. According to the New China News Agency, Tang Jiaxuan, China's state counselor, told the U.S. secretary of state Colin Powell in a telephone call Friday that China, "strongly urged an end to military actions against Iraq, so as to avoid hurting innocent people."

Chinese leaders have been debating for years whether to set up a strategic petroleum reserve. China has been something of a free rider until now, relying on other countries to bear the considerable expense of keeping such reserves while assuming that those reserves will be released into world markets to drive down prices during any international crisis.

But China has gone from exporting oil in 1990 to becoming the world's fastest growing importer of oil now. This is mainly because oil demand from transportation, especially private cars, has soared while production has barely increased.

The main opponent of a strategic petroleum reserve, probably because of the cost, appears to have been Zhu Rongji, who retired this week as prime minister, said David Pietz, a China specialist at Washington State University who has just completed a study of China's thinking on strategic petroleum reserves. Chinese agencies announced two years ago and again at the end of last year that a strategic reserve would be created, but little actually happened.

With Zhu's departure, Pietz said, "It
• “For the first time in our history, ideology and theology hold a monopoly of power in Washington. Theology asserts propositions that cannot be proven true; ideologues hold stoutly to a world view despite being contradicted by what is generally accepted as reality. When ideology and theology couple, their offspring are not always bad but they are always blind. And there is the danger: voters and politicians alike, oblivious to the facts”.

• [Bill Moyers, 12/2004, Harvard University]
FIGURE 8.23
Complete cycles of world crude-oil production for two values of $Q_x$. 

[Graph showing production rate over years with peaks around 1975 and 2025, with annotations and shading indicating different production rates and possible future outcomes.]
Complete cycle of world crude oil production

Modified from M.K. Hubbert (1956)
Where the oil comes from

Although OPEC countries are far and away the world’s leading oil producers, America actually gets a smaller percentage of its imported oil products from the Middle East today than it did 25 years ago.

IMPORTED OIL: 10 LARGEST SUPPLIERS

- Persian Gulf 13.7%
- Saudi Arabia 8.9%
- Iraq 3.2%
- Non-Persian Gulf 46.6%
- Canada 9.1%
- Venezuela 8.2%
- Mexico 6.8%
- Nigeria 4.7%
- Norway 1.9%
- Angola 1.7%
- Britain 1.6%
- Colombia 1.4%

FORTUNE CHART / SOURCE: AMERICAN PETROLEUM INSTITUTE
Production vs. Consumption in US lower 48 states

After Smith & Lidsky (TLE, 1993)
Production includes crude oil, natural gas liquids and refinery gain. Source: EIA.
Fig. 3. Lower 48 crude oil life cycle as of 1991 (ultimate = 189 billion bbl).
World consumption:

@ 27 billion barrels/year

Recoverable oil in Gulf of Mexico deep water:

@ 15 billion barrels

Equivalent world consumption:

@ 7 months
“On Predicting”

How do you want it – the crystal mumbo-jumbo or statistical probability?  [Harris, 1992]
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.
Oil and War: Revisiting M. King Hubbert’s Prediction

Amos M. Nur
Stanford University
Population changes due to ecological disturbance

![Graph showing population changes over time](image)

*M.K. Hubbert, 1956*
Figure 54. Total World Production of Fossil Fuels in Time Perspective

[Diagram of production levels over time]

Width?
Height?
When peaked?

M. K. Hubbert
1956