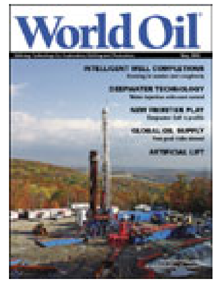

May 2005 Vol. 226 No. 5 Pages 47-53

Global Oil Supply

Mitigating a long-term shortfall of world oil production

The timing of a long-term or irreversible shortfall in supply is a contentious subject that may be impossible to agree on, but the effects are not. Mitigating these effects is crucial to economic well-being. What they are, and how to manage the risks, should find widespread agreement.

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A peak in world oil production would subject the world to its first-ever sustained discontinuity in energy - a commodity essential to the functioning of the world economy. A number of knowledgeable experts forecast that peaking of conventional oil production will occur sometime within the next 20 years. Given today's oil demand levels and usage patterns, such a forced disruption would have severe negative impacts on the economies of all oil-importing nations, perhaps the exporting ones as well. Viable mitigation options exist, but the timing of their implementation will be critical.

This article highlights that the problem is one of adequate *liquid fuel* supply, not energy in general. Viable technologies to mitigate oil shortages are available for deployment. They include improved vehicle fuel efficiency, enhanced conventional oil recovery, and the production of substitute fuels. While research and development on other options could be important, their commercial success is by no means assured, and none offer overnight solutions.

MITIGATION TRIAGE

Three alternative mitigation scenarios were analyzed: One where action is initiated when peaking occurs, a second where action is assumed to start 10 years before peaking, and a third where action is assumed to start 20 years before peaking, as shown in Fig. 1.

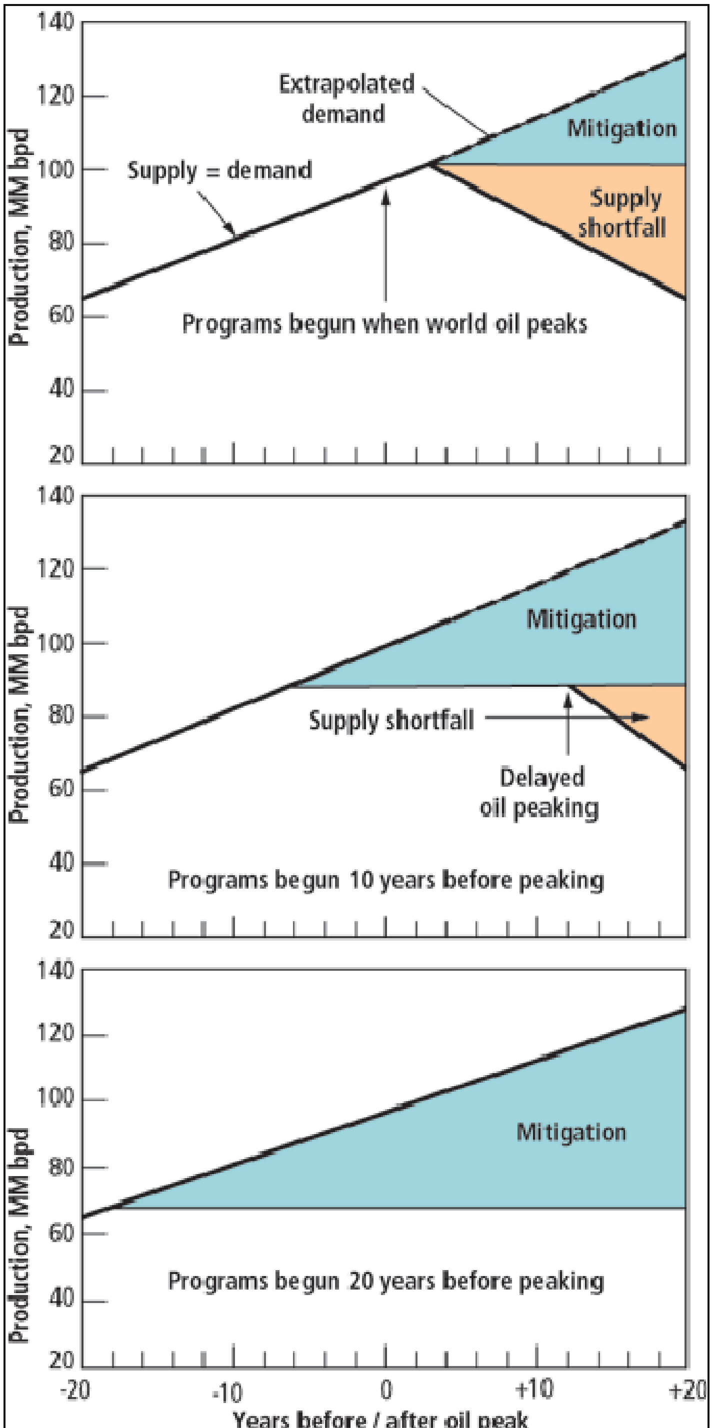

Fig. 1. Mitigation crash programs started when world oil peaks, 10 years and 20 years before: A significant supply shortfall occurs in the first two scenarios.

Estimates of the possible contributions of each mitigation option were developed, based on crash program implementation. Crash programs represent the fastest possible implementation - the best case. In practical terms, real-world action is almost certain to be slower, especially for the last two scenarios.

Analysis of the simultaneous implementation of all of the options showed that an impact of roughly 25 million bpd might be possible 15 years after initiation. For reference, the world consumed over 80 million bpd of liquid hydrocarbons last year. Even as a crash program, mitigation inherently cannot avert massive shortages unless it is initiated well in advance of peaking. Specifically:

Scenario I. Waiting until world conventional oil production peaks before initiating crash program mitigation leaves the world with a significant liquid fuel deficit for 20 years or longer.

Scenario II. Initiating a crash program 10 years before world oil peaking would help considerably, but would still result in a worldwide liquid fuels shortfall, starting roughly a decade after the time that oil would have otherwise peaked.

Scenario III. Initiating crash program mitigation 20 years before peaking offers the possibility of avoiding a world liquid fuels shortfall for the forecast period.

MITIGATION TECHNOLOGIES

While greater end-use efficiency is essential, increased efficiency alone will be neither sufficient nor timely enough to solve the problem. Production of large amounts of substitute liquid fuels will be required. A number of commercial or near-commercial substitute fuel production technologies are available for deployment, so the production of vast amounts of substitute liquid fuels is feasible with existing technology.

Enhanced Oil Recovery (EOR). This can help moderate oil production declines from older conventional oil fields. EDR is already in use in many places, but still has a long way to go for full effect.

Heavy oil/ oil sands. This is a large, unconventional resource of heavy oil, bitumen, oil sands, and tar sands lower grade oils, now produced primarily in Canada and Venezuela, with smaller resources in Russia, Europe and the US. These oils have potential to play a much larger role in satisfying the world's needs for liquid fuels. While the size of the Canadian and Venezuela resources are enormous, 3 to 4 trillion bbl in total, the amount of economically recoverable oil is of the order of 600 billion bbl, which is in large part due to the extremely difficult task of extracting these oils. [1]

Current Canadian production is about 1 million bpd of which 600,000 bpd is synthetic crude oil and 400,000 bpd is lower-grade products. [2] This production uses large amounts of natural gas for heating and processing, as well as water (3 to 5 bbl water per bbl of oil) [2] and diluent. Canada recently recognized that it no longer has the large natural gas resources once thought; so, oil sands producers are considering building coal or nuclear plants as substitute energy sources to replace natural gas. [3] Expansion will exacerbate already significant environmental issues, such as SOX and NOX emissions, waste water cleanup, and brine, coke, and sulfur disposition. In addition, because Canada is a signatory to the Kyoto Protocol and because oil sands production results in significant CO_2 emissions per barrel, there may be related constraints yet to be fully evaluated.

The present Canadian vision is to produce a total of about 5 million bpd of products from oil sands by 2030. This would include about 3 million bpd of synthetic crude oil from which refined fuels can be produced, with the remainder being poorer quality products that could be used for heat, power, and/or hydrogen and petrochemicals production.

There is a very large potential in Venezuela also. Venezuela's 2003 production was about 500,000 bpd of synthetic crude oil. That is expected to increase to 600,000 bpd by 2005. [4]

Gas-To-Liquids (GTL). Very large reservoirs of natural gas exist around the world, many in isolated locations. This "stranded gas" can and is being liquefied and transported to various markets in refrigerated, pressurized ships in the form of LNG.

Another method to monetize this gas is via the Fisher-Tropsch (F-T) liquefaction process. As with coal liquefaction, F-T based GTL results in clean, finished fuels, ready for use in existing end-use equipment with only modest finishing and blending. This GTL process has undergone significant development over the past decade. Shell now operates a 14,500 bpd GTL plant in Malaysia. A number of large, new commercial plants recently announced include three large units in Qatar: a 140,000 bpd Shell facility, a 160,000 bpd ConocoPhillips facility, and a 120,000 bpd Marathon Oil plant. Projects under development and consideration total roughly 1.7 million bpd, but not all will come to fruition.

Coal, oil shale and biomass. High-quality liquid fuel can be made from these resources. To derive liquid fuels from **coal,** the leading process involves gasification of the coal, removal of impurities from the resultant gas, and then synthesis of liquid fuels using the F-T process. Modern gasification technologies have been dramatically improved over the years, with the result that hundreds of gasifiers are in commercial operation around the world, a number operating on coal. Gas cleanup technologies are well developed and utilized in refineries worldwide. F-T synthesis is also well developed and commercially practiced. A number of coal liquefaction plants were built and operated during World War II, and Sasol in South Africa subsequently built a number of larger, more modern facilities. [5]

Coal liquids from gasification/ F-T synthesis do not need to be refined. When co-producing electricity, coal liquefaction is a near commercial technology, currently believed capable of providing clean substitute fuels at $30 - $35 per barrel. [6]

The US is endowed with a vast resource of **oil shale,** located primarily in the western part of the Lower 48 states with lesser quantities in the mid Atlantic region. The western shale resource was recently estimated to have 130 billion bbl of recoverable oil. Processes for mining shale and retorting it at high temperatures were developed intensively in the late 1970s and early 1980s. However, when oil prices decreased in the mid-1980s, all large-scale oil shale R&D was terminated. [7]

Previous oil shale processing technologies required large volumes of water, which is now increasingly scarce in the western states. Also, air emissions regulations have become much stricter in the ensuing years, presenting additional challenges.

Newer Canadian technologies have been tested at a the Stuart upgrading demonstration project in Australia. That project has been the subject of considerable attention by environmentalists and is currently suspended pending project re-design. Nonetheless, the same technology has been licensed by operators in Estonia. Oil produced from shale retorting requires refining before it can be used as transportation fuels.

In recent years, Shell has been developing a new shale oil recovery process that uses in situ heating and avoids mining and massive materials handling. Little is known about the process and its economics, so its potential cannot now be evaluated. [8]

Biomass can be grown, collected and converted to substitute liquid fuels by a number of processes. Currently, biomass-to-ethanol is produced on a large scale to provide a gasoline additive. The market for ethanol derived from biomass is influenced by federal requirements and facilitated by generous federal and state tax subsidies. Research holds promise of more economical ethanol production from cellulosic ("woody") biomass.

Fuel switching to electricity. Electricity is only used to a limited extent in the transportation sector. In the 1990s, electric automobiles were introduced to the market, spurred by a California clean vehicle requirement. The effort failed because existing batteries were inadequate, and a breakthrough in battery storage price and density never materialized.

Hydrogen. The Department of Energy is currently conducting a high profile program aimed at developing a "hydrogen economy." DOE's primary emphasis is on hydrogen for light duty vehicle application (automobiles and light duty trucks). Recently, the National Research Council (NRC) completed a study that included an evaluation of the technical, economic and societal challenges associated with the development of a hydrogen economy. [9] The study concluded that, for fuel cells to compete with existing petroleum-based internal combustion engines, particularly for light-duty vehicles, fuel cells must improve by 1) a factor of 10-20 in cost, 2) a factor of five in lifetime, and 3) roughly a factor of two in efficiency. The NRC did not believe that such improvements could be achieved by technology development alone; instead, inventions (breakthroughs) would be required, which are inherently unpredictable.

MITIGATION OPTIONS

Our focus was on large-scale, physical mitigation, as opposed to policy actions, e.g. tax credits, rationing, automobile speed restrictions, etc. We define physical mitigation as: 1) implementation of technologies that can substantially reduce the consumption of liquid fuels (improved fuel efficiency) while still delivering comparable service, and 2) the construction and operation of facilities that yield large quantities of liquid fuels.

Overnight, go-ahead decision-making is most probable in our Scenario I, which assumes no action prior to the onset of peaking. By assuming overnight implementation in all three of our scenarios, we avoid the arduous and potentially arbitrary challenge of developing a more likely, real world decision-making sequence. This is obviously an optimistic assumption because government and corporate decision-making is never instantaneous.

Our criteria for selecting candidates for our energy saving and substitute oil production "wedges" in Fig. 2 were as follows:

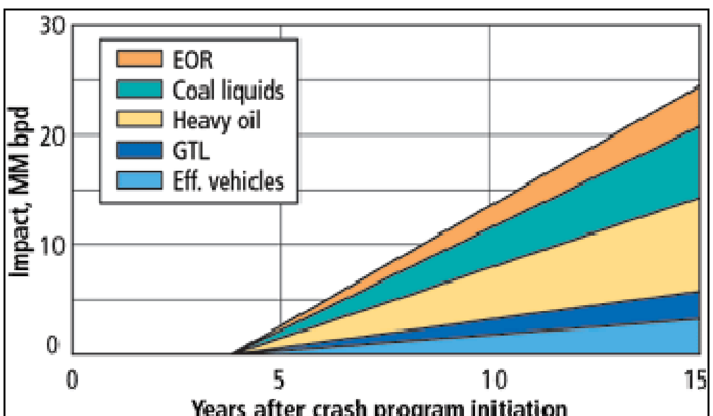

Fig. 2. Total impact of proposed mitigation efforts that meet certain criteria.

1. The option must produce liquid fuels that can, as produced or as refined, substitute for liquid fuels currently in widespread use, e.g. gasoline, jet fuel, diesel, etc. The end products will thus be compatible with existing distribution systems and end-use equipment.
2. The option must be capable of liquid fuels savings or production on a massive scale - ultimately millions to tens of millions of barrels per day worldwide.
3. The option must include technology that is commercial or near commercial, which at a minimum requires that the process has been demonstrated at commercial scale. For production technologies, this means that at least one plant has operated at greater than 10,000 bpd for at least two years, and product prices from the process are less than $50/barrel in 2004 dollars. For fuel efficiency technologies, the technology must have at least entered the commercial market by 2004.
4. Substitute fuel production technologies must be inherently energy efficient, which we assume to mean that greater than 50% of process energy input is contained in the clean liquid fuels product.
5. The option must be environmentally clean by 2004 standards.
6. While domestic resources are of greatest interest to the US, the oil market is international, so substitute fuel feedstocks not abundantly available in the US must also be considered, e.g. heavy oil/tar sands and gas-to-liquids.
7. Energy sources or energy efficiency technologies that produce or save electricity are not of interest in this context because commercial processes to convert electricity to clean hydrocarbon fuels do not currently exist.

The following processes and technologies meet the above criteria: Fuel efficient transportation; heavy oil/oil sands; coal liquefaction; enhanced oil recovery; and gas-to-liquids, Fig. 2.

PEAKING CONSIDERATIONS

World oil demand is expected to grow 50% by 2025. [10] To meet that demand, ever-larger volumes of oil will have to be produced. New reservoirs must be continually discovered and brought into production to compensate for depletion of older reservoirs. We believe that it is more important for oil peaking discussions to focus primarily on prudent risk management and secondarily on forecasting the timing of oil peaking, which will always be inexact.

The date of world oil peaking is not known with certainty, complicating the decision-making process, Table 1. A fundamental problem in predicting oil peaking is uncertain and politically biased oil reserves claims from many oil producing countries.

TABLE 1. Projections of the peaking of world oil production.

Projected Date	Source of Projection	Background & Reference
2006-2007	Bakhitari, A.M.S.	Iranian oil executive [a]
2007-2009	Simmons, M.R.	Investment banker [b]
After 2007	Skrebowski, C.	Petroleum journal editor [c]
Before 2009	Deffeyes, K.S.	Oil company geologist (ret.) [d]
Before 2010	Goodstein, D.	Vice provost, Cal. Tech [e]
Around 2010	Campbell, C.J.	Oil company geologist (ret.) [f]

After 2010	World Energy Council	World non-government org. [g]
2010-2020	Laherrere, J.	Oil company geologist (ret.) [h]
2016	EIA nominal case	DOE analysis/ information [i]
After 2020	CERA	Energy consultants [j]
2025 or later	Shell	Major oil company [k]
No visible peak	Lynch, M.C.	Energy economist [l]

[a] Bakhtiari, A.M.S. "World Oil Production Capacity Model Suggests Output Peak by 2006-07," Oil and Gas Journal, April 26, 2004.
[b] Simmons, M. R., ASPO Workshop. May 26, 2003.
[c] Skrebowski, C., "Oil Field Mega Projects - 2004," Petroleum Review, January 2004.
[d] Deffeyes, K. S., "Hubbert's Peak-The Impending World Oil Shortage," Princeton University Press. 2003.
[e] Goodstein, D., "Out of gas - the end of the age of oil," W.W. Norton, 2004.
[f] Campbell, C. J. , "Industry urged to watch for regular oil production peaks, depletion signals," Oil and Gas Journal, July 14, 2003;
[g] "Drivers of the energy scene," World Energy Council. 2003.
[h] Laherrere, J. Seminar Center of Energy Conversion. Zurich. May 7, 2003
[i] DOE EIA. "Long- term world oil supply." April 18, 2000. See Appendix I for discussion.
[j] Jackson, P. et al. "Triple witching hour for oil arrives early in 2004 - but, as yet, no real witches." CERA Alert. April 7, 2004.
[k] Davis, G. "Meeting future energy needs," The Bridge. National Academies Press, Summer 2003.
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World oil peaking represents a problem like no other. The political, economic and social stakes are enormous. Prudent risk management demands urgent attention and early action.

Petroleum in the US economy. The 39 quad consumption of oil in the US in 2003 is equivalent to 19.7 million bpd, including almost 13.1 bpd consumed by the transportation sector and 4.9 million bpd by the industrial sector. Motor gasoline consumption accounted for 45% of US daily petroleum consumption, nearly 9 million bpd, almost all of which was used in autos and light trucks. Clearly, advancements in energy efficiency and replacement of this capital stock (for instance, electric-hybrid engines) would help mitigate the economic impacts of rising oil prices caused by world oil peaking.

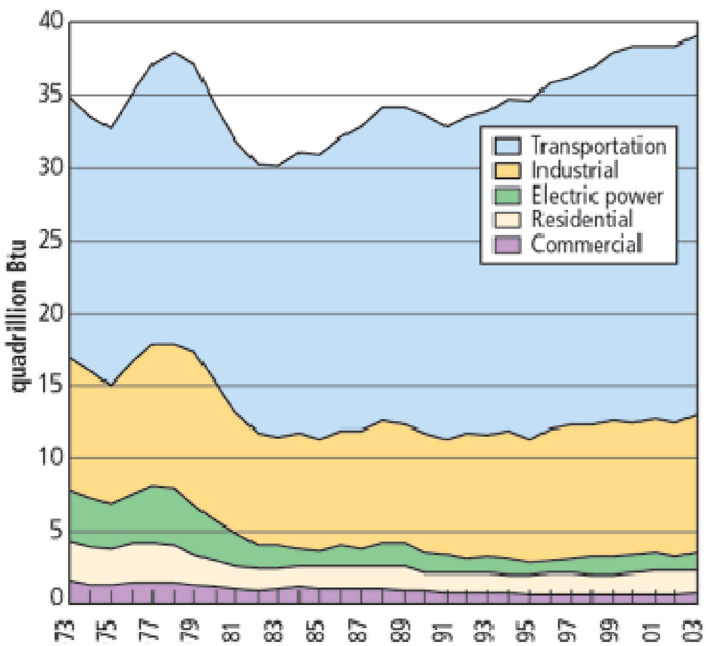
Government-mandated vehicle fuel efficiency requirements are virtually certain to be an element in the mitigation of world oil peaking. One result would almost certainly be the more rapid deployment of diesel and/or hybrid engines. Market penetration of these technologies cannot happen rapidly, because of the time and effort required for manufacturers to retool their factories for large-scale production and because of the slow turnover of existing stock. In addition, a shift from gasoline to diesel fuel would require a major refitting of refineries, which would take time.

One retrofit technology that might prove attractive is "displacement on demand" in which a number of cylinders in an engine are disabled when energy demand is low. The technology is now available on new cars, and fuel economy savings of roughly 20% have been claimed. The feasibility and cost of such retrofits are not known, so we consider this option to be speculative.

However, recent studies show that one half of the 1990-model year cars will remain on the road 17 years later in 2007. At normal replacement rates, consumers will spend an estimated $1.3 trillion (constant 2003 dollars) over the next 10-15 years to replace one-half the stock of automobiles. In the short run, much of the burden of adjustment will likely be borne by decreases in consumption from discretionary decisions, since 67% of personal automobile travel and nearly 50% of airplane travel are discretionary. [12]

Today, the US depends on foreign sources of oil for about 60% of its needs, and future US imports are projected to rise to 70% of demand by 2025. [10]

After the two oil-price shocks and supply disruptions in 1973 -'74 and 1979, oil consumption in the US decreased 13%, declining from nearly 35 quads in 1973 to 30 quads in 1983. However, consumption grew after the 1983 low and has continuously increased over the last 20 years, reaching over 39 quads in 2003, as shown in Fig. 3. Of particular note are decreases in the residential, commercial and electrical sectors. Combined, they are down to 9% of oil demand in 2003, while the transportation sector rose to 65%.



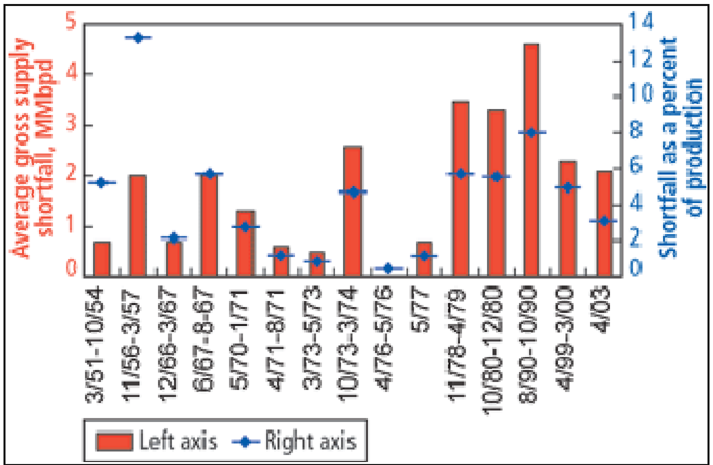


Fig. 4. Previous global oil supply disruptions: 1954 - 2003.

Since 1970, most large oil price increases were eventually followed by oil price declines, and, since these cycles were expected to be repeated, it was generally felt that "the problem will take care of itself as long at the government does nothing and does not interfere." [15] The frequent and incorrect predictions of oil shortfalls have been often used to discredit future predictions of a longer-term problem and to discredit the need for appropriate long-term US energy policies.

Peaking will result in dramatically higher oil prices, which will cause protracted economic hardship in the United States and the world. However, the problems are not insoluble. Timely, aggressive mitigation initiatives will be required.

Intervention by governments will be required, because the economic and social implications of oil peaking would otherwise be chaotic. The experiences of the 1970s and 1980s offer important guides as to government actions that are desirable and those that are undesirable, but the process will not be easy. Mitigating the peaking of world conventional oil production presents a classic risk management problem with regard to the prediction of timing, but aggressive risk management will nevertheless be essential and must address both supply and demand. The time required to mitigate world oil production peaking is measured on a decade time-scale. Related production facility size is large and capital intensive.

A higher oil price outlook often means that more oil can be produced, but geology places an upper limit on price-dependent reserves growth; in well managed oil fields, it is often 10% to 20% more than what is available at lower prices.

How oil supply shortfalls affect the global economy. Oil prices play a key role in the global economy, since the major impact of an oil supply disruption is higher oil prices. [16] Oil price increases transfer income from oil importing to oil exporting countries, and the net impact on world economic growth is negative. For oil importing countries, increased oil prices reduce national income because spending on oil rises, and there is less available to spend on other goods and services. [17] The larger the oil price increase and the longer higher prices are sustained, the more severe is the macroeconomic impact.

Developing countries suffer more than the developed countries from oil price increases because they generally use energy less efficiently and because energy-intensive manufacturing accounts for a larger share of their GDP. On average, developing countries use more than twice as much oil to produce a unit of output as developed countries, and oil intensity is increasing in developing countries as commercial fuels replace traditional fuels and industrialization/ urbanization continues.[18]

The vulnerability of developing countries is exacerbated by their limited ability to switch to alternative fuels. In addition, an increase in oil import costs also can destabilize trade balances and increase inflation more in developing countries, where financial institutions and monetary authorities are often relatively unsophisticated. This problem is most pronounced for the poorest developing countries.

Higher oil prices result in increased costs for the production of goods and services, as well as inflation, unemployment, reduced demand for products other than oil, and lower capital investment. Tax revenues decline and budget deficits increase, driving up interest rates. These effects will be greater the more abrupt and severe the oil price increase, and will be exacerbated by the impact on consumer and business confidence.

Government policies cannot eliminate the adverse impacts of sudden, severe oil disruptions, but they can minimize them. Conversely, inappropriate monetary and fiscal policies to control inflation can exacerbate recessionary income and unemployment effects.

HISTORICAL OIL CRISIS CONSIDERATIONS

Economists have debated whether the economic problems of the 1970s were due to the oil supply disruptions or to inappropriate fiscal, monetary, and energy policies implemented to deal with them. The consensus is that the disruptions would have caused economic problems irrespective of fiscal, monetary, and energy policies, but that price and allocation controls exacerbated the impacts in the US during the 1970s.[19]

There is general consensus on the following: Appropriate actions taken included CAFE, the 55 mph speed limit, reorganization of the Federal energy bureaucracy, greatly increased energy R&D, establishment of the Strategic Petroleum Reserve (SPR), energy efficiency standards and building codes, establishment of IEA and EIA, and burden sharing agreements among nations.

Inadvisable actions included price and allocation controls, excessive regulations, de-facto gasoline rationing, "excess profits" taxes, policies targeting "greedy energy companies," prohibitions on energy use, and subsidy programs.

Some actions that seemed to be inappropriate may have been desirable if the problem had not been short-lived. For example, synthetic fuel initiatives may have looked prescient had oil prices not collapsed in the mid 1980s.[20]

Estimated costs to US oil supply disruptions range from $25 billion to $75 billion per year, and the cumulative costs since 1973 -'74 total about $4 trillion.[21] Nevertheless, except for several serious disruptions (and then only temporarily), oil prices have risen little in real terms over the past century, as shown in Fig. 5. At present, oil would have to be nearly $80 per barrel and gasoline would have exceed $3 per gallon to equal real 1981 prices. Even then, however, energy would still be a less significant factor in the US economy because average US per capita incomes have doubled since 1981 and energy is a much smaller component of expenditures.

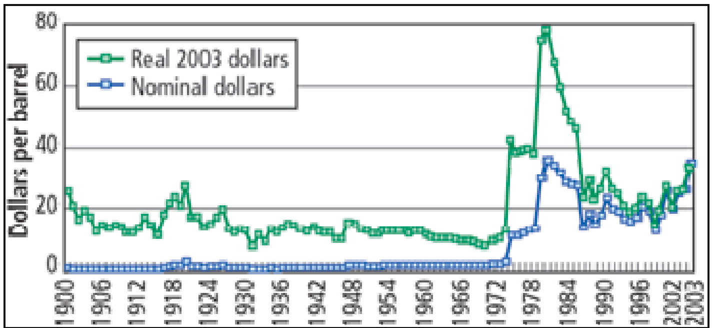


Fig. 5. Oil Prices in current and constant dollars: 1900 - 2004

The US is currently less oil-dependent (in terms of oil/ GDP ratios) than during the 1970s. However, the US is now importing twice as much oil (in percentage terms) as 30 years ago and its transportation sector consumes a larger portion of total oil consumption.[22] Further, by 2000, most of the energy saving trends resulting from the 1970s disruptions (increased energy efficiency and conservation, increased vehicle mpg, etc.) had been captured.

The US experience. As illustrated in Fig. 6, oil price increases have preceded four out of six US recessions since 1969, and virtually every serious oil price shock was followed by a recession. Thus, while oil price spikes may not be necessary to trigger a recession in the US, they have proven to be sufficient over the past 30 years.

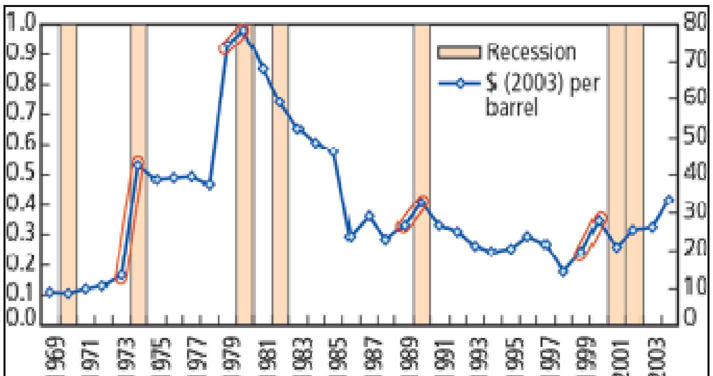


Fig. 6. Oil prices and US recessions: 1969-2003[23]

For the US, each 50% sustained increase in the price of oil will lower real US GDP by about 0.5%, and a doubling of oil prices would reduce GDP by a full percentage point. Depending on the US economic growth rate at the time, this could be a sufficient negative impact to drive the country into recession. Thus, assuming an oil price in the $25 per barrel range - the 2002 - 2003 average, an increase of the price of oil to $50 per barrel would cost the economy a reduction in GDP of around $125 billion.

If the shortfall persisted or worsened (as is the case with peaking), the economic impacts would be much greater. Oil supply disruptions over the past three decades have cost the US economy about $4 trillion, so supply shortfalls associated with the approach of peaking could cost the US as much as all of the oil supply disruptions since the early 1970s combined.

The natural gas experience. The general schism between economists and some geologists continues, with economists generally believing higher oil prices and improved technologies will continue to provide ever-increasing oil production for the foreseeable future. Many geologists disagree.

There is a dramatic example, perhaps an analogue, of the risks of over-reliance on geological resource projections. North American natural gas supplies roughly 20% of US energy demand. It has been plentiful at real prices of roughly $2/Mcf for almost two decades. Over the past 10 years, natural gas has become the fuel of choice for new electric power generation plants and, at present, virtually all new electric power generation plants use natural gas.

Optimistic resource estimates for the US and Canada that promised growing supply at reasonable prices have turned out to be wrong, with the US now experiencing supply constraints and high gas prices. In 1999 the National Petroleum Council stated "US production is projected to increase from 19 Tcf in 1998 to 25 Tcf in 2010 and could approach 27 Tcf in 2015?. Imports from Canada are projected to increase from 3 Tcf in 1998, to almost 4 Tcf in 2010." [24]

In 2001, Cambridge Energy Research Associates (CERA) stated "The rebound in North American gas supply has begun and is expected to be maintained at least through 2005. In total, we expect a combination of US lower-48 activity, growth in Canadian supply, and growth in LNG imports to add 8.95 Bcf per day of production by 2005." [25]

The US Energy Department's Energy Information Administration (EIA) in 1999 projected that US natural gas production would grow continuously from a level of 19.4 Tcf in 1998 to 27.1 Tcf in 2020. [26]

These groups have now completely reversed themselves, finding that gas supply difficulties are almost certain for at least the remainder of the decade. This experience provides a useful cautionary lesson relevant to optimistic forecasts for peaking of conventional world oil production.

OTHER FACTORS

What used to be termed the "not-in-my-back-yard" (NIMBY) principle has evolved into the "build-absolutely-nothing-anywhere-near-anything" (BANANA) principle, which is increasingly being applied to facilities of any type, including low-income housing, cellular phone towers, prisons, sports stadiums, water treatment facilities, airports, hazardous waste facilities, and even new fire houses. [27] Construction of even a single, relatively innocuous, urgently needed facility can easily take more than a decade. Opponents can often extend the permitting process until sponsors terminate their plans.

For example, approval for new, small, distributed energy systems requires a minimum of 18 separate steps, requiring approval from four federal agencies, 11 state government agencies, and 14 local government agencies. [28] Opponents of energy facilities routinely exercise their right to raise objections and offer alternatives. Intervenors in permitting processes may delay decisions and in some cases force outright cancellations, although cases do exist in which facilities have been sited quickly.

To replace dwindling supplies of conventional oil, large numbers of expensive and environmentally intrusive substitute fuel production facilities will be required. Under current conditions, it could easily require more than a decade to construct a large coal liquefaction plant in the US. The prospects for constructing 25 - 50, with the first ones coming into operation within a three year time window are essentially nil. Absent change, the US may end up on the path of least resistance, allowing only a few substitute fuels plants to be built on US soil; in the process the US would be adding substitute fuel imports to its increasing dependence on imports of conventional oil.

For the US to attain a lower level of dependence on liquid fuel imports after the advent of world oil peaking, a major paradigm shift will be required in the present approach to the construction of capital-intensive energy facilities. Federal and state governments will have to adopt legislation allowing the acceleration of the development of substitute fuels projects from current decade time-scales. During World War II, facilities of all types were constructed on a scale and schedules that would have previously been inconceivable. In the face of the 1973 energy crisis, the Alaska oil pipeline was approved and constructed in record time, albeit approved by only a one-vote margin in the US Senate. Currently, EIA anticipates that an Alaska gas pipeline will not be completed prior to 2020.

The world has never faced a problem like this, but we can manage it if we start early enough.

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The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

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