

M. KING HUBBERT CENTER FOR PETROLEUM SUPPLY STUDIES

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IS THE WORLD'S OIL BARREL HALF FULL OR HALF EMPTY?

It Depends Upon Whether You are an Economist or a Geologist !

by
Joseph P. Riva

There has been a recent escalation in the age-old debate between geologists and economists over the size and nature of the world's oil resources base. Since oil is the world's most important commodity, the debate is more than an academic exercise. The economy of the modern world depends upon transportation and transportation depends upon oil. However, economics makes no distinction between a commodity's price and its societal value, with oil no exception.

Economists are oil resource optimists and are encouraged by the current low oil prices and the constantly rising reported world oil reserves. It seems as if as more oil is produced more remains in the ground. This is viewed as the result of the success of ever improving exploration and production technology and increasing investment. To add to the economist's argument, past oil shortages, as predicted by geologists, failed to materialize so there is an often-cited credibility gap. Estimates of declining oil reserves and production made by geologists are always wrong, economists believe, because they treat as a quantity what is actually a dynamic process driven by growing knowledge.

To the economist, the earth's resources are huge and unknowable. Thus, there is a large oil reserve base that is expanding over time and can support increasing world oil production far into the next century. Therefore, for many years, world oil availability will be essentially an economically driven technological matter that includes, but is not limited to such new developments as 3-D seismic technology, interactive computer work stations, multidisciplinary teams, horizontal and multilateral drilling, smart completions, and expanding solutions to deep water challenges.

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Low oil prices are not, however, an indicator of increasing oil reserves. The world oil market is unstable since much of the oil supply does not follow economic logic. Oil supply should depend upon the economic incentive to produce from available capacity as reflected in the profits derived from oil sales. When oil demand weakens and prices decline, the most expensive production should be shut-in first, and the rest in the order defined by cost. The workings of the oil market are quite the opposite. The largest producers, with the lowest cost production, try to support oil prices with coordinated cuts in output. Then the market develops an overhang of idle state owned production capacity, while the commercially owned more expensive capacity remains onstream. Over time, the world's production capacity is expanded more rapidly than is economically justified, creating volume competition for producers with the lowest operating costs.

With the production cost advantage diminished, most output sacrificed to price management belongs to governments with national budgets dependent on oil revenues, introducing a political dimension to the oil markets. Since political agreements on reducing production volumes always leak, there are strong motivations to overdevelop supply. Also, camouflaged in this unstable market situation is a dependable economic indicator of the health of world oil reserves. As increases in oil production capacity are often politically driven, so are estimates of proved oil reserves.

Supply is not the only factor that determines cost. There is also demand, and world oil demand has slowed just as the extensive production investments of prior years brought new supplies to the market. The demand slowdown is largely the result of Asia's economic collapse. The collapse is of further interest in that there was so little warning. Economic experts said that the Asian markets wouldn't crash. They crashed. They said that the crisis would not spread. It spread, and all efforts for an economic fix have failed. A creditability gap is not only a problem for the geologists. Serious questions remain about structural weaknesses in the quality of information about world economic matters in general. Are economists, in their self-confident view that their ideology is the global standard and in their desire to direct investments, giving sufficient attention to potentially negative economic factors? Is the potential of a significantly lower than reported volume of world oil reserves one of these factors?

Proved oil reserves are those that are economically recoverable and have been measured on the basis of geologic and engineering data. To the economist they are inventory, paid for up-front. Thus the quantities reported should be reasonably dependable. In the past three years, reported world oil reserves have increased by nearly 60 billion barrels, despite an oil production of over 70 billion barrels. However, during this period less than 20 billion barrels of oil were discovered worldwide. Thus, oil field reserve growth would appear to have been in excess of 100 billion barrels.

Reported world oil reserves have increased by more than 300 billion barrels over the past 20 years. The major factor in this increase is the more than 250 billion barrels added to Middle Eastern reserves between 1986 and 1989. During that period the

reported oil reserves in the region were increased by about 65 percent. Since OPEC production quotas are partly determined by reserve size, it was more than a coincidence that each country chose this time of market share competition to increase reported reserves. A more important consideration, however, is whether the reserve increases were political or real.

During the late 1980's, little exploration drilling was done in the Middle East and few discoveries were made. Most of the reserve increases were based on the assumption that higher percentages of the oil in-place in the known fields could be recovered. Currently, continuing oil field growth in the region is presumed, in spite of the massive water floods in place in some fields to maintain reservoir pressure. Such field growth, if achievable, would depend upon a vast array of additional and costly infrastructure, some not currently contemplated and most difficult to finance.

During Desert Storm, Iraqi troops set fire to Kuwait's oil fields, destroying over two billion barrels of crude oil. Following the war, official Kuwaiti reserves showed no decline. That such oil destruction does not affect reported reserves erodes confidence in their accuracy and indicates that they may be artificially held at optimistic levels.

The Middle East is not the only region of the world with questionable oil reserves estimates. Venezuela, also subject to OPEC output quotas, reports very high reserves compared to production. Mexico's reported reserves rapidly escalated in the 1980's, during an international borrowing spree. At that time, a large oil reserve was seen as general collateral for the loans, but the higher reserve numbers persist. Currently, most of the reserve estimates quoted for the Caspian Sea are wildly optimistic, probably for political reasons as well as for the justification of the considerable investments contemplated by the major oil companies.

A related reserve problem concerns the apparent year-by-year replacement of world oil production. Although relatively small amounts of oil are discovered in new fields, reported world oil reserves continue to increase, despite significant production. This implies field growth on a huge and almost unbelievable scale. Often the reserve reports appear to have been the result of technical incompetence, creative accounting, or politics. Many countries report the same or similar volumes of proved oil reserves year after year, regardless of production or the absence of new discoveries, either through inertia or a reluctance to have their reserves appear to have declined. As to future field growth, some 90 percent of current world oil production comes from fields that are more than 20 years old and 70 percent from fields more than 30 years old. These fields are well known and have little technical possibility for continuing the huge upward reserve revisions.

Thus, proved world oil reserves, which are an important component of any economic oil supply forecast, are not a high quality statistic. There is good reason to believe that there has been considerable latitude in estimating world oil reserves, with a tendency to favor the high side. It follows that the technical advances in exploration

and production, though very impressive, may not have been as successful in adding oil reserves as is claimed, nor are all reserves paid-for inventory.

Nonetheless, some proved oil reserves have declined. In the United States, where there is a strict legal incentive to employ only engineering and scientific methods in oil reserve estimates, proved oil reserves have declined by more than 40 percent since 1970, causing a 35 percent drop in oil production.

In 1997, however, the first reserve increase in a decade was recorded. Almost half of this 2 percent raise came from reserve growth in California's large heavy oil fields and much of the rest from known fields on Alaska's North Slope. In addition, new fields were discovered, 80 percent of which were in the Gulf of Mexico and most of the rest in Alaska. The recent oil reserve increase was the result of improved exploration and development technology, but the 40 percent decline also was experienced in a highly technical environment. The new oil field discoveries in the Gulf of Mexico and Alaska highlight the highly questionable governmental policies that keep much of the North Slope and almost all of the continental shelves (except the Gulf of Mexico) off limits to oil exploration, when it is necessary to import more than half of the domestic oil supply. Although the small increase in proved reserves is positive, it is not an indication that domestic oil reserves will again equal the 1970 level, even with additional exploration in currently forbidden regions and/or through the application of advanced technologies.

According to economic theory, as conventional low cost resources decline, increasingly costly deposits that are assumed to exist in ever larger quantities will be exploited. In the case of oil, this would include deep water accumulations, as well as heavy oil deposits, tar sands, and oil shales. Economists presuppose continuing advances in technology. While a compliment to the geologists and engineers who must do much of the work, there is a vast difference between incremental advances and breakthroughs which don't always materialize. To drill in somewhat deeper water is an incremental advance in technology which can usually be counted on to occur. Heavy oils can be made to flow from a well by the application of heat and solvents, an incremental (although expensive) advance in technology over conventional oil deposits. However, production after treatment usually ranges from about 5 to 100 barrels per day per well, compared to giant conventional oilfields where a single well can produce as much as 20 thousand barrels of oil daily at a trivial cost in money and the labor of very few people. Also, on average the energy equivalent of one barrel of oil is expended to produce the heat necessary to net two barrels of heavy oil.

The exploitation of tar sands and oil shales is a different and a much more complex matter. After mining, the bitumen in tar sands and the solid organic matter in oil shales requires extensive processing before it can be utilized. The entire operation is complicated, expensive, and produces relatively little oil compared to the effort expended. For a product that must be mined to compete volumetrically with a product that flows in a well would require technological breakthroughs that not even geologists or engineers might achieve.

Thus, not only world oil reserves but the world oil resource base may be significantly smaller than reported. This would, of course, impact supply and considerably reduce the time at which world oil production peaks, oil prices soar, and serious world energy problems begin. To some geologists the production peak will come shortly after the turn of the century. However, with the slowing of demand due to the spreading world economic crisis, this appears overly pessimistic. The power of the quest for profits is sometimes underappreciated by geologists in their projections of future oil availability, whereas economists have had little experience in dealing with finite resources. An oil supply crisis in the next few years appears somewhat premature, but the scales seem to be tipping in favor of geology. In the context of the 21st century, a world oil supply crisis, while not imminent, appears more likely sooner than later.

There is another worry. Increases in world oil demand will have to be met primarily from Persian Gulf supplies. This is a region with a history of wars, illegal occupations, coups, revolutions, sabotage, terrorism, and oil embargoes. To these possibilities may be added growing Islamist movements with various antipathies to the West, and especially to the United States. To the economist there is no security problem here because any country will always act in its economic interest. That is why Iran, Iraq, and Red Russia sold oil on the market, even with the knowledge that it benefited their protagonists. While there may be a future Islamist regime that puts ideology ahead of economic interest, there are even more likely crisis scenarios. Concerted terrorist attacks could severely cripple oil production and/or transportation facilities, although potentially more disruptive would be drawn out Islamist led revolution fought above the world's largest oil fields. Since these, or related scenarios, could occur at any time so could the resulting oil supply crisis.

In summary, oil is special. Cheap and abundant oil powers the industrial economy, stands between the present affluence and a 19th century life style, and makes modern military operations possible. There is no known substitute for oil that combines its high energy content, its portability, its flexibility, and, most importantly, its abundance. Geologists know several things about the world's oil:

Less than 5 percent of the world's oil fields originally contained about 95 percent of total world oil;

The giant oil fields, because of their anomalous geology, are usually discovered early in an exploration cycle and provide enormous amounts of oil rapidly from a relatively small number of wells;

The geology of the world's currently unproductive basins is generally unfavorable for the formation of giant fields, nor can many expect to remain undiscovered in maturely explored basins; and

The unconventional oil deposits, such as tar sands and oil shales, cannot replace giant field production on a volume per time basis.

Thus, there will be a point when world oil production peaks and demand overtakes supply. Geologists and economists are divided as to when that point will occur. Geologists, whose careers depend upon putting numbers on oil accumulations, feel that the barrel is half empty and that oil production will soon peak. Economists optimistically feel that oil reserves will be created (by geologists) out of a resource whose limits we do not know and will never know. Nothing is impossible unless you have to do it yourself. One thing is certain, when world oil production is no longer able to meet oil demand, the world will never be the same!

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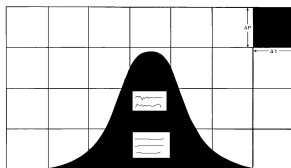
After receiving an M.S. in Geology in 1959, J. P. Riva worked as an exploration geologist for the Tenneco Oil Company in the Rocky Mountains. In 1966 he joined the Smithsonian Institution, specializing in energy and water resources research. In 1974 he moved to the Congressional Research Service of the Library of Congress to become a non-partisan congressional advisor on world oil and gas. During 1980 he worked as a senior research geologist with the U.S. Geological Survey in the World Energy Program. He has testified before Congress and has authored over 200 publications including the Fossil Fuels section of Encyclopaedia Britannica and the following four books: World Petroleum Resources and Reserves (1983), and U.S. Conventional Oil and Gas Production Prospects to the Year 2000 (1985), both from Westview Press; and Exploration Opportunities in Latin America (1992), and Petroleum Exploration Opportunities in the Former Soviet Union (1994) both from PennWell Books. He has served on the Committee on Offshore Hydrocarbon Resource Estimation Methodology and on the Committee on Undiscovered Oil and Gas Resources (National Research Council, National Academy of Sciences) and on the Coordinating Committee of the World Energy Program of the U.S. Geological Survey. He is a member of the AAPG, the AIPG, and Sigma Xi. In 1996 he retired from the Library of Congress and now writes and consults in world petroleum geology.

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H.C. NEWSLETTER



The M. KING HUBBERT CENTER FOR PETROLEUM SUPPLY STUDIES

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Golden, Colorado

The Hubbert Center has been established as a non-profit organization for the purpose of assembling and studying data concerning global petroleum supplies and disseminating such information to the public.

The question of WHEN worldwide oil demand will exceed global oil supply is stubbornly ignored. The world's oil problems, timing and ramifications can be debated and realistic plans made only if the question is publicly addressed. A growing number of informed US and European evaluations put this crisis as close as the years 2000 - 2014. The formation of this center is to encourage a multi-field research approach to this subject.

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