

M. KING HUBBERT CENTER FOR PETROLEUM SUPPLY STUDIES

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U.S. CONVENTIONAL WISDOM AND NATURAL GAS

by
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THE OLD CONVENTIONAL WISDOM

Domestic natural gas production peaked in 1973 at 22.6 trillion cubic feet (tcf), but then declined to 18.8 tcf only four years later, creating an atmosphere of extreme pessimism about future output. Supply shortages, particularly during the 1976-77 winter, were responsible for periodic curtailments of gas deliveries that caused considerable economic hardship to industrial and commercial users, and occasionally even to residential customers. In certain areas, new gas hookups were prohibited because of supply problems. At that time, the conventional wisdom that dominated energy policy considerations was the expectation of sustained gas shortages. Such projections were based on disturbing trends, such as declining finding rates for new gas fields and a continuing drop in proved gas reserves. The domestic natural gas resource base was considered mature, the largest gas fields having been discovered between 1910 and 1956. The extreme pessimism regarding the future of natural gas culminated in 1978 with the passage of the Power Plant and Industrial Fuel Use Act, which legally restrained the utilization of natural gas in industrial and electric utility plants.

THE NEW CONVENTIONAL WISDOM

Currently, there is a new and radically different conventional wisdom regarding the future of natural gas. Short-term production is in relative balance with demand, after a period of surplus capacity caused by a combination of energy conservation and industrial fuel switching away from gas. Natural gas is now a preferred fuel. It offers environmental advantages over other fossil fuels and, with the 1987 modifications of the Fuel Use Act, it is expected to play an increasingly important role in the future domestic energy mix. In its Annual Energy Outlook,

HC#97/3-1-1
JULY 1997

the Energy Information Administration (EIA), in its reference case, projected that Lower-48 State gas production would increase from 18.07 tcf to 25.52 tcf in 20 years. The estimates of several other energy research institutions have been comparably optimistic.

While many of the models seem to be driven from the demand side, there is some good news on the supply side as well. Proved natural gas reserves are no longer in free fall. While down by 15 percent over the past 10 years, they have declined by only 2 percent since 1990, and even slightly increased in 1994 and 1995. However, new gas discoveries remain rare. In the 1990s, the amount of gas discovered in new fields amounted to less than eight percent of total domestic gas output. Little new gas is being added to reserves to back up production. More than 90 percent of proved gas reserve additions come from new reservoirs in, or extensions to, old fields, or from revisions and adjustments to previous reserve estimates.

Additional drilling obviously will be required to meet the EIA projection of a Lower-48 State output of 25.52 tcf of gas by 2015. Current average Lower-48 States annual per-well gas production is 60 million cubic feet (cf) from just over 294,000 wells. This can be compared to the peak gas production year of 1973, when about 124,200 wells averaged 182 million cf. If average annual per-well gas production remains at 60 million cf, some 425,300 producing gas wells would be needed in 2015 to meet the EIA projection. During the 1980s, about two wells had to be drilled for gas to net one additional gas producing well. At this rate, an average of about 13,100 wells would have to be drilled for gas each year for the next 20 years to achieve the EIA reference case. However, the average annual per-well gas output declined by 20 percent over the past dozen years. If it falls by the same percentage over the next 20 years, some 638,000 producing gas wells would be needed, requiring the drilling of about 31,900 wells per-year.

In the 1980s, which included a drilling boom, an average of 17,940 wells were drilled annually for natural gas in the Lower-48 States. In the 1990s, the average fell to 12,090. While the drilling of an average of 13,100 gas wells should not present a significant difficulty, especially with rising gas prices, the drilling of 31,900 wells per-year will be virtually impossible. Also, of interest, was the effect of the early 1980s gas drilling boom on proved natural gas reserves. Many of the gas prospects drilled at the time were of marginal quality with unrealistic expectations of financial success. Thus, in spite of the large number of wells drilled, proved gas reserves increased very little.

However, aside from drilling, the major problem with projections of significantly increasing Lower-48 State gas production over the next 20 years is inadequate natural gas resources and reserves. To achieve the EIA reference case (a Lower-48 State gas production increase to 25.52 tcf in 20 years) requires increasing gas production each year. When each year's output is added, the total amount of gas produced over the 20-year period is about 442 tcf (see Table 1). At the current R:P (reserves:production) ratio of 9:1, any increase in gas production must be

accompanied by nine times as much gas added to proved reserves. The proved gas reserves necessary to support an output of 25.52 tcf is about 230 tcf. Thus the total proved gas reserves needed to support the EIA forecast is 672 tcf.

Is this much gas available? Current proved reserves are about 156 tcf (see Table 1). Also, perhaps it optimistically could be assumed that the currently producing gas fields will have experienced half of their maximum growth during the next 20 years (the USGS estimates 40 years). If achieved, an additional 145 tcf of reserve additions would be realized.

This leaves 371 tcf of gas reserves needed to meet the EIA projection. Most of this gas will have to come from new fields. EIA has estimated that about 4 tcf of 2015 gas production will come from continuous-type (unconventional) deposits. Since these are mostly known, $4 \times 9 = 36$ tcf of reserve additions may not be needed. Thus, some 335 tcf of proved reserve additions must be accounted for by finding new fields. However, over the past ten years a total of only 14.24 tcf of gas has been added to proved reserves from new field discoveries. At this rate, it would take 235 years to discover 335 tcf of gas! To find that volume of gas in 20 years (even considering the potential growth of the new fields), the past decade's discovery rate would have to be increased by an order of magnitude, clearly a case of the triumph of hope over experience.

CONCLUSIONS

If Lower-48 State proved gas reserves are reported to EIA with reasonable accuracy, and inferred reserves (field growth) and undiscovered gas resources as assessed by the Department of the Interior prove generally reliable, it will not be possible to increase gas output to 25.52 tcf in 2015. It would require finding and converting all of the assessed (mean) undiscovered gas resources to proved reserves in 20 years, as well as experiencing half of total estimated field growth. It is probably over-optimistic even to project sustainable gas production for the next 20 years. However, OCS drilling offers a chance of finding large gas fields, with high recovery rates. Such large discoveries will be needed in all OCS regions or, by early in the next century, natural gas will have become more of an energy problem than an energy solution.

TABLE 1

LOWER-48 STATES NATURAL GAS NEEDED FOR EIA YEAR 2015
REFERENCE CASE PRODUCTION PROJECTIONS

2015 Projected Gas Production	25.52	tcf	-EIA
2015 Proved Gas Reserves (R:P = 9:1)	230	tcf	
Total Gas Produced, 1996-2015	<u>442</u>	tcf	
TOTAL RESERVES NEEDED FOR REFERENCE CASE	672	tcf	
<u>Available Natural Gas Reserves</u>			
1995 Proved Reserves	156	tcf	-EIA
Producible Unconventional Reserves	<u>36</u>	tcf	-EIA
AVAILABLE RESERVES	192	tcf	
<u>Additional Gas Needed (672-192)</u>			
1/2 Inferred Reserves (total 290 tcf)	145	tcf	-USGS
RESERVES NEEDED FROM NEW FIELDS	335	tcf	
<u>Undiscovered Recoverable Lower-48 States Gas Resources (mean)</u>			
Onshore and States Waters	190	tcf	-USGS
Federal Outer Continental Shelf	<u>142</u>	tcf	-MMS
TOTAL CONVENTIONAL UNDISCOVERED RESOURCES	332	tcf	
<u>Unconventional Gas Deposits</u>			
Continuous-type onshore clastic deposits	308	tcf	-USGS
Continuous-type onshore coal deposits	50	tcf	-USGS

NOTE: The amount of gas reserves needed from new fields (335 tcf) is greater than the total (mean) amount of undiscovered recoverable conventional gas resources assessed by the Department of the Interior (332 tcf).

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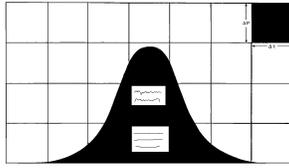
After receiving an M.S. in geology from the University of Wyoming in 1959, J.P. Riva worked in the Rocky Mountains as an exploration geologist for the Tenneco Oil Company. In 1966, he joined the Smithsonian Institution, specializing in energy and water resources research. In 1974 he moved to the congressional 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 sections 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), Westview Press; and Exploration Opportunities in Latin America (1992), and Petroleum Exploration Opportunities in the Former Soviet Union (1994), 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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July 1997



The M. KING HUBBERT CENTER FOR PETROLEUM SUPPLY STUDIES

Located in the Department of Petroleum Engineering
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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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