The Importance of Reserve Growth to the Nation's Supply of Natural Gas

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Introduction

Experience shows that initial estimates of the size of newly discovered oil or gas fields are usually too low. As years pass, successive estimates of the ultimate recovery of fields tend to increase. The term "reserve growth" refers to the typical increases in estimated ultimate recovery that occur as oil or gas fields are developed and produced (Arrington, 1960; Attanasi and Root, 1994).

An example for a particular field helps explain the nature of reserve growth. Figure 1 shows ultimate recovery for a large natural-gas field in Texas as estimated in each year from 1977 through 1991. This gas field was discovered in the mid-1940's. In 1977, its ultimate recovery was estimated to be 2.1 trillion cubic feet of gas (tcfg). One might think that after some 30 years of development and production, the resource potential of a field would be well understood. However, by 1991 the estimated ultimate recovery of this field had increased to 3.1 tcfg. Reserve growth over the 15-year period totaled 1.0 tcfg and shows no signs of stopping.

Historical Reserve-Growth Trends for Natural Gas

Increases of estimated ultimate recovery over time such as shown in figure 1 are typical of many United States gas fields. From 1978 through 1993, reserve growth of natural gas in existing United States fields totaled 205 tcfg, whereas initial size estimates of new-field discoveries totaled only 31 tcfg (fig. 2). (United States natural-gas production during the same time period totaled 277 tcfg.) From 1989 through 1993, reserve growth contributed about 15 tcfg/yr to United States proved gas reserves, whereas new-field discoveries added only about 1 tcfg/yr (fig. 2). In recent years, reserve growth has contributed far more to United States proved gas reserves than new-field discoveries.

Causes of Reserve Growth

Factors that contribute to reserve growth include (1) physical expansion of fields by areal extensions and development of new producing intervals, (2) improved recovery resulting from application of new technology and engineering methods, and (3) upward revisions of reserve calculations based on production experience and changing relations between price and cost. The causative factors that contribute to reserve growth are complex and interrelated, and have thus far resisted individual analysis. Estimates of the future reserve growth of a set of fields are at present usually based on empirical projections of past reserve-growth patterns.

U.S. Geological Survey (USGS) Estimates of Future Reserve Growth for Natural Gas

The USGS 1995 National Assessment of United States oil and gas resources (Gautier and others, 1995) was a scientifically based, unbiased analysis. In this assessment, the USGS estimated that 1,074 tcfg of technically recoverable natural gas remains in the United States (exclusive of Federal waters), of which 322 tcfg (30 percent of the total) is in the category of reserve growth of existing fields (fig. 3). By comparison, the ultimate technically recoverable volume of gas in conventional fields not yet discovered is estimated to be 259 tcfg (fig. 3).

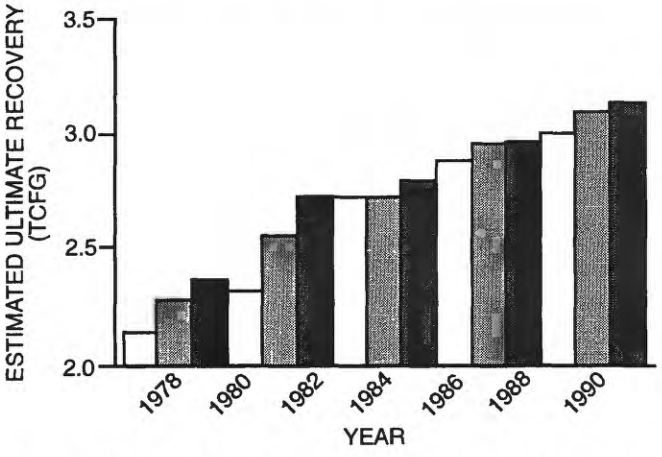

Figure 1. Estimates of ultimate recovery made in each year from 1977 through 1991 for a Texas gas field that was discovered in the mid-1940's. Reserve growth for this time period (the net increase in estimated ultimate recovery) totaled 1.0 trillion cubic feet of natural gas (tcfg). Successive estimates of field size are from unpublished data compiled by the U.S. Energy Information Administration.

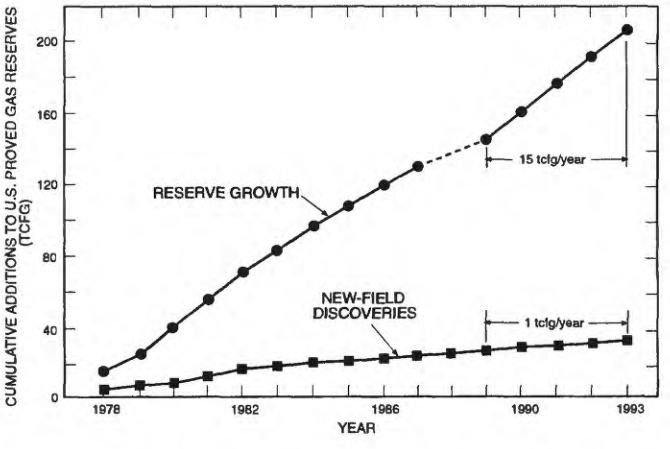

Figure 2. Cumulative additions to United States proved natural-gas reserves resulting from reserve growth and from initial size estimates of new-field discoveries. During the time period shown, reserve growth exceeded new-field discoveries by 174 trillion cubic feet of gas (tcfg). Graphs are from data compiled by the American Gas Association (1994).

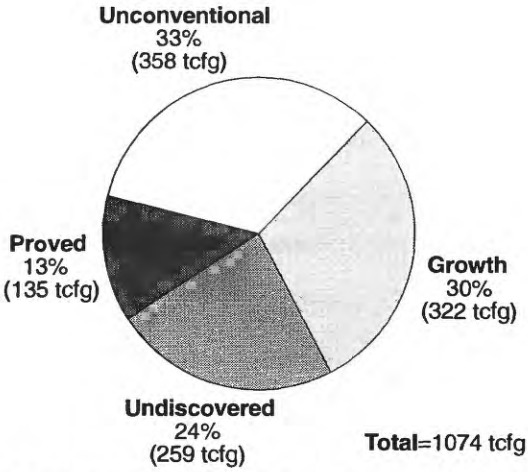

Figure 3. Assessment based on data as of 1994 of mean technically recoverable natural-gas resources remaining in the United States, exclusive of the Federal offshore (U.S. Geological Survey National Oil and Gas Resource Assessment Team, 1995). Reserve growth in fields already discovered is projected to add 322 trillion cubic feet of gas (tcfg) to proved reserves by the year 2071. Categories shown are for undiscovered (undiscovered conventional fields with growth of initial size estimates built in), growth (reserve growth in existing fields), unconventional (undeveloped portions of unconventional accumulations such as coalbed gas, basin-center gas, and gas in shales), and proved (proved reserves). Estimates include both nonassociated gas and associated/dissolved gas.

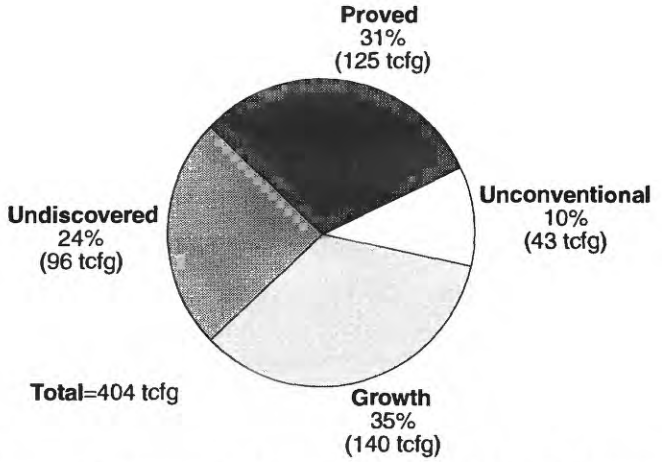

Figure 4. Assessment based on data as of 1994 of mean economically recoverable natural-gas resources remaining in the United States, exclusive of the Federal offshore and omitting Alaska. Economic assumptions are (1) gas in undiscovered conventional fields and in undeveloped portions of unconventional accumulations must be discovered, developed, and produced for $2.50 per thousand cubic feet of gas or less, and (2) gas in the category of reserve growth is economic if reserve-growth projections are not extended beyond 2015. Under this scenario, reserve growth of existing fields amounts to 35 percent of remaining United States economically recoverable gas resources. Figure is based on analyses of data from Attanasi, Gautier, and Root (1995), Attanasi and Rice (1995), and Attanasi, Schmoker, and Quinn (1995).

Placing economic constraints upon the assessment of technically recoverable resources significantly changes estimates of remaining natural gas. For an example based on a wellhead price of $2.50 per thousand cubic feet of gas coupled with reserve-growth projections only to the year 2015, the estimated total remaining United States gas resource drops from 1,074 tcfg (fig. 3) to 404 tcfg (fig. 4). The percentage attributed to reserve growth of existing fields increases from 30 percent to 35 percent. The reserve growth of gas remains extremely important to the Nation's energy future if one narrows the assessment scope from technically recoverable to economically recoverable gas resources (fig. 4).

Summary and Conclusions

Reserve growth is a major component—perhaps THE major component—of remaining United States natural-gas resources. Historical data (figs. 1, 2) support this premise, as do estimates of technically recoverable and of economically recoverable gas resources remaining in the United States (figs. 3, 4).

Yet, as Attanasi and Root (1994) emphasized when they referred to "the enigma of oil and gas field growth," reserve growth is poorly understood. Projections of future reserve growth in the United States carry large uncertainty. Much work remains to be done on the phenomenon of reserve growth, which is arguably the most significant research problem in the field of hydrocarbon resource assessment.

References

American Gas Association, 1994, Gas facts—1993 data: Policy Analysis and International Affairs Group, The American Gas Association, 1515 Wilson Boulevard, Arlington, VA 22209, 206 p.

Arrington, J.R., 1960, Predicting the size of crude reserves is key to evaluating exploration programs: Oil and Gas Journal, v. 58, no. 9 (February 29), p. 130-134.

Attanasi, E.D., Gautier, D.L., and Root, D.H., 1995, Economics and undiscovered conventional oil and gas accumulations in the 1995 National Assessment of U.S. oil and gas resources: U.S. Geological Survey Open-File Report 95-75H, 50 p.

Attanasi, E.D., and Rice, D.D., 1995, Economics and coalbed gas in the 1995 National Assessment of U.S. oil and gas resources: U.S. Geological Survey Open-File Report 95-75A, 22 p.

Attanasi, E.D., and Root, D.H., 1994, The enigma of oil and gas field growth: American Association of Petroleum Geologists Bulletin, v. 78, no. 3, p. 321-332.

Attanasi, E.D., Schmoker, J.W., and Quinn, J.C., 1995, Economics and continuous-type oil and gas accumulations in the 1995 National Assessment of U.S. oil and gas resources: U.S. Geological Survey Open-File Report 95-75F, 35 p.

Gautier, D.L., Dolton, G.L., Takahashi, K.I., and Varnes, K.L., eds., 1995, 1995 National Assessment of United States oil and gas resources—Results, methodology, and supporting data: U.S. Geological Survey Digital Data Series DDS-30.

U.S. Geological Survey National Oil and Gas Resource Assessment Team, 1995, 1995 National Assessment of United States oil and gas resources: U.S. Geological Survey Circular 1118, 20 p.

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