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Reserve-Growth Assessment Project

Assessment of Potential Additions to Conventional Oil and Gas Resources in Discovered Fields of the United States from Reserve Growth, 2012

The U.S. Geological Survey estimated volumes of technically recoverable, conventional petroleum resources that have the potential to be added to reserves from reserve growth in 70 discovered oil and gas accumulations of the United States, excluding Federal offshore areas. The mean estimated volumes are 32 billion barrels of crude oil, 291 trillion cubic feet of natural gas, and 10 billion barrels of natural gas liquids.

Introduction

The U.S. Geological Survey (USGS) estimated volumes of technically recoverable, conventional oil and gas resources that have the potential to be added to reserves (called "reserve growth" hereafter) in 70 discovered accumulations of the United States, excluding Federal offshore areas. Most reserve growth results from delineation of new reservoirs, field extensions, improved technology that enhances efficiency, and recalculation of reserves due to changing economic and operating conditions.

Unlike past estimates of reserve growth that relied entirely on statistical extrapolations of growth trends, this assessment is based in part on detailed analysis of geology and engineering practices used in the assessed producing accumulations. The assessment used published and commercial, proprietary sources of geologic information and field production data.

Pumps at Santa Fe Springs field, Los Angeles, California, U.S.A. Photograph by Ken Takahashi, U.S. Geological Survey, January 2011.

Methodology

In the past, the USGS estimated reserve growth by statistical curve-fitting, regression methods using historical data on known recoverable oil and gas (cumulative production plus remaining reserves). Those regression methods were based on growth rates averaged by the number of years since accumulation discovery. Accumulations within mature petroleum provinces that exhibit volumetrically significant reserve growth, however, cause bias regression models of the data. Therefore, accumulations that have grown by greater proportions than other accumulations of similar age are best analyzed separately from those with only minor reserve growth. Reserve growth in fields of the United States was analyzed to determine which fields contributed most to reserve growth between 1982 and 2006, using field- and reservoir-production data from a commercial, proprietary database.

The assessment methodology used to assess reserve growth in conventional accumulations of U.S. fields is described in Klett and others (2011). The primary data used to estimate reserve growth are original in-place volumes and recovery factors. Identified unconventional (continuous) oil and gas accumulations were excluded from the assessment.

Fifty-five large oil fields and 35 large gas fields significantly contributed to reserve growth during the time of the dataset. Within the 55 oil fields, 68 individual conventional accumulations (reservoirs or groups of reservoirs) were identified and assessed. Of the 35 gas fields, only 2 accumulations were individually assessed. Unconventional accumulations contributed to reserve growth in the remaining 33 gas fields, which were excluded from the assessment. Once the identified unconventional reservoirs were removed, many of the 33 gas fields showed little significant reserve growth and were assessed by regression methods.

Probability distributions were assigned to reported original in-place volumes and to reported recovery factors. The original in-place and recovery factor distributions assigned to a given accumulation were statistically combined (multiplied) by Monte Carlo simulation, and known recoverable volumes were subtracted to provide a probability distribution of estimated reserve growth. Estimates of reserve growth for each accumulation were aggregated together and aggregated with estimates of reserve growth calculated by regression methods.

Reserve growth of oil was assessed for oil accumulations (accumulations having a gas-to-oil ratio of less than 20,000 cubic feet of recoverable natural gas per barrel of recoverable crude oil), and nonassociated gas was assessed for only gas accumulations (20,000 cubic feet of recoverable natural gas per barrel of recoverable crude oil or more). Reserve growth of coproducts was calculated by statistical combination (multiplication) using Monte Carlo simulation of the reserve growth of the primary commodity (oil or gas) with the volumetric coproduct ratios. The growth of associated and dissolved gas, along with natural gas liquids in the associated and dissolved gas, was calculated for oil fields. The growth of oil plus natural gas liquids (total liquids) was calculated for nonassociated gas fields. Coproduct reserve growth was not estimated for fields having unreported coproduct volumes.

Growth of oil reserves in the 68 assessed individual oil accumulations accounts for about 70 percent of the potential reserve growth of the United States; the other 30 percent attributed to smaller accumulations was estimated by regression methods. Almost all of the reserve growth of nonassociated gas and liquids in gas accumulations was estimated by regression methods. Although identified unconventional accumulations were not included in the assessment, unrecognized unconventional accumulations, particularly gas in tight reservoirs, might have been included. Inclusion of unconventional accumulations greatly affects the assessment results by providing unrealistically large estimates.

Assessment Results

Estimated mean volumes of technically recoverable, conventional oil and gas resources of the United States that have the potential to be added to reserves from reserve growth are listed in table 1. The estimates are about 32 billion barrels (BB) of crude oil, 291 trillion cubic feet (TCF) of natural gas (50 TCF of associated and dissolved natural gas and 241 TCF of nonassociated natural gas), and 10 BB of natural gas liquids (3 BB of natural gas liquids in oil accumulations and 7 BB of total liquids in nonassociated gas accumulations). No attempt was made to estimate economically recoverable resources. Continuous, or unconventional, oil and gas accumulations, such as shale gas, tight gas, tight oil, and tar sands, were not included in this study.

Table 1. Estimated reserve growth of discovered accumulations of the United States (technically recoverable, conventional petroleum resources).

[BB, billion barrels; TCF, trillion cubic feet. For gas fields, all liquids are included under the natural gas liquids (NGL) category. Accums., accumulations. F95 denotes a 95-percent chance of at least the amount tabulated. Other fractiles are defined similarly. Negative values indicate the possibility that reported reserves could decrease. Fractiles are not additive except under the assumption of perfect positive correlation. Gray shading indicates not applicable]

Reserve growth by assessment method for discovered fields of the United States	Field type	Number of accums.	Estimated reserve growth											
			Oil (BB)				Gas (TCF)				NGL (BB)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Individual accumulation analysis	Oil	68				22				32				2
	Gas	2								0.3				-0.2
Regression method	Oil	9,168				10				18				1
	Gas	5,169								241				7
Aggregated reserve growth by commodity	Oil	9,236	23	31	41	32	39	50	62	50	2	3	4	3
	Gas	5,171					187	240	298	241	6	7	9	7
Total reserve growth		**14,407**				**32**				**291**				**10**

Estimated mean volumes of technically recoverable, conventional oil and gas resources of U.S. regions that have the potential to be added to reserves from reserve growth are listed in table 2. They are as follows:

1. For the combined Alaska and the Pacific regions, about 20,210 million barrels (MMB) of crude oil, 31,921 billion cubic feet (BCF) of natural gas (23,717 BCF of associated and dissolved natural gas and 8,204 BCF of nonassociated natural gas), and 1,466 MMB of natural gas liquids (1,443 MMB of natural gas liquids in oil accumulations and 23 MMB of total liquids in nonassociated gas accumulations).

2. For the Colorado Plateau and Basin and Range region, which was combined with the Rocky Mountains and Northern Great Plains region, about 1,730 MMB of crude oil, 18,434 BCF of natural gas (2,359 BCF of associated and dissolved natural gas and 16,075 BCF of nonassociated natural gas), and 561 MMB of natural gas liquids (149 MMB of natural gas liquids in oil accumulations and 412 MMB of total liquids in nonassociated gas accumulations).

3. For the West Texas and Eastern New Mexico region, about 4,855 MMB of crude oil, 51,721 BCF of natural gas (13,601 BCF of associated and dissolved natural gas and 38,120 BCF of nonassociated natural gas), and 2,699 MMB of natural gas liquids (881 MMB of natural gas liquids in oil accumulations and 1,818 MMB of total liquids in nonassociated gas accumulations).

4. For the Gulf Coast region, about 3,448 MMB of crude oil, 143,557 BCF of natural gas (8,576 BCF of associated and dissolved natural gas and 134,981 BCF of nonassociated natural gas), and 4,814 MMB of natural gas liquids (412 MMB of natural gas liquids in oil accumulations and 4,402 MMB of total liquids in nonassociated gas accumulations).

5. For the combined Midcontinent and Eastern regions, about 1,522 MMB of crude oil, 45,318 BCF of natural gas (1,561 BCF of associated and dissolved natural gas and 43,757 BCF of nonassociated natural gas), and 788 MMB of natural gas liquids (89 MMB of natural gas liquids in oil accumulations and 699 MMB of total liquids in nonassociated gas accumulations).

The combined Alaska and the Pacific Coast regions should have the greatest amount of oil reserve growth, whereas the Gulf Coast region should have the greatest amount of gas reserve growth.

For Further Information

Supporting geologic studies of total petroleum systems and assessment units, and reports on the methodology used in this assessment of the world outside the United States, as well as the assessment results, are available at the USGS Energy website: *http://energy.usgs.gov/*.

Table 2. Estimated reserve growth of discovered accumulations in regions of the United States (technically recoverable, conventional petroleum resources).

[MMB, million barrels; BCF, billion cubic feet. For gas fields, all liquids are included under the natural gas liquids (NGL) category. F95 denotes a 95-percent chance of at least the amount tabulated. Other fractiles are defined similarly. Negative values indicate the possibility that reported reserves could decrease. Fractiles are not additive except under the assumption of perfect positive correlation. Gray shading indicates not applicable]

Regions of the United States	Field type	Number of fields	Estimated reserve growth											
			Oil (MMB)				Gas (BCF)				NGL (MMB)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Alaska and Pacific Coast	Oil	296	12,849	19,894	28,603	20,210	15,347	23,439	33,016	23,717	900	1,426	2,043	1,443
	Gas	154					4,021	7,867	13,479	8,204	11	22	38	23
Total		**450**				**20,210**				**31,921**				**1,466**
Colorado Plateau and Basin and Range, and Rocky Mountains and Northern Great Plains	Oil	1,402	1,287	1,712	2,223	1,730	1,823	2,335	2,961	2,359	116	148	186	149
	Gas	243					6,541	14,810	29,529	16,075	168	379	756	412
Total		**1,645**				**1,730**				**18,434**				**561**
West Texas and Eastern New Mexico	Oil	2,511	2,952	4,786	6,983	4,855	10,181	13,521	17,319	13,601	607	873	1,184	881
	Gas	774					25,407	37,256	53,613	38,120	1,212	1,777	2,557	1,818
Total		**3,285**				**4,855**				**51,721**				**2,699**
Gulf Coast	Oil	2,239	2,671	3,422	4,310	3,448	6,766	8,515	10,555	8,576	320	409	514	412
	Gas	2,712					98,050	134,783	172,103	134,981	3,195	4,395	5,612	4,402
Total		**4,951**				**3,448**				**143,557**				**4,814**
Midcontinent and Eastern	Oil	2,788	1,146	1,503	1,962	1,522	1,228	1,546	1,944	1,561	-22	79	230	89
	Gas	1,288					28,738	43,055	61,280	43,757	409	687	1,032	699
Total		**4,076**				**1,522**				**45,318**				**788**

Reference Cited

Klett, T.R., Attanasi, E.D., Charpentier, R.R., Cook, T.A., Freeman, P.A., Gautier, D.L., Le, P.A., Ryder, R.T., Schenk, C.J., Tennyson, M.E., and Verma, M.K., 2011, New U.S. Geological Survey method for the assessment of reserve growth: U.S. Geological Survey Scientific Investigations Report 2011-5163, 8 p., accessed August 1, 2012, at *http://pubs.usgs.gov/sir/2011/5163/*.

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