

2. Overview

National Summary

The United States had the following proved reserves as of December 31, 1999:

- **Crude Oil — 21,765 million barrels**
- **Dry Natural Gas — 167,406 billion cubic feet**
- **Natural Gas Liquids — 7,906 million barrels.**

This Overview summarizes the 1999 proved reserves balances of crude oil, dry natural gas, and natural gas liquids on a National level and provides historical comparisons between 1999 and years past.

Table 1 lists the estimated annual reserve balances since 1989. From 1998 to 1999, proved reserves of crude oil increased by 3.5 percent—the largest percentage increase in the 23-year EIA reserves program. Proved reserves of dry natural gas increased by 2 percent. Natural gas liquids reserves increased 5 percent.

Crude Oil

Proved reserves of crude oil increased by 731 million barrels in 1999. **Figure 1** shows the crude oil proved reserves levels by major region and **Figure 2** shows the components of reserves changes from 1989 through 1999.

As shown in **Figure 2**, total reserve additions (the positive side of the scale) were up substantially in 1999, due primarily to the substantial difference in oil prices seen in December 1998 and December 1999. Operators replaced 137 percent of the 1999 oil production with reserve additions. Production of crude oil (the negative side of the scale of **Figure 2**) declined slightly for the eighth year in a row.

Total discoveries are those reserves attributable to field extensions, new field discoveries, and new reservoir discoveries in old fields. There were 725 million barrels of total discoveries of crude oil proved reserves in 1999. This is 21 percent more than what was discovered in 1998, but still 3 percent less than what was discovered on average in the prior 10 years.

Extensions added 259 million barrels of proved reserves. This is 21 percent less than in 1998 (327 million barrels) and 40 percent less than the average extensions in the prior 10 years (433 million barrels).

New field discoveries were 321 million barrels, more than double the 1998 level and 74 percent more than the average volume discovered in the prior 10 years (184 million barrels). New field discoveries in Alaska and the Gulf of Mexico Federal Offshore made up 99 percent of the 1999 volume of new field discoveries.

New reservoir discoveries in old fields added 145 million barrels of proved reserves. This is more than the 1998 level (120 million barrels) and the prior 10-year average for the United States (135 million barrels).

Net revisions and adjustments added 1,958 million barrels of proved reserves. This is substantially more than 1998's -120 million barrels, which was the first negative total for net revisions and adjustments for crude oil since EIA began collecting this data. In the past 10 years, net revisions and adjustments have added an average of 986 million barrels of crude oil proved reserves per year. Revisions include sales and acquisitions.

Production removed an estimated 1,952 million barrels of proved reserves from the National total. Production was down 2 percent from 1998's level (1,991 million barrels), and down 16 percent from the prior 10-year average (2,317 million barrels).

Natural Gas

U.S. proved reserves of dry natural gas increased 2 percent, resuming an increasing trend that began 5 years ago but was interrupted by a decline in 1998. Dry natural gas reserves increased by 3,558 billion cubic feet in the Lower 48 States, and in Alaska declined by 193 billion cubic feet. **Figure 3** shows the dry natural gas proved reserves levels by major region and **Figure 4** shows the components of reserves changes from 1989 through 1999. Dry natural gas production increased 1 percent from 1998 to 1999. Operators were able to replace 118 percent of 1999's dry gas production with new reserves.

For 1999, U.S. total discoveries of dry gas reserves were 10,807 billion cubic feet, down 5 percent from 1998, but almost equal the average annual volume discovered in the past 10 years. Total discoveries were 48 percent of all reserve additions in 1999.

Table 1. Total U.S. Proved Reserves of Crude Oil, Dry Natural Gas, and Natural Gas Liquids, 1989-1999

Year	Adjustments (1)	Revision Increases (2)	Revision Decreases (3)	Revisions ^a and Adjustments (4)	Extensions (5)	New Field Discoveries (6)	New Reservoir Discoveries in Old Fields (7)	Total ^b Discoveries (8)	Estimated Production (9)	Proved ^c Reserves 12/31 (10)	Change from Prior Year (11)
Crude Oil (million barrels of 42 U.S. gallons)											
1989	213	2,698	1,365	1,546	514	112	90	716	2,586	26,501	-324
1990	86	2,483	1,000	1,569	456	98	135	689	2,505	26,254	-247
1991	163	2,097	1,874	386	365	97	92	554	2,512	24,682	-1,572
1992	290	1,804	1,069	1,025	391	8	85	484	2,446	23,745	-937
1993	271	2,011	1,516	766	356	319	110	785	2,339	22,957	-788
1994	189	2,364	1,357	1,196	397	64	111	572	2,268	22,457	-500
1995	122	1,823	795	1,150	500	114	343	957	2,213	22,351	-106
1996	175	1,723	986	912	543	243	141	927	2,173	22,017	-334
1997	520	1,998	1,084	1,434	477	637	119	1,233	2,138	22,546	+529
1998	-638	2,752	2,234	-120	327	152	120	599	1,991	21,034	-1,512
1999	139	6,284	4,465	1,958	259	321	145	725	1,952	21,765	+731
Dry Natural Gas (billion cubic feet, 14.73 psia, 60° Fahrenheit)											
1989	3,013	26,673	23,643	6,043	6,339	1,450	2,243	10,032	16,983	167,116	-908
1990	1,557	18,981	13,443	7,095	7,952	2,004	2,412	12,368	17,233	169,346	+2,230
1991	2,960	19,890	15,474	7,376	5,090	848	1,604	7,542	17,202	167,062	-2,284
1992	2,235	18,055	11,962	8,328	4,675	649	1,724	7,048	17,423	165,015	-2,047
1993	972	17,597	12,248	6,321	6,103	899	1,866	8,868	17,789	162,415	-2,600
1994	1,945	21,365	15,881	7,429	6,941	1,894	3,480	12,315	18,322	163,837	+1,422
1995	580	20,465	12,731	8,314	6,843	1,666	2,452	10,961	17,966	165,146	+1,309
1996	3,785	17,132	13,046	7,871	7,757	1,451	3,110	12,318	18,861	166,474	+1,328
1997	-590	21,658	16,756	4,312	10,585	2,681	2,382	15,648	19,211	167,223	+749
1998	-1,635	28,003	22,263	4,105	8,197	1,074	2,162	11,433	18,720	164,041	-3,182
1999	982	42,167	31,663	11,486	7,043	1,568	2,196	10,807	18,928	167,406	+3,365
Natural Gas Liquids (million barrels of 42 U.S. gallons)											
1989	-277	1,143	1,020	-154	259	83	74	416	731	7,769	-469
1990	-83	827	606	138	299	39	73	411	732	7,586	-183
1991	233	825	695	363	189	25	55	269	754	7,464	-122
1992	225	806	545	486	190	20	64	274	773	7,451	-13
1993	102	764	640	226	245	24	64	333	788	7,222	-229
1994	43	873	676	240	314	54	131	499	791	7,170	-52
1995	192	968	691	469	432	52	67	551	791	7,399	+229
1996	474	844	669	649	451	65	109	625	850	7,823	+424
1997	-15	1,199	910	274	535	114	90	739	864	7,973	+150
1998	-361	1,302	1,094	-153	383	66	88	537	833	7,524	-449
1999	99	2,048	1,321	826	313	51	88	452	896	7,906	+382

^aRevisions and adjustments = Col. 1 + Col. 2 - Col. 3.

^bTotal discoveries = Col. 5 + Col. 6 + Col. 7.

^cProved reserves = Col. 10 from prior year + Col. 4 + Col. 8 - Col. 9.

Notes: Old means discovered in a prior year. New means discovered during the report year. The production estimates in this table are based on data reported on Form EIA-23, "Annual Survey of Domestic Oil and Gas Reserves" and Form EIA-64A, "Annual Report of the Origin of Natural Gas Liquids Production." They may differ from the official EIA production data for crude oil, natural gas, and natural gas liquids for 1999 contained in the *Petroleum Supply Annual 1999*, DOE/EIA-0340(99) and the *Natural Gas Annual 1999*, DOE/EIA-0131(99).

Sources: *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves*, 1989 through 1999 annual reports, DOE/EIA-0216.

Figure 1. U.S. Crude Oil Proved Reserves, 1989-1999

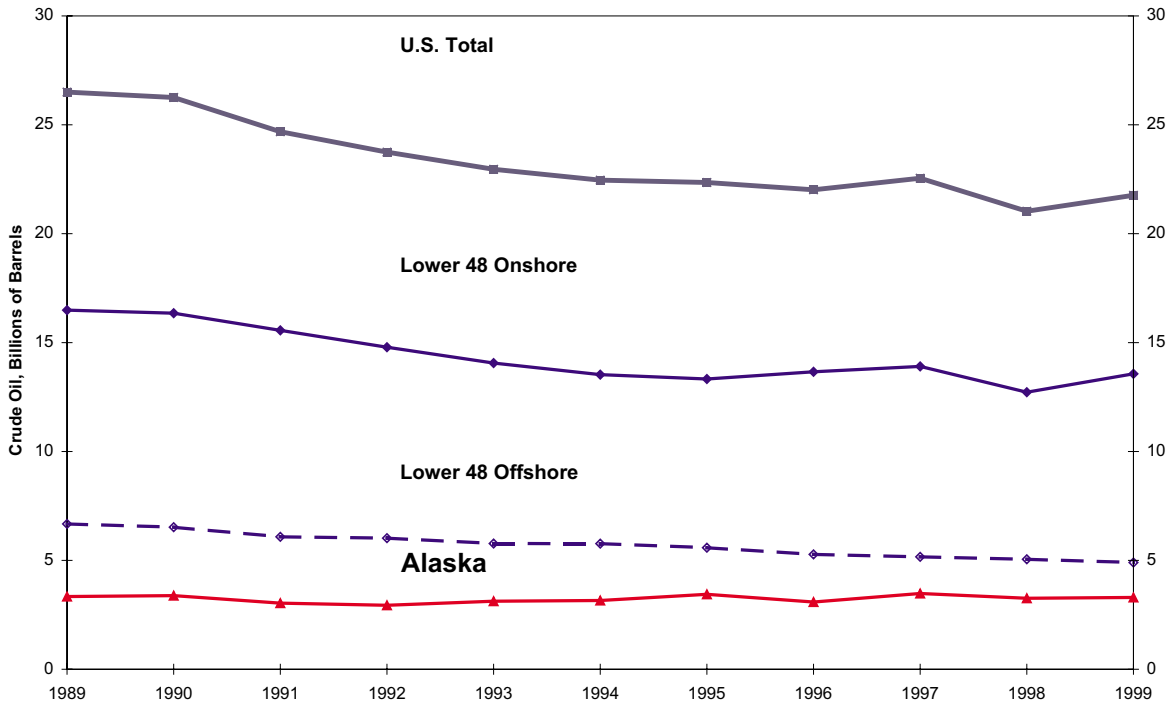
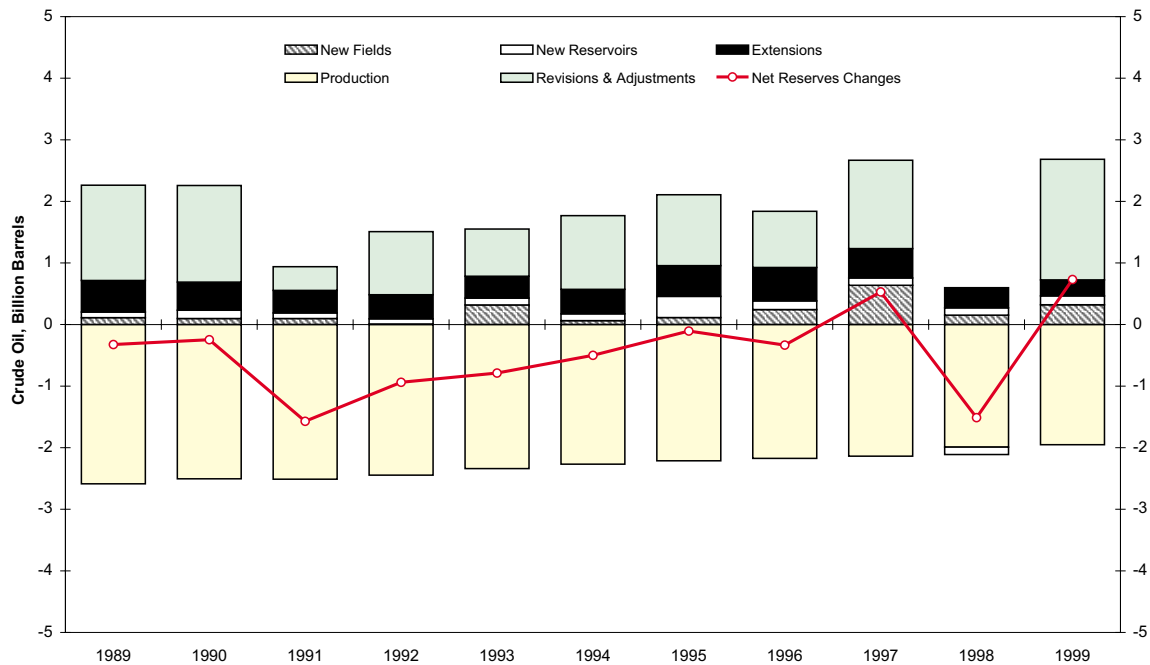


Figure 2. Components of Reserves Changes for Crude Oil, 1989-1999



Source: U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 1989-1999 annual reports, DOE/EIA-0216.{12-22}

Figure 3. U.S. Dry Natural Gas Proved Reserves, 1989-1999

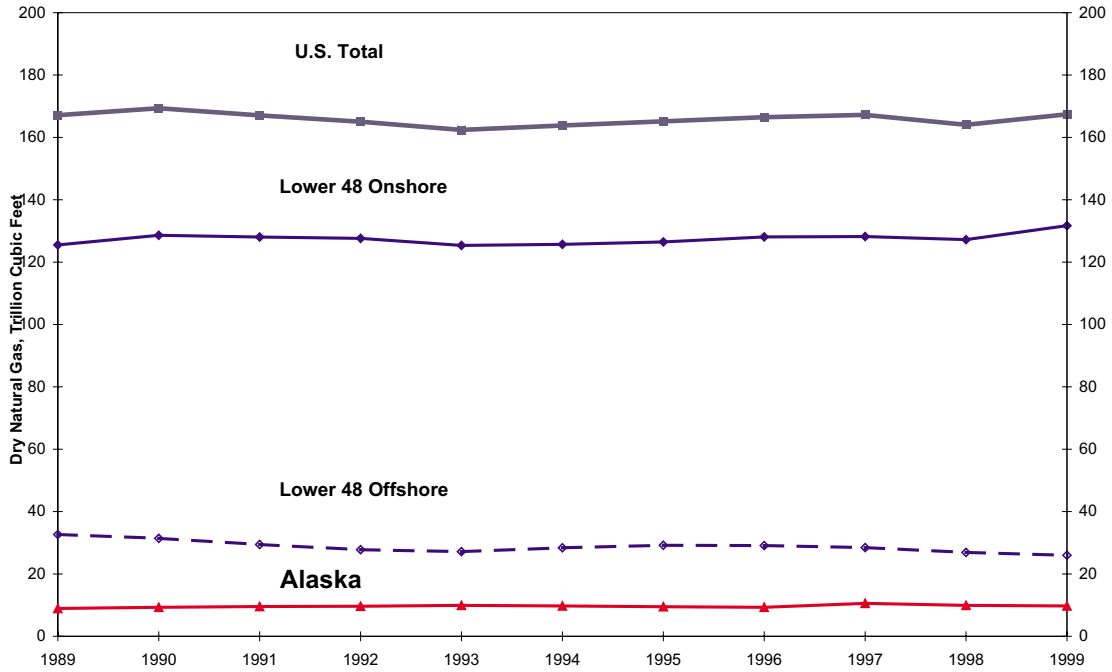
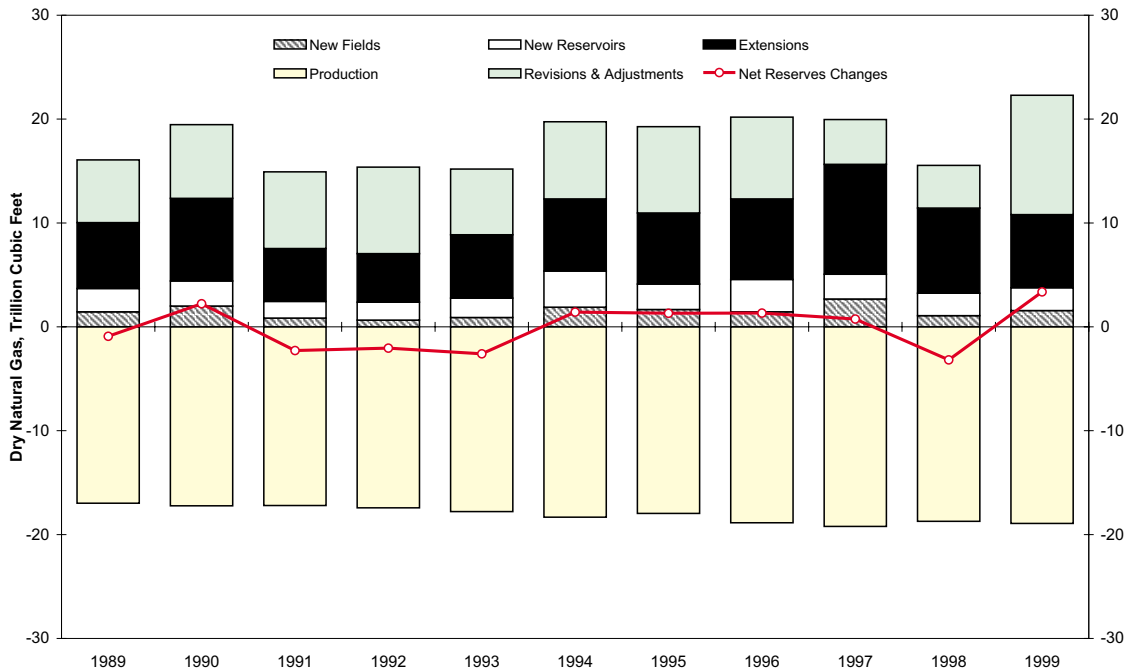


Figure 4. Components of Reserves Changes for Dry Natural Gas, 1989-1999



Source: U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 1989-1999 annual reports, DOE/EIA-0216.{12-22}

Extensions added 7,043 billion cubic feet of proved reserves. This is 14 percent less than 1998's *extensions* but is comparable to the average of *extensions* in the prior 10 years (7,048 billion cubic feet).

New field discoveries added 1,568 billion cubic feet of proved reserves. This is 46 percent higher than what was discovered in 1998 and 7 percent higher than the average volume discovered in the prior 10 years (1,462 billion cubic feet).

New reservoir discoveries in old fields added 2,196 billion cubic feet of proved reserves. This is 2 percent more than the volume discovered in 1998, and 6 percent lower than the prior 10-year average (2,344 billion cubic feet).

Net revisions and adjustments added 11,486 billion cubic feet of proved reserves. This is 180 percent more than 1998's revisions and adjustments and 71 percent more than the prior 10-year average (6,719 billion cubic feet). Revisions include sales and acquisitions.

Production removed an estimated 18,928 billion cubic feet of proved reserves from the National total. Dry gas production increased 1 percent compared to 1998.

Coalbed methane gas production and reserves are included in the 1999 totals. However, EIA separately tracks these reserves in order to record the development and performance of this gas source. Coalbed methane reserves increased in 1999 to a volume of 13,229 billion cubic feet. Coalbed methane accounted for 8 percent of 1999 U.S. dry natural gas reserves and 7 percent of 1999 U.S. dry gas production.

Natural Gas Liquids

Proved reserves of natural gas liquids increased 382 million barrels to 7,906 million barrels during 1999—a 5 percent increase from 1998 levels. **Figure 5** shows the natural gas liquids proved reserves levels by major region and **Figure 6** shows the components of reserves changes from 1989 through 1999.

Operators replaced 143 percent of their 1999 natural gas liquids production with reserve additions. *Total discoveries* added 452 million barrels, and *net revisions and adjustments* added 826 million barrels.

Total proved reserves of liquid hydrocarbons (crude oil plus natural gas liquids) were 29,671 million barrels in 1999—a 4 percent increase from the 1998 level. Natural

gas liquids represented 27 percent of total liquid hydrocarbon proved reserves in 1999.

Reserves Changes Since 1977

EIA has collected oil and gas reserves estimates annually since 1977. **Table 2** lists the cumulative totals of the components of reserves changes for crude oil and dry natural gas from 1978 through 1999. **Table 2** contains two sections, one for the lower 48 States and another for the U.S. total (which includes Alaska's contribution). Annual averages for each component of reserves changes are also listed, along with the percentage of that particular component's impact on total U.S. proved reserves. In this section, we compare these averages to the 1999 proved reserves estimates as a means of gauging the past year against history.

Crude Oil: Since 1977 U.S. operators have:

- discovered an average of 800 million barrels per year of new reserves
- revised and adjusted their proved reserves upward by an average of 1,328 million barrels per year from *revisions and adjustments*
- ended each year with an average net reduction in U.S. proved reserves of 508 million barrels (the difference between post-1976 average annual production and post-1976 average annual reserve additions) because production has outpaced reserve additions.

Since 1977, crude oil reserves have been primarily sustained by the extension and development of existing fields (called field growth, reserves growth, or the EIA preferred term: proved ultimate recovery appreciation; see the Proved Ultimate Recovery section later in this chapter) rather than the discovery of new oil fields. Only 8 percent of reserves additions since 1976 were booked as *new field discoveries*. Proved ultimate recovery appreciation is the sum of net revisions and adjustments, extensions, and new reservoirs in old fields. Since 1977, the largest component of proved ultimate recovery appreciation for crude oil is upward *revisions and adjustments*, which accounted for 62 percent of all crude oil reserves additions. The 18,393 million barrels of *total discoveries* accounted for the remaining 38 percent of reserves additions.

Compared to the average reserves changes since 1977, 1999 was a down year for crude oil discoveries. *Total discoveries* of crude oil (725 million barrels) in 1999 were 9 percent less the post-1976 U.S. average. In 1999, *net*

Figure 5. U.S. Natural Gas Liquids Proved Reserves, 1989-1999

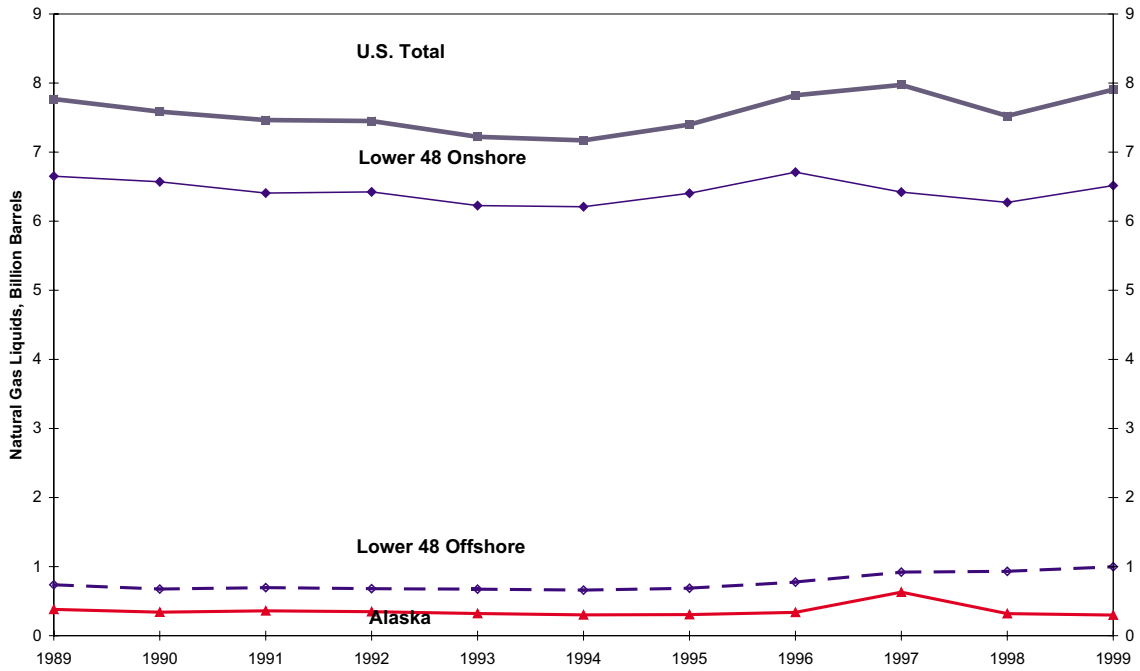
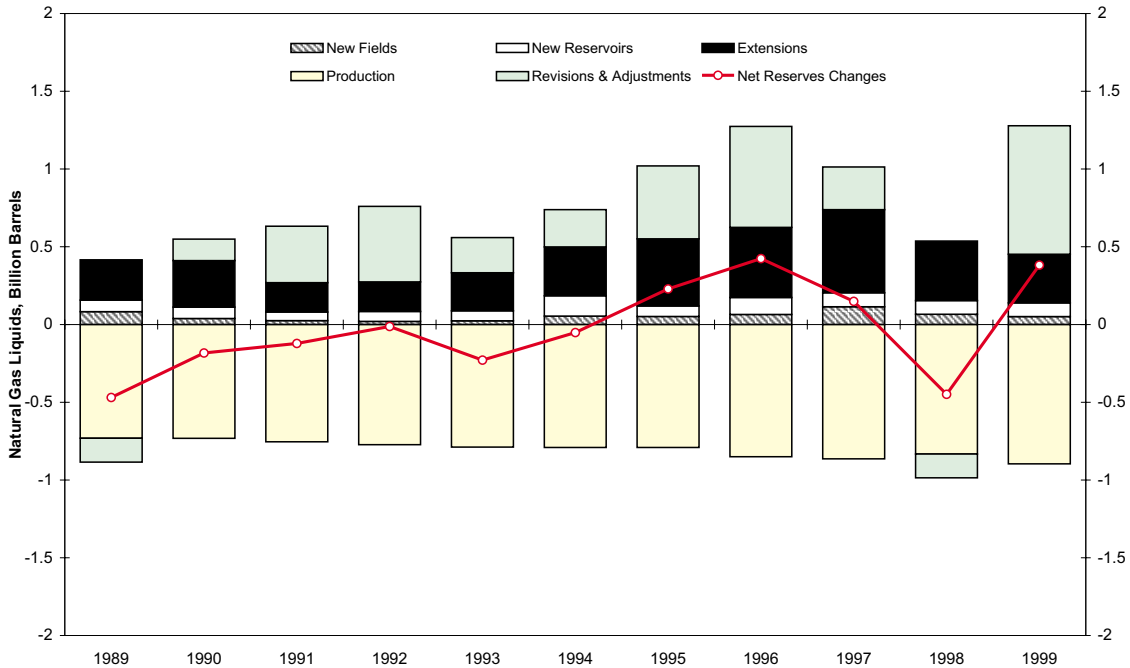


Figure 6. Components of Reserves Changes for Natural Gas Liquids, 1989-1999



Source: U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 1989-1999 annual reports, DOE/EIA-0216.(12-22)

Table 2. Reserves Changes, 1977-1999

Components of Change	Lower 48 States			U.S. Total		
	Volume	Average per Year	Percent of Reserve Additions	Volume	Average per Year	Percent of Reserve Additions
Crude Oil (million barrels of 42 U.S. gallons)						
Proved Reserves as of 12/31/76	24,928	—	—	33,502	—	—
New Field Discoveries	3,285	143	8.3	3,955	172	8.1
New Reservoir Discoveries in Old Fields	3,144	137	8.0	3,174	138	6.5
Extensions	10,109	440	25.7	11,264	490	23.1
Total Discoveries	16,538	719	42.0	18,393	800	37.7
Revisions and Adjustments	22,831	993	58.0	30,458	1,324	62.3
Total Reserve Additions	39,369	1,712	100.0	48,851	2,124	100.0
Production	47,432	2,062	120.5	60,588	2,634	124.0
Net Reserve Change.	-8,063	-351	-20.5	-11,737	-510	-24.0
Dry Natural Gas (billion cubic feet at 14.73 psia and 60° Fahrenheit)						
Proved Reserves as of 12/31/76	180,838	—	—	213,278	—	—
New Field Discoveries	44,149	1,920	11.7	44,297	1,926	12.2
New Reservoir Discoveries in Old Fields	58,473	2,542	15.5	58,861	2,559	16.3
Extensions	171,296	7,448	45.5	172,215	7,488	47.6
Total Discoveries	273,918	11,909	72.7	275,373	11,973	76.1
Revisions and Adjustments	102,808	4,470	27.3	86,600	3,765	23.9
Total Reserve Additions	376,726	16,379	100.0	361,973	15,738	100.0
Production	399,892	17,387	106.1	407,845	17,732	112.7
Net Reserve Change.	-23,166	-1,007	-6.1	-45,872	-1,994	-12.7

Source: U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves 1977-1999 annual reports, DOE/EIA-0216.{1-22}

revisions and adjustments were 47 percent higher than the post-1976 U.S. Average.

Looking at the components of *total discoveries* in 1999:

- both *new field discoveries* and *new reservoir discoveries in old fields* exceeded the post-1976 averages for crude oil, and
- 1999's extensions fell far short of the post-1976 average -- enough to result in the 9 percent decline in *total discoveries*.

Dry Natural Gas: Since 1977, U.S. operators:

- discovered an average of 11,972 billion cubic feet per year of new reserves
- revised and adjusted their proved reserves upward by an average 3,759 billion cubic feet per year
- had an average net reduction in U.S. reserves of 2,001 billion cubic feet per year.

Like crude oil reserves, natural gas reserves have been sustained primarily by proved ultimate recovery appreciation since 1977. Usually *extensions* rather than

net revisions and adjustments are the largest component. *Extensions* account for 48 percent while *net revisions and adjustments* account for only 24 percent of all reserve additions since 1977. In 1999, *net revisions and adjustments* were 52 percent of all reserves additions. In 1999, *extensions* were 32 percent of all reserves additions.

Compared to the average reserves changes since 1977, 1999 was a below average year for natural gas reserve additions from *total discoveries*. U.S. total dry natural gas reserves increased 2 percent, resuming an increasing trend. Operators reported 10,807 billion cubic feet of *total discoveries* of dry natural gas proved reserves—10 percent less than the post-1976 average (11,972 billion cubic feet). However, *net revisions and adjustments* were substantially more in 1999 (11,486 billion cubic feet) compared to the post-1976 U.S. Average (3,759 billion cubic feet).

Table 3. U.S. Average Annual Domestic First Purchase Prices for Crude Oil, Wellhead Prices for Natural Gas, and the Average Number of Active Rotary Drilling Rigs, 1977-1999

Year	Crude Oil		Natural Gas		Number of Rigs
	Current	1999 Constant	Current	1999 Constant	
	(dollars per barrel)		(dollars per thousand cubic feet)		
1977	8.57	20.38	0.79	1.88	2,001
1978	9.00	19.89	0.91	2.01	2,259
1979	12.64	25.76	1.18	2.40	2,177
1980	21.59	40.28	1.59	2.97	2,909
1981	31.77	54.33	1.98	3.39	3,970
1982	28.52	45.85	2.46	3.95	3,105
1983	26.19	40.38	2.59	3.99	2,232
1984	25.88	38.43	2.66	3.95	2,428
1985	24.09	34.54	2.51	3.60	1,980
1986	12.51	17.49	1.94	2.71	964
1987	15.40	20.89	1.67	2.26	936
1988	12.58	16.47	1.69	2.21	936
1989	15.86	19.93	1.69	2.12	869
1990	20.03	24.12	1.71	2.06	1,010
1991	16.54	19.16	1.64	1.90	860
1992	15.99	18.02	1.74	1.96	721
1993	14.25	15.65	2.04	2.24	754
1994	13.19	14.14	1.85	1.98	775
1995	14.62	15.33	1.55	1.62	723
1996	18.46	19.00	2.17	2.23	779
1997	17.23	17.40	2.32	2.34	943
1998					
January	13.45	13.72	1.95	1.99	993
February	12.17	12.41	1.95	1.99	974
March	11.15	11.36	2.05	2.09	932
April	11.28	11.48	2.15	2.19	886
May	11.13	11.31	2.04	2.07	855
June	10.00	10.15	1.90	1.93	854
July	10.44	10.58	2.08	2.11	816
August	10.20	10.33	1.81	1.83	792
September	11.29	11.42	1.69	1.71	774
October	11.32	11.45	1.85	1.87	734
November	9.64	9.74	1.93	1.95	688
December	8.03	8.10	1.94	1.96	647
1998	10.87	11.03	1.94	1.97	827
1999					
January	8.59	8.64	1.80	1.81	587
February	8.58	8.62	1.73	1.74	542
March	10.75	10.78	1.70	1.71	526
April	12.84	12.87	1.93	1.93	496
May	13.84	13.85	2.10	2.10	516
June	14.34	14.34	2.09	2.09	558
July	16.13	16.14	2.07	2.07	588
August	17.58	17.60	2.34	2.34	639
September	20.10	20.12	2.42	2.42	696
October	19.21	19.73	2.31	2.31	741
November	21.35	21.39	2.44	2.44	782
December	22.55	22.60	2.03	2.03	798
1999	15.56	15.56	2.08	2.08	625

=Revised data.

Sources: Current dollars and number of rigs: *Monthly Energy Review August 2000*, DOE/EIA-0035(00/08). 1999 constant dollars: U.S. Department of Commerce, Bureau of Economic Analysis, Gross Domestic Product Implicit Price Deflators, August 2000.

Economics and Drilling

Economics: Price matters. In 1999, resurgent crude oil prices generated the largest positive net revisions to proved reserves in over a decade. This section describes the price behavior in 1999 and the following section addresses drilling.

Table 3 lists the average annual domestic wellhead prices of crude oil and natural gas, as well as the average number of active rotary drilling rigs, from 1970 to 1999.

The U.S. crude oil first purchase price started at an average of \$8.03 per barrel in December 1998 (an inflation-adjusted 53-year low), then accelerated during the year, reaching \$22.55 per barrel in December 1999. The average U.S. crude oil first purchase price increased from an average \$10.87 in 1998 to \$15.56 per barrel in 1999. The price increases continue in the year 2000.

Oil prices vary by region. In Texas the average 1999 crude oil first purchase price was \$17.29 per barrel, while in California it was \$14.08 per barrel, and only \$12.46 per barrel on the Alaskan North Slope. The lowest average crude oil first purchase price in 1999 was for Federal Offshore California oil—\$11.78 per barrel. {23}

The average annual wellhead natural gas price increased from \$1.94 in 1998 to \$2.08 per thousand cubic feet in 1999. Natural gas prices started at \$1.80 per thousand cubic feet in January 1999 and rose to \$2.44 per thousand cubic feet by November 1999 (the highest average price of the year). The price increases continue in 2000, passing \$3.00 per thousand cubic feet in June 2000. {24}

Drilling: From 1998 to 1999, the annual average active rig count decreased from 827 to 625 (**Table 3**), a 24 percent decline in active rigs. The rig count remains well below the peak activity level of the early 80's. Operators are now using significantly improved drilling and seismic exploration technology to dramatically increase their drilling success rate.

Looking first at exploratory wells, there were 2,123 exploratory wells drilled in 1999 (**Table 4**). Of these, 7 percent were oil wells, 27 percent were gas wells, and 66 percent were dry holes. The total (which includes dry holes) was 21 percent less than in 1998.

There were 1 percent more exploratory gas wells (**Figure 7**) and 50 percent fewer exploratory oil wells

(**Figure 8**) than in 1998. The number of successful development wells decreased 42 percent for oil and decreased 14 percent for gas from 1998.

Figures 9 and 10 show the average volume of discoveries per exploratory well for dry natural gas and oil, respectively, since 1977. The average volume of gas discoveries per exploratory well decreased slightly, while the average volume of oil discoveries per exploratory well in 1999 increased. Altogether there were an estimated 18,180 exploratory and development wells drilled in 1999, 25 percent less than in 1998 and 28 percent less than the average number of wells drilled annually in the prior 10 years (25,328).

For the seventh year in a row, the number of gas well completions exceeded the number of oil well completions in both the exploratory and development categories.

Mergers and Acquisitions

Not all the notable activity in 1999 occurred in frontier drilling areas. Some occurred around the boardroom tables of major oil and gas corporations. The following large mergers were announced in 1999, and are expected to have a major impact on the energy industry in the future:

On November 30, 1999, Exxon Corporation and Mobil Corporation confirmed that the U.S. Federal Trade Commission (FTC) completed its review of the proposed merger and has approved a consent order for the merger of the two companies. Exxon and Mobil have accepted terms and conditions specified by the FTC and will comply with them fully and in a timely manner. The merged ExxonMobil Corporation expects that the scale of the worldwide near-term cost savings and the long-term strategic benefits will likely exceed those announced last year. The FTC's review was one of the most thorough and exhaustive ever undertaken, lasting some 11 months. Exxon and Mobil worked closely with the FTC to provide appropriate information on a timely basis to facilitate regulatory review of the merger. {25}

On August 17, 1999 Devon Energy Corporation and PennzEnergy Company announced that their merger had been completed. The merger was announced on May 20, 1999. Shareholders of both companies approved the merger at special meetings of shareholders on August 17, 1999. PennzEnergy shareholders will own approximately 31 percent of the

Table 4. U.S. Exploratory and Development Well Completions,^a 1970-1999

Year	Exploratory ^b				Total Exploratory and Development ^b			
	Oil	Gas	Dry	Total	Oil	Gas	Dry	Total
1970	763	478	6,193	7,434	13,043	4,031	11,099	28,173
1971	664	472	5,995	7,131	11,903	3,983	10,382	26,268
1972	690	659	6,202	7,551	11,437	5,484	11,013	27,934
1973	642	1,067	5,952	7,661	10,167	6,933	10,320	27,420
1974	859	1,190	6,833	8,882	13,647	7,138	12,116	32,901
1975	982	1,248	7,129	9,359	16,948	8,127	13,646	38,721
1976	1,086	1,346	6,772	9,204	17,688	9,409	13,758	40,855
1977	1,164	1,548	7,283	9,995	18,745	12,122	14,985	45,852
1978	1,171	1,771	7,965	10,907	19,181	14,413	16,551	50,145
1979	1,321	1,907	7,437	10,665	20,851	15,254	16,099	52,204
1980	1,764	2,081	9,039	12,884	32,639	17,333	20,638	70,610
1981	2,636	2,514	12,349	17,499	43,598	20,166	27,789	91,553
1982	2,431	2,125	11,247	15,803	39,199	18,979	26,219	84,397
1983	2,023	1,593	10,148	13,764	37,120	14,564	24,153	75,837
1984	2,198	1,521	11,278	14,997	42,605	17,127	25,681	85,413
1985	1,679	1,190	8,924	11,793	35,118	14,168	21,056	70,342
1986	1,084	793	5,549	7,426	19,097	8,516	12,678	40,291
1987	925	754	5,049	6,728	16,164	8,055	11,112	35,331
1988	855	732	4,693	6,280	13,636	8,555	10,041	32,232
1989	607	705	3,924	5,236	10,204	9,539	8,188	27,931
1990	654	689	3,715	5,058	12,198	11,044	8,313	31,555
1991	592	534	3,314	4,440	11,770	9,526	7,596	28,892
1992	493	423	2,513	3,429	8,757	8,209	6,118	23,084
1993	502	548	2,469	3,519	8,407	10,017	6,328	24,752
1994	570	726	2,405	3,701	6,721	9,538	5,307	21,566
1995	542	570	2,198	3,310	7,627	8,354	5,075	21,056
1996	483	570	2,136	3,189	8,314	9,302	5,282	22,898
1997	428	536	2,110	3,074	10,436	11,327	5,702	27,465
1998	303	579	1,816	2,698	7,064	12,106	4,913	24,083
1999	151	583	1,389	2,123	4,087	10,513	3,580	18,180

^aExcludes service wells and stratigraphic and core testing.

^bAll drilling counts for the years 1973-1998 have been revised.

Notes: Estimates are based on well completions taken from American Petroleum Institute data tapes through August 2000. Due to the method of estimation, data shown are frequently revised. Data are no longer rounded to nearest 10 wells.

Sources: Years 1970-1972: Energy Information Administration, Office of Oil and Gas. Years 1973-1999: *Monthly Energy Review August 2000*, DOE/EIA-0035(00/08).

combined company and Devon shareholders will own approximately 69 percent. The new Devon Energy Corporation now ranks in the top 10 of all U.S.-based independent oil and gas producers in terms of market capitalization, total proved reserves and annual production. Devon Energy Corporation operates one of the world's largest coal bed methane fields in the San Juan Basin, plus has significant exposure to the developing Powder River Basin and Raton Basin coal

seam plays. Devon also is one of the largest producers in the Gulf of Mexico with operations on 75 blocks and interests in an additional 98 undeveloped blocks. {26}

On October 25, 1999, El Paso Energy Corporation and Sonat Incorporated completed their \$6 billion merger. The transaction creates a natural gas transmission system comprising over 40,000 miles, the largest natural gas transmission system in North America,

Figure 7. U.S. Exploratory Gas Well Completions, 1977-1999

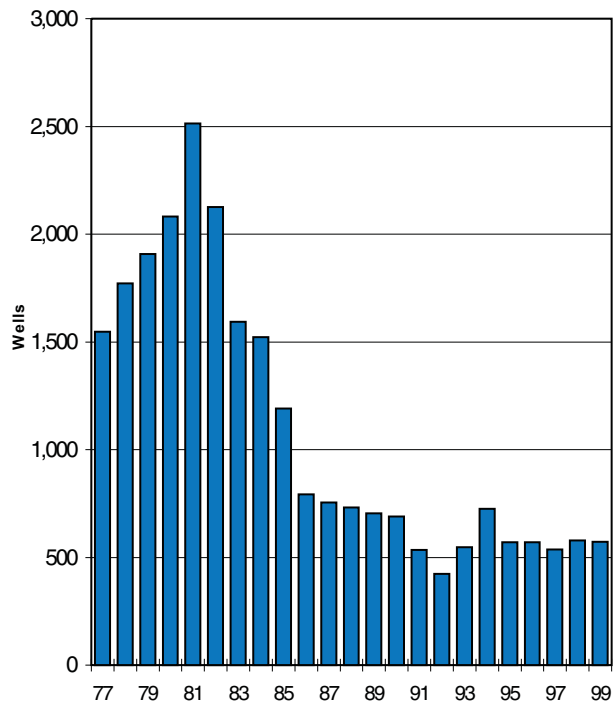


Figure 9. U.S. Total Discoveries of Dry Natural Gas per Exploratory Gas Well Completion, 1977-1999

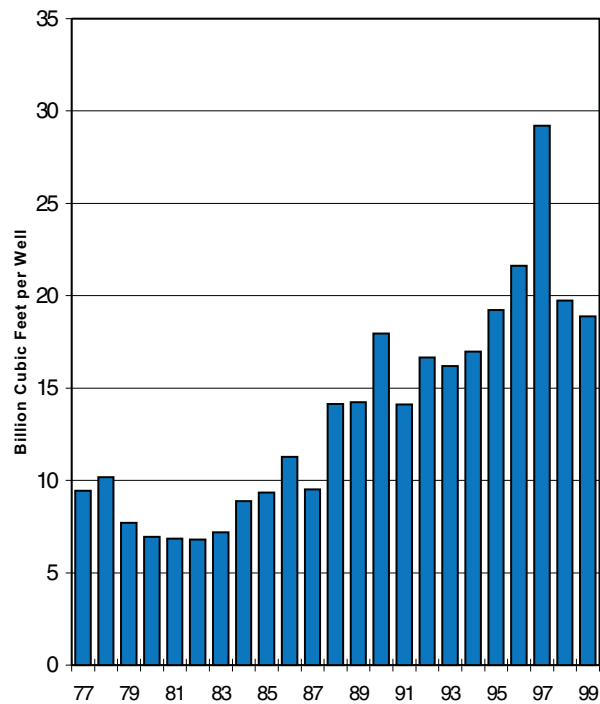


Figure 8. U.S. Exploratory Oil Well Completions, 1977-1999

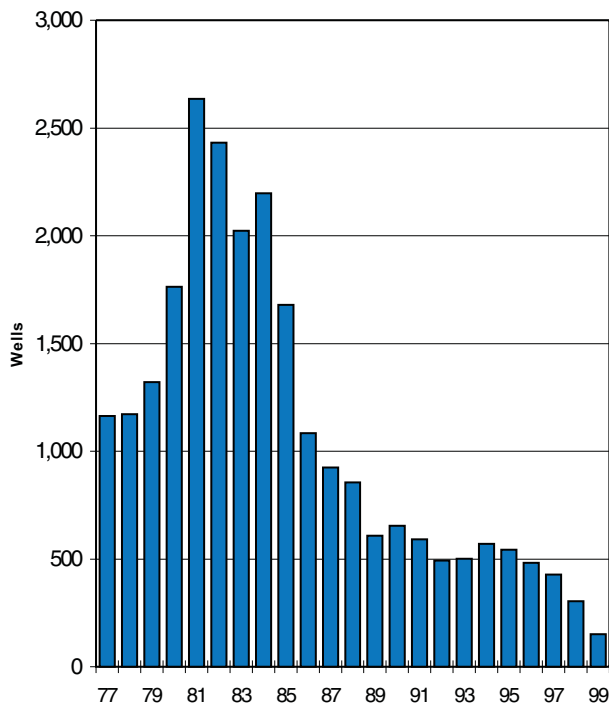
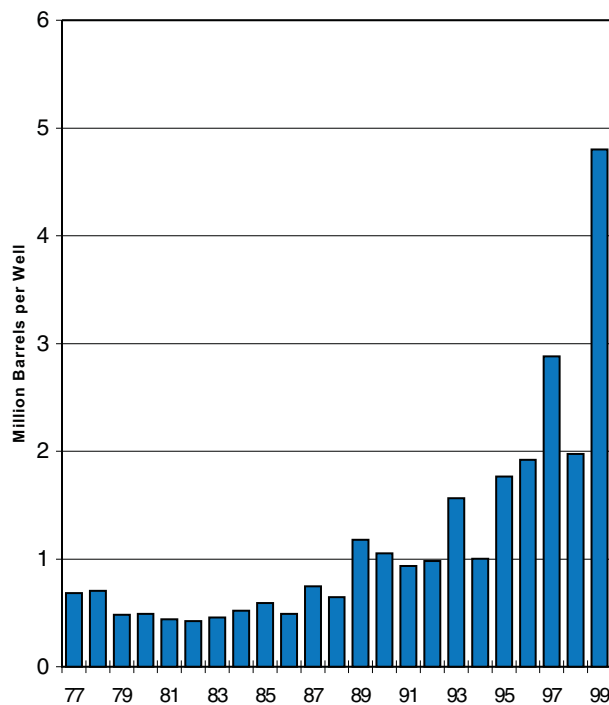


Figure 10. U.S. Total Discoveries of Crude Oil per Exploratory Oil Well Completion, 1977-1999



Source: Energy Information Administration, Office of Oil and Gas.

both in terms of throughput and miles of pipeline. El Paso Energy's pipeline systems will transport 12.4 billion cubic feet of natural gas—fully one quarter of the natural gas volumes transported in the United States each day. El Paso Energy has agreed to divest its 100-percent ownership in East Tennessee Natural Gas Company, Sonat's 100-percent ownership of Sea Robin Pipeline Company, and Sonat's one-third interest in Destin Pipeline Company, L.L.C. following the merger. {27}

Reserve-to-Production Ratio and Ultimate Recovery

R/P Ratios

The relationship between proved reserves and production levels, expressed as the ratio of reserves to production (R/P ratio) is often used in analyses. For a mature producing area, the R/P ratio tends to be reasonably stable, so that the proved reserves at the end of a year serve as a rough guide to the production level that can be maintained during the following year. Operators report data which yield R/P ratios that vary widely by area depending upon:

- category of operator
- geology and economics
- number and size of new discoveries
- amount of drilling that has occurred.

R/P ratios are an indication of the state of development in an area and, over time, the ratios change. For example, when the Alaskan North Slope oil reserves were booked, the U.S. R/P ratio for crude oil increased because significant production from these reserves did not begin until 7 years after booking due to the need to first build the Trans Alaska pipeline. The U.S. R/P ratio for crude oil decreased from 11.1-to-1 to 9.4-to-1 between 1977 and 1982, as Alaskan North Slope oil production reached high levels.

In 1999, U.S. crude oil proved reserves increased, while oil production decreased—resulting in an upward shift in the National average R/P ratio (11.1).

Figure 11 shows the U.S. R/P ratio trend for crude oil since 1945. After World War II, increased drilling and discoveries led to a greater R/P ratio. Later, when drilling found fewer reserves than were produced, the ratio became smaller. R/P ratios also vary geographically. Less developed areas of the country, such as the Pacific offshore, have higher R/P ratios for

crude oil than the 1999 National average of 11.1-to-1. Other areas with relatively high R/P ratios are the Permian Basin of Texas and New Mexico, and California, where enhanced oil recovery techniques such as carbon dioxide (CO₂) injection or steamflooding have improved recoverability of oil in old, mature fields. Areas that have the lowest R/P ratios, like the Mid-Continent region, usually have many older fields. There, new technologies such as horizontal drilling have helped add reserves equivalent to the annual production, keeping the regional reserves and R/P ratio for oil relatively stable.

Figure 12 shows the historical R/P ratio for wet natural gas since 1945. Prior to 1945, R/P ratios were very high since the interstate pipeline infrastructure was not well developed. The market for and production of natural gas grew rapidly after World War II, lowering the R/P ratio. The U.S. average R/P ratio for natural gas increased in 1999, as reserves increased 2 percent Nationally while production had a slight increase.

Different marketing, transportation, and production characteristics for gas are seen when looking at regional average R/P ratios, compared to the 1999 U.S. average R/P ratio of about 8.9-to-1. The areas with the higher range of R/P ratios are the less developed or less productive areas of the country, such as the Pacific offshore and the Rockies, and also include areas such as Alabama and Colorado where considerable booking of coalbed methane reserves has recently occurred. Several major gas producing areas have R/P ratios below the National average, particularly Texas, the Gulf of Mexico Federal Offshore, and Oklahoma. The R/P ratio of these three areas combined increased from 6.9-to-1 in 1998 to 7.1-to-1 in 1999, and is below the National 1999 average.

Proved Ultimate Recovery

EIA has in past reports defined Ultimate Recovery as the sum of proved reserves and cumulative production. However, despite EIA's clear definition, the volume presented by EIA has often been misused or misinterpreted as the maximum recoverable volume of resources for an area. This neglects the addition of proved reserves over time through ultimate recovery appreciation (a.k.a. reserves growth or field growth) and has led some to make overly-pessimistic resource assessments for the United States. EIA is therefore introducing a new term, *Proved Ultimate Recovery*:

Proved Ultimate Recovery is the sum of proved reserves and cumulative production. It is

Figure 11. Reserves-to-Production Ratios for Crude Oil, 1945-1999

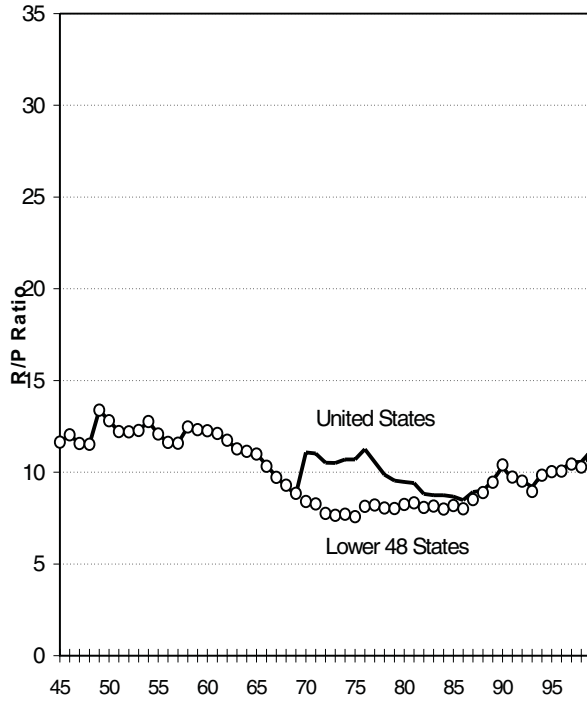


Figure 13. Components of Proved Ultimate Recovery for Crude Oil and Lease Condensate, 1977-1999

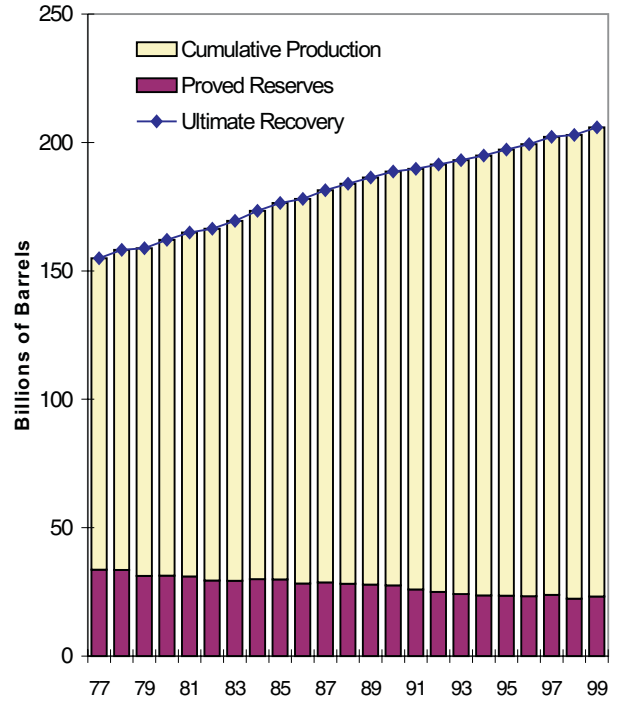


Figure 12. Reserves-to-Production Ratios for Wet Natural Gas, 1945-1999

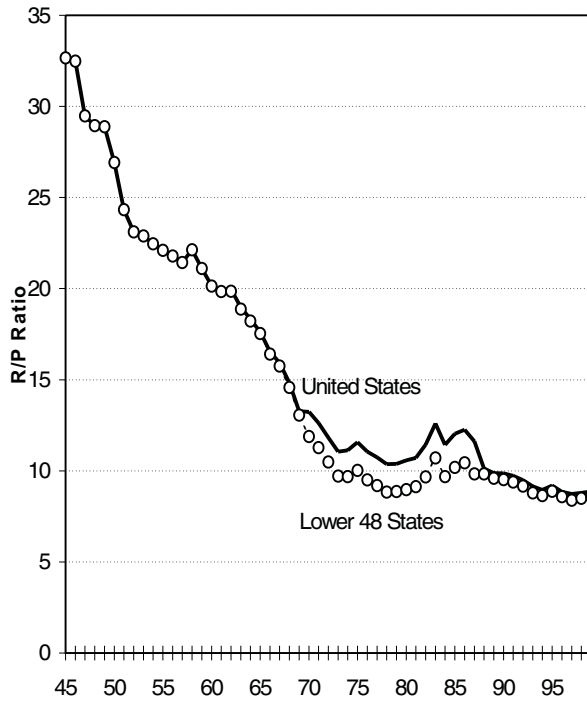
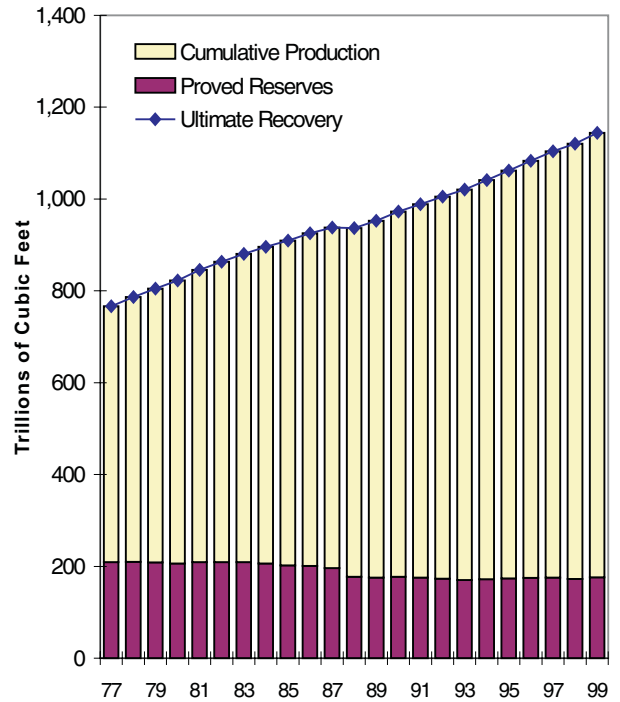


Figure 14. Components of Proved Ultimate Recovery for Wet Natural Gas, 1977-1999



Sources: Annual reserves and production - American Petroleum Institute and American Gas Association (1945-1976){28} and Energy Information Administration, Office of Oil and Gas (1977-1999){1-22}. Cumulative production: *U.S. Oil and Gas Reserves by Year of Field Discovery* (1977-1988){29}

Table 5. International Oil and Natural Gas Reserves as of December 31, 1999

Oil (million barrels)				Natural Gas (billion cubic feet)			
Rank ^a	Country	Oil & Gas Journal	World Oil	Rank ^b	Country	Oil & Gas Journal	World Oil
1	Saudi Arabia ^c	^d 263,500	^d 261,425	1	Former U.S.S.R.	1,979,330	1,935,731
2	Iraq ^c	112,500	100,000	2	Iran ^c	812,300	789,990
3	Kuwait ^c	^d 96,500	^d 94,725	3	Qatar ^c	300,000	394,000
4	Iran ^c	89,700	93,100	4	Saudi Arabia ^c	^d 204,500	^d 208,000
5	United Arab Emirates ^c	96,200	63,460	5	United Arab Emirates ^c	200,200	202,550
6	Former U.S.S.R.	57,252	63,016	6	United States	^e164,041	160,920
7	Venezuela ^c	72,600	47,058	7	Algeria ^c	159,700	159,700
8	Libya ^c	29,500	29,500	8	Venezuela ^c	142,500	145,763
9	China	24,000	34,100	9	Nigeria ^c	124,000	126,000
10	Mexico	28,399	28,259	10	Iraq ^c	109,800	112,600
Top 10 Total		870,151	814,643	Top 10 Total		4,196,371	4,235,254
11	Nigeria ^c	22,500	24,500	11	Malaysia	81,700	85,200
12	United States	^e21,034	19,625	12	Indonesia ^c	72,268	80,832
13	Algeria ^c	9,200	13,000	13	Canada	63,874	63,515
14	Norway	10,787	10,026	14	Netherlands	62,542	59,763
15	Brazil	7,357	8,150	15	Kuwait ^c	^d 52,700	^d 57,350
16	Angola	5,412	8,475	16	Libya ^c	46,400	46,400
17	Indonesia ^c	4,980	8,380	17	China	48,300	41,300
18	Oman	5,283	5,700	18	Australia	44,638	44,600
19	Canada	4,931	5,578	19	Norway	41,389	42,854
20	United Kingdom	5,153	5,003	20	Egypt	35,180	42,500
21	Qatar ^c	3,700	5,437	21	Mexico	30,064	30,393
22	Malaysia	3,900	4,557	22	Oman	28,416	29,300
23	India	4,838	3,390	23	United Kingdom	26,663	26,828
24	Egypt	2,948	3,767	24	Argentina	24,247	24,300
25	Yemen	4,000	2,100	25	Pakistan	21,600	22,900
Top 25 Total		986,174	942,331	Top 25 Total		4,876,352	4,933,289
OPEC Total		800,880	740,585	OPEC Total		2,224,368	2,323,185
World Total		1,016,041	978,868	World Total		5,146,207	5,197,863

^aRank is based on an average of oil reserves reported by *Oil & Gas Journal* and *World Oil*.

^bRank is based on an average of natural gas reserves reported by *Oil & Gas Journal* and *World Oil*.

^cMember of the Organization of Petroleum Exporting Countries (OPEC).

^dIncludes one-half of the reserves in the Neutral Zone.

^eEnergy Information Administration proved reserves as of December 31, 1998 were published by the *Oil & Gas Journal* as its estimates as of December 31, 1999.

Note: The Energy Information Administration does not certify these international reserves data, but reproduces the information as a matter of convenience for the reader.

Sources: PennWell Publishing Company, *Oil and Gas Journal*, December 20, 1999, pp. 91-93. Gulf Publishing Company, *World Oil*, August, 2000, pp. 31-35.

expected to change over time for any field, group of fields, State, or Country. Proved Ultimate Recovery does not represent the maximum recoverable volume of resources for an area. It is instead a gauge of how much has already been produced plus proved reserves. Proved reserves of crude oil or natural gas are the estimated quantities of petroleum which geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions. When deterministic proved reserves estimation methods are used, the term reasonable certainty is intended to express a high degree of confidence that the estimated quantities will be recovered. When probabilistic methods are used there should be at least a 90 percent probability that the actual quantities recovered will exceed the estimate.

Figures 13 and 14 show successive estimates of proved ultimate recovery and its components, proved reserves and cumulative production, for crude oil plus lease condensate, and wet natural gas, from 1977 through 1999. They illustrate the continued appreciation (growth) of proved ultimate recovery over time.

In 1977, U.S. crude oil and lease condensate proved reserves were 33,615 million barrels. Cumulative production of crude oil and lease condensate for 1977 through 1999 was 61,356 million barrels. This substantially exceeds the 1977 proved reserves, but at the end of 1999 there were still 23,168 million barrels of crude oil and lease condensate proved reserves. Therefore, the Nation's estimated proved ultimate recovery of crude oil was fundamentally increased during this period owing to the *proved ultimate recovery appreciation* process (continued development of old fields). In fact, only 8 percent of proved reserves additions of crude oil were booked as *new field discoveries* from 1976 through 1999. The rest was from proved reserves categories included in the proved ultimate recovery appreciation process (*new reservoir discoveries in old fields, extensions, and revisions and adjustments.*) A significant part of the total proved ultimate recovery appreciation came from the proved ultimate recovery appreciation of those new fields discovered between 1976 and 1999.

Similarly, the 1977 wet natural gas proved reserves were 209,490 billion cubic feet, and cumulative dry gas production from 1977 through 1999 was 410,846 billion cubic feet. Cumulative wet gas production exceeded the 1977 reserves, but at the end of 1999 there were still

176,159 billion cubic feet of wet natural gas proved reserves, for the same reasons. Only 12 percent of proved reserve additions of natural gas were booked as *new field discoveries* from 1976 through 1999.

International Perspective

International Reserves

The EIA estimates domestic oil and gas reserves but does not systematically estimate worldwide reserves. As shown in **Table 5**, international reserves estimates are presented in two widely circulated trade publications. The world's total reserves are estimated to be roughly 1 trillion barrels of oil and 5 quadrillion cubic feet of gas.

The United States ranked 12th in the world for proved reserves of crude oil and 6th for natural gas in 1999. A comparison of EIA's U.S. proved reserves estimates with worldwide estimates obtained from other sources shows that the United States had about 2 percent of the world's total crude oil proved reserves and over 3 percent of the world's total natural gas proved reserves at the end of 1999. There are sometimes substantial differences between the estimates from these sources. The *Oil & Gas Journal* reported oil reserves for the United Arab Emirates at about 96 billion barrels. This is about 50 percent higher than the *World Oil* estimate of 63 billion. One reason (among many) for these differences is that condensate is often included in foreign oil reserve estimates.

The *Oil & Gas Journal*{30} estimate for world oil reserves decreased 2 percent in 1999, while the *World Oil*{31} estimate increased 1 percent. For world gas reserves, the *Oil & Gas Journal* reported no change, while *World Oil* reported a 1 percent increase.

Several foreign countries have oil reserves considerably larger than those of the United States. Saudi Arabian oil reserves are the largest in the world, dwarfing U.S. oil reserves. Iraqi oil reserves are almost 5 times U.S. reserves. Closer to home, Venezuela has almost triple and Mexico has around 30 percent more than the United States' oil reserves. (Based on averages of the *World Oil* and *Oil & Gas Journal* estimates).

Petroleum Consumption

The United States is the world's largest energy consumer. The EIA estimates energy consumption and publishes it in its *Annual Energy Review*.{32} In 1999:

- The U.S. consumed 96,596,000,000,000,000 Btu of energy (96.6 quadrillion Btu).
- 62 percent of U.S. energy consumption was provided by petroleum and natural gas—crude oil and natural gas liquids combined (39 percent), and natural gas (23 percent).
- U.S. petroleum consumption was about 19.4 million barrels of oil and natural gas liquids and 58.7 billion cubic feet of dry gas per day.

Dependence on Imports

The United States remains heavily dependent on imported oil and gas to satisfy its ever-increasing appetite for energy. In 1999, crude oil imports made up 59 percent of the U.S. crude oil supply.

Net gas imports increased slightly in 1999 to 3.56 trillion cubic feet, which is approximately 17 percent of consumption. Almost all of this gas was pipelined from Canada, some came from Mexico, though Mexico remains a net importer of natural gas from the U.S., and liquefied natural gas was imported from Algeria and Australia.

Canada, Saudi Arabia, Venezuela, and Mexico were the primary foreign suppliers of petroleum to the United States.^{33}

List Of Appendices

Appendix A: Reserves by Operator Production Size Class - How much of the National total of proved reserves are owned and operated by the large oil and gas corporations? Appendix A separates the large operators from the small and presents reserves data according to operator production size classes.

Appendix B: Top 100 Oil and Gas Fields - What fields have the most reserves and production in the United States? The top 100 fields for oil and natural gas out of the inventory of more than 45,000 oil and gas fields are listed in Appendix B. These fields hold two-thirds of U.S. crude oil proved reserves. Table B3 in Appendix B lists the top U.S. operators by reported 1999 production and indicates pending mergers announced in 1999 with linked arrows.

Appendix C: Conversion to the Metric System - To simplify international comparisons, a summary of U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves expressed in metric units is included as Appendix C.

Appendix D: Historical Reserves Statistics - Appendix D contains selected historical reserves data presented at the State and National level. Readers interested in a historical look at one specific State or region can review these tables. We have again included Table D9, Deepwater Production and Proved Reserves of the Gulf of Mexico Federal Offshore 1992-1999, due to expressed interest from the industry regarding this area. Table D9 contains the production and proved reserves for 1992-1999 for the Gulf of Mexico Federal Offshore region by water depths greater than 200 meters, and less than 200 meters.

Appendix E: Summary of Data Collection Operations - This report is based on two EIA surveys. Proved reserves data is collected annually from U.S. oil and gas field operators on Form EIA-23. Natural gas liquids production data is collected annually from U.S. natural gas plant operators on Form EIA-64A. Appendix E describes survey designs, response statistics, reporting requirements, and sampling frame maintenance.

Appendix F: Statistical Considerations - The EIA strives to maintain or improve the accuracy of its reports. Since complete coverage of all oil and gas operators is impractical, the EIA has adopted sound statistical methods to impute data for those operators not sampled and for those data elements that smaller operators are not required to file. These methods are described in Appendix F.

Appendix G: Estimation of Reserves and Resources - Reserves are not measured directly. Reserves are estimated on the basis of the best geological, engineering, and economic data available to the estimator. Appendix G describes reserve estimation techniques commonly used by oil and gas field operators and EIA personnel when in the field performing quality assurance checks. A discussion of the relationship of reserves to overall U.S. oil and gas resources is also included.

Appendix H: Maps of Selected State Subdivisions - Certain large producing States have been subdivided into smaller regions to allow more specific reporting of reserves data. Maps of these States identifying the smaller regions are provided in Appendix H.

Appendix I: Annual Survey Forms of Domestic Oil and Gas Reserves - Samples of Form EIA-23 and Form EIA-64A are presented in Appendix I.

Glossary - Contains definitions of many of the technical terms used in this report.