

Chapter Two

PETROLEUM ECONOMICS

Chapter One includes several charts containing historical economic statistics. Chapter Two emphasizes the importance of E&P reserve values and describes current economics in terms of the leading countries and companies.

A FOCUS ON ADDING RESERVE VALUE

Petroleum exploration and production economics center on the size and nature of oil and gas reserves in relation to oil and gas prices. An E&P company may be said to have two key assets:

1. Its people and their ability to profitably find (or acquire), develop, and produce oil and gas reserves and
2. Its existing reserves and their ability, when produced, to generate positive cash flow.

The ability to apply new technology (such as 3D seismic, horizontal drilling, deep water drilling and production techniques, and global internet knowledge sharing) will be key to managing risks and adding billions in reserve value for the E&P industry in the coming decade.

E&P company managements appreciate that true exploration success is not measured by the *success ratio*, i.e., the number of producible wells to total wells drilled. A ten-well program with discovery of a single large reservoir may be far more profitable than a ten-well program discovering five marginally economic reservoirs. Nor is exploration success truly measured by the quantity of reserves found. In many remote parts of the world, large quantities of gas reserves have been found that have relatively limited value because transportation costs to gas markets are so high.

A U.S. property with one million barrels of proved heavy, sour crude oil reserves with high future development and production costs might sell for only \$1 million, while a fully developed U.S. property with one million barrels of proved light, sweet crude oil and low production costs might sell for \$6 million. Hence, an E&P company often must evaluate potential E&P investments using sophisticated computer-generated, present value analyses of expected future cash flows.

These analyses can project estimated future monthly production volumes, revenues, and production expenses per well over the well's economic life of many years. From these projected cash flows and the required investment, an expected annual rate of return and other profit indicators can be calculated to evaluate the investment's economic merits. Often a company's records of historical production, revenue, and cost categories by well and by field are instrumental in developing reasonable cash flow projections for investment decision making. Such analysis is illustrated in Chapter Thirty on valuation of proved oil and gas properties. Historical cost may be dramatically greater or less than the value of reserves found. E&P financial statement accounting recognizes the economic importance of reserves in three ways:

- ♦ Capitalized costs of properties with proved reserves (proved properties) are amortized on a units-of-production method based on the ratio of volumes currently produced to the sum of those volumes and remaining proved reserves;
- ♦ Proved properties' net capitalized costs are limited to certain computations of value of the underlying proved reserves; and
- ♦ Public companies must disclose, with audited financial statements, certain supplemental unaudited information on the proved reserve volumes and certain related values.

Even so, an E&P company's stock price is more closely correlated to historical and expected cash flow from production of reserves and to estimated values of reserves than to historical earnings measured under generally accepted accounting principles, as further discussed at the end of Chapter Twenty-Nine.

PETROLEUM ECONOMICS TODAY FROM A GLOBAL PERSPECTIVE

The world's reserve values by country are not publicly disclosed, but estimated reserve volumes are. Figure 2-1 summarizes the world's proved oil and gas reserves, production, and oil wells by country. Over 92 percent of the world's proved oil and gas reserves are found in the 25 countries listed in Figure 2-1. The top ten countries have nearly 80 percent of the world's oil and gas reserves and the majority of the world's current production. Sixty-four percent of the world's proved oil reserves are in five Middle East countries, and the majority of the world's proved oil and

gas reserves are in only four countries—Russia, Saudi Arabia, Iran and Iraq.

Figure 2-1: World Reserves and Production by Country

Twenty-five largest (OPEC members in bold)	Reserves (1/1/00)			Annual Production			Oil Wells*
	Oil*	Gas*	Total Boe*	Oil*	Gas*	Total Boe*	
1 Russia	49	1,700	382	2.2	20.5	5.6	104.1
2 Saudi Arabia	261	204	295	2.7	1.6	3.0	1.4
3 Iran	90	812	225	1.3	1.8	1.6	1.1
4 Iraq	113	110	131	1.0	-	1.0	1.7
5 Abu Dhabi (UAE)	92	196	125	0.6	-	0.6	1.2
6 Kuwait	94	52	103	0.6	0.3	0.7	0.8
7 Venezuela	73	143	97	1.0	1.1	1.2	14.7
8 Qatar	4	300	54	0.2	0.7	0.3	0.3
9 United States	21	164	48	2.2	18.9	5.3	574.0
10 Nigeria	23	124	44	0.7	0.2	0.7	2.0
11 Libya	30	46	38	0.5	0.2	0.5	1.9
12 Mexico	28	30	33	1.1	1.2	1.3	3.6
13 China	24	48	32	1.2	0.8	1.3	72.3
14 Algeria	9	130	31	0.3	2.6	0.7	1.3
15 Turkmenistan	1	101	18	0.0	0.4	0.1	2.5
16 Malaysia	4	82	18	0.3	1.5	0.5	0.8
17 Norway	11	41	18	1.1	1.7	1.4	0.6
18 Indonesia	5	72	17	0.5	2.4	0.9	8.5
19 Kazakhstan	5	65	16	0.2	0.3	0.2	11.7
20 Canada	5	64	16	0.7	5.7	1.7	50.7
21 Uzbekistan	1	66	12	0.1	1.9	0.4	2.2
22 Netherlands	0	63	11	0.0	2.6	0.5	0.2
23 Australia	3	45	11	0.2	1.1	0.4	1.3
24 Oman	5	28	10	0.3	0.2	0.4	2.3
25 United Kingdom	5	27	10	1.0	3.2	1.5	1.3
Subtotal	956	4,713	1,742	19.8	70.7	31.6	862.5
Others	60	433	132	4.4	10.8	6.2	65.6
Total	1,016	5,146	1,874	24.2	81.5	37.8	928.1

*Oil reserves and production are in billions of barrels. Gas reserves and production are in trillion cubic feet. Combined total reserves and production are in billion barrels of oil equivalent at 6 mcf per barrel. Annual oil production is for 1999; annual gas production is for 1998. Numbers of producing oil wells are in thousands as of December 31, 1998.

Primary Sources: *Oil and Gas Journal*, December 20, 1999 and *BP Amoco Statistical Review of World Energy 1999*

The one trillion barrels of world oil reserves are 50 times current production (Figure 2-1). In 1950 that ratio was only 20. World oil reserves have increased nearly 80 percent since 1981, but virtually all of the increase is in OPEC countries.

Figure 2-2: Ratio of World Reserves to Production by Country and Production Barrels of Oil per Day (BOPD) per Well

Twenty-five largest per Figure 2-1: (OPEC members in bold)		Reserves to Production BOE*	1999 BOPD per Well*
1	Russia	59.7	57
2	Saudi Arabia	98.7	5,321
3	Iran	144.7	3,147
4	Iraq	135.6	1,561
5	Abu Dhabi (UAE)	202.2	1,407
6	Kuwait	157.7	2,041
7	Venezuela	81.3	189
8	Qatar	155.0	2,107
9	United States	9.1	10
10	Nigeria	58.3	984
11	Libya	71.9	703
12	Mexico	26.0	814
13	China	24.7	44
14	Algeria	43.3	589
15	Turkmenistan	155.1	51
16	Malaysia	34.7	909
17	Norway	13.1	4,947
18	Indonesia	19.5	151
19	Kazakhstan	66.6	45
20	Canada	9.7	37
21	Uzbekistan	31.7	76
22	Netherlands	23.4	290
23	Australia	29.8	365
24	Oman	27.0	389
25	United Kingdom	6.2	2,104
For the top 25 Countries		55.2	63
Other countries		21.2	158
Worldwide		49.6	70
Worldwide, excluding U.S.		56.2	165

*Per data in Figure 2-1
 Primary Sources: *Oil & Gas Journal*, December 20, 1999 and
BP Amoco Statistical Review of World Energy 1999

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Figure 2-3 lists the World's Top 45 petroleum companies as ranked by the Energy Intelligence Group (EIG) in December 1999. Not surprisingly, the number one company was Saudi Arabia's Saudi Arabian Oil Company or Saudi Aramco (pronounced a-RAM-co) with 26 percent of the world's proved oil reserves.

Figure 2-3: World's Top 45 Petroleum Companies

<u>Country</u>	<u>Rank</u>	<u>State Owned</u>	<u>Company Name (Short Name)</u>
Saudi Arabia	1	100%	Saudi Aramco (Aramco)
Venezuela	2	100%	Petroleos de Venezuela S.A. (PDVSA)
United States	3	-	ExxonMobil
Iran	4	100%	National Iranian Oil Company (NIOC)
UK/Netherlands	4	-	Royal Dutch/Shell Group
UK	6	-	BP Amoco
Mexico	7	100%	Petroleos Mexicanos (Pemex)
France	8	-	TotalFina Elf
Kuwait	9	100%	Kuwait Petroleum Corporation (KPC)
China	10	100%	China National Petroleum Corp. (CNPC)
Indonesia	11	100%	Pertamina
Algeria	12	100%	Sonatrach
United States	13	-	Chevron
Brazil	14	51%	Petrobras
United States	15	-	Texaco
UAE	16	100%	Adnoc
Italy	17	37%	Ente Nazionale Idrocarburi (ENI) - parent of AGIP
Spain	17	21%	Repsol-YPF
Iraq	19	100%	Iraq National Oil Company (INOC)
Libya	20	100%	Libya NOC
China	21	100%	Sinopec
Malaysia	22	100%	Petronas
Russia	23	-	Surgutneftegaz
United States	24	-	Conoco
Nigeria	25	100%	Nigerian National Petroleum Corp (NNPC)
Qatar	26	100%	Qatar General Petroleum Corp (QGPC)
Egypt	27	100%	Egyptian General Petroleum Corp. (EGPC)
United States	28	-	Marathon - (sub of USX)
Russia	29	41%	Gazprom
Russia	30	-	Yukos
United States	31	-	Phillips
Norway	32	100%	Statoil
Russia	33	-	Sidanco
Russia	34	27%	Lukoil
India	35	100%	Oil and Natural Gas Corporation (ONGC)
Colombia	36	100%	Ecopetrol
Russia	37	-	Tyumen Oil
Russia	38	100%	Rosneft
Russia	39	51%	Sibneft
United States	40	-	Amerada Hess
Syria	41	100%	Syrian Petroleum
Oman	42	60%	Petroleum Development Oman (PDO)
Russia	43	77%	Slavneft
Canada	44	18%	Petro-Canada
United States	45	-	Unocal

Primary Source: EIG's *Petroleum Intelligence Weekly*, December 20, 1999 in which EIG updated its Top 50 list to reflect major mergers in 1999 that reduced the number of companies from 50 to 45.

The EIG ranking system for Figure 2-3 reflects an average of rankings for reserves, production, refinery capacity, and product sales.

Some of the national oil companies of the largest oil-producing countries have invested overseas, particularly in refining joint ventures that provide ready customers for exported crude oil. Aramco has a joint venture with Texaco and Shell called Equilon, a major U.S. refiner. Aramco supplies Saudi crude to the Equilon refineries once wholly owned by Texaco and Shell. Venezuela's national oil company, PDVSA (pe-da-VAY-sa), owns CITGO, which has one of the most widely branded gasolines in the United States and is one of the 20 largest U.S. refiners. PDVSA has a refining joint venture in Germany with VEBA (VAY-ba) Oel. Mexico's national oil company, Pemex (pronounced PE-mex, usually with a short e on the first syllable), bought 50 percent of Shell's large U.S. refinery at Deer Park, Texas in 1994 and is supplying Mexican crude to the refinery. Kuwait's national oil company, Kuwait Petroleum Corporation (KPC), owns the Q8 company, a European refining and marketing giant. KPC also owns various other petroleum-related companies in the United States and elsewhere.

By 1994, seven OPEC members owned portions of 35 overseas refineries and had total worldwide refining capacity of ten million barrels per day—equivalent to 40 percent of all OPEC production. The overseas downstream investments discourage a repeat of the 1973 oil embargo.

THE FRAMEWORK FOR U.S. ECONOMICS

The United States, a large producer and consumer of oil and gas, ranks only ninth in combined oil and gas reserves, yet ranks second in annual combined production, and has 62 percent of the world's producing oil wells (Figure 2-1). On average, U.S. oil wells produce 10 barrels per day, whereas Saudi wells produce on average 5,321 barrels per day (Figure 2-2). The U.S. is believed to have substantial undiscovered oil and gas reserves, but:

- ♦ Some of those potential reserves are in areas closed to exploration and production under various environmental protection laws;
- ♦ Some potential reserves are not believed to be economical to explore unless oil and gas prices rise substantially or exploration, development, and production costs decline substantially; and
- ♦ Some reserves are not as economically attractive to find and produce as reserves in other parts of the world.

As shown in Chapter One, U.S. oil and gas companies, as a whole, are actively searching for new oil and gas reserves in many areas of the U.S. and the world.

Unlike many countries, the United States allows mineral rights to be owned by individuals, corporations, and other entities and allows almost any U.S. company to explore and produce oil and gas reserves subject to various federal and state regulations and taxations. Consequently, in the U.S. there are over two million royalty interest owners and over 5,000 E&P companies, partnerships, and sole proprietorships, including some 200 publicly held entities. The U.S. E&P market is highly competitive.

The past successes of the U.S. petroleum industry, the freedom for large numbers of independent entities to own and develop reserves, the country's large land mass, and the citizens' high demand for oil and gas have established an enviable economic framework that explains why the United States has 62 percent of the world's producing oil wells and remains the second largest oil and gas producing country, despite having less than three percent of the world's proved oil and gas reserves. Adverse U.S. tax law changes since 1976, the oil and gas price declines since 1985, and environmental restrictions on U.S. exploration reduced the economic incentives for U.S. exploration in the 1990s.

U.S. oil and gas producers range from giant ExxonMobil with annual sales exceeding \$180 billion to individuals holding small interests in one or two wells.

The importance of the petroleum industry in the U.S. and world economy is marked by the fact that the world's four largest corporations in terms of annual revenues are General Motors, DaimlerChrysler, Ford Motor, and now ExxonMobil—three major manufacturers of gasoline powered vehicles and the largest petroleum company. The products of the oil and gas industry are essential to the continued well being and security of this country for the foreseeable future.

Figure 2-4 lists the 40 largest of the 200 largest publicly traded oil and gas producing companies with U.S. petroleum reserves, referred to as the OGI200, the latest annual list published by the *Oil & Gas Journal* each September. The list does not reflect the merger of Exxon and Mobil.

According to the Independent Petroleum Association of America (IPAA) the petroleum industry employed 1.4 million persons in 1997, of which 320,100 people were in E&P, as shown in Figure 2-5.

Figure 2-4: OGJ200 Oil and Gas Companies, Ranked by Assets

Rank	Company Name	YE 1998 Assets (\$000,000)	1998 Revenues (\$000,000)	1998 U.S. Production (mboe)*	1998 Global Production (mboe)*
1	Exxon	\$92,630	\$117,772	333	1,008
2	Mobil ***	42,754	53,531	158	621
3	Chevron	36,540	30,557	232	561
4	Texaco	28,570	31,707	270	508
5	BP Amoco (U.S.)**	27,537	33,160	443	0
6	Shell Oil	26,543	15,451	310	359
7	ARCO ***	25,199	10,809	269	377
8	Conoco	16,075	23,168	87	219
9	Occidental Petroleum	15,252	7,381	69	163
10	USX-Marathon Group	14,544	22,075	98	149
11	Phillips Petroleum Co.	14,216	11,845	94	192
12	Coastal ***	12,304	7,368	46	46
13	Unocal	7,952	5,479	91	190
14	Amerada Hess	7,883	6,617	36	113
15	Union Pacific Resources Group ***	7,642	1,841	107	156
16	Burlington Resources	5,917	1,637	127	138
17	Kerr-McGee	5,451	2,200	59	101
18	Apache	3,996	876	17	33
19	Anadarko Petroleum	3,633	560	48	49
20	Pioneer Natural Resources	3,481	721	50	65
21	Enron Oil & Gas	3,018	769	48	72
22	PennzEnergy ***	2,417	837	49	50
23	Murphy Oil	2,164	1,699	14	37
24	Questar	2,161	906	18	19
25	Ocean Energy	2,007	523	33	45
26	Equitable Resources	1,854	883	12	12
27	Noble Affiliates	1,686	912	47	51
28	Sonat Exploration ***	1,636	535	49	49
29	Tesoro Petroleum	1,428	1,492	6	8
30	CNG Producing ***	1,426	631	36	36
31	Seagull Energy ***	1,416	426	20	27
32	Louis Dreyfus Natural Gas	1,284	278	21	21
33	Devon Energy	1,226	388	19	39
34	Cross Timbers Oil	1,208	249	21	21
35	Mitchell Energy & Development	1,146	702	34	34
36	Vintage Petroleum Inc.	1,014	329	17	25
37	MCNIC Oil and Gas	988	207	17	17
38	Plains Resources	974	1,294	8	8
39	Range Resources	922	149	11	11
40	Pogo Producing	862	204	13	16
Totals for the top 40 companies		428,959	398,171	3,436	5,643
Totals for the next 160 companies		26,446	8,123	476	513
Totals for the OGJ200		\$455,405	\$406,293	3,912	6,156
Percent of top 40 to the OGJ200		94%	98%	88%	92%

*Barrels of oil equivalent reflect 5.6 mcf per barrel
** a wholly-owned subsidiary of London-based BP Amoco
*** After 1998, by May 2000, many companies above have merged or announced merging with others: Exxon & Mobil merged into ExxonMobil; BP Amoco acquired ARCO; El Paso Energy acquired Sonat, acquiring Coastal; Union Pacific merging into Anadarko; Devon acquired PennzEnergy; Seagull merged into Ocean Energy; Dominion Resources acquired CNG Producing.
Primary Source of Figure 2-4: *Oil & Gas Journal*, September 13, 1999

Figure 2-5: 1997 U.S. Petroleum Industry Employment by Industry Sector by State

(amounts in thousands)						
<u>State</u>	<u>E&P</u>	<u>Refining</u>	<u>Trans- portation</u>	<u>Whole- sale</u>	<u>Retail</u>	<u>Total</u>
Texas	158.1	24.2	28.9	16.6	35.0	262.7
Louisiana	51.7	10.9	4.9	4.9	10.5	82.9
Oklahoma	30.4	4.4	6.4	3.7	9.1	54.0
California	21.3	17.4	10.5	9.9	56.7	115.8
New Mexico	10.0	0.7	1.5	1.4	6.0	19.6
Wyoming	8.4	0.8	1.0	0.5	4.1	14.9
Alaska	8.0	0.4	1.2	0.8	1.5	11.9
Colorado	7.8	0.5	2.4	2.3	11.2	24.3
Kansas	6.8	1.6	2.9	4.1	8.1	23.5
Mississippi	5.2	1.9	1.9	2.5	9.0	20.5
Ohio	4.5	3.8	7.3	4.7	32.6	52.8
W. Virginia	3.6	0.5	4.1	0.9	6.3	15.3
Subtotal	315.8	67.0	72.8	52.4	190.2	698.2
Other states	4.3	30.0	84.1	109.8	485.0	713.2
Total	320.1	97.0	156.9	162.2	675.2	1,411.4

Primary Source: The Independent Petroleum Association of America's *The Oil & Gas Producing Industry in Your State*, 1998

The petroleum industry is a major source of government revenue, including excise taxes and lease rents, bonuses and royalties—approximately \$23.6 billion distributed to the U.S. Department of the Treasury in 1998. Federal and mineral lease revenues totaled \$6 billion in 1998 as reported by the *1998 Statistical Highlights*, published by the U.S. Department of the Interior's Minerals Management Service (MMS). Royalties and similar payments to the federal government for leasing of federal lands were \$5.6 billion in 1998 according to Mineral Revenue Collections, 1998, published by the MMS. The Independent Petroleum Association of America reports \$3.7 billion in state taxes assessed on oil and gas production in 1998. Income taxes are also significant to E&P economics—a matter discussed in Chapter Thirty on valuation of proved oil and gas properties.

