WHO will fund America's energy future?



About the IOGCC

The Interstate Oil and Gas Compact Commission is a multi-state government agency that promotes the conservation and efficient recovery of our nation's oil and natural gas resources while protecting health, safety and the environment.

The IOGCC consists of the governors of 37 states (30 members and seven associate states) that produce most of the oil and natural gas in the United States, as well as seven international affiliates. Chartered by Congress in 1935, the organization is the oldest and largest interstate compact in the nation.

The IOGCC assists states in balancing interests through sound regulatory practices. These interests include: maximizing domestic oil and natural gas production, minimizing the waste of irreplaceable natural resources, and protecting human and environmental health.

The IOGCC also provides an effective forum for government, industry, environmentalists and others to share information and viewpoints, allowing members to take a proactive approach to emerging technologies and environmental issues. For more information visit www.iogcc.state.ok.us or call 405-525-3556.

Report by Dr. William F. Lawson

Contents

Executive Summary	3
R&D Expenditure Trends by Industry Segment	4
Upstream Oil and Gas R&D Investments	8
Impact of Continuing Corporate Consolidation	11
Federal R&D Budget Trends	12
U.S. Department of Energy R&D Funding	14
The Energy Policy Act of 2005	16
R&D Spending Outlook	17

Executive Summary

Energy is the lifeblood of America. It is essential to virtually every aspect of our quality of life. Our economic well-being relies on abundant, reliable and affordable energy. Our national security depends on the ability to harness energy resources when they are most needed. And on a more fundamental level, absent energy, our homes and schools are not heated, our crops are not planted, and our cars do not run. Today and for the foreseeable future, crude oil and natural gas will fuel our pursuit of the American Dream.

Ensuring U.S. oil and natural gas resources are not wasted has been a goal of the Interstate Oil and Gas Compact Commission since its inception in 1935. This goal is more urgent than ever. All experts agree vast quantities of oil and natural gas exist onshore in the United States. The challenge lies in recovering the resource. And the answer lies in technology.

This publication updates the 2002 and 1998 editions, which were prescient in their warnings about the impact of underfunding technology that supports domestic natural gas and oil production.

Since the beginning years of petroleum production, the key to increasing the percentage of recoverable reserves has been breakthrough research and development (R&D). Thousands of incremental advances in exploration and production have increased oil recovery rates from less than 10 percent to in excess of 40 percent in some cases. It is therefore troubling for the governors of the IOGCC to consider the question of "Who Will Fund America's Energy Future?" when reviewing the results of this report.

The sad conclusion shows that just when R&D is most needed, federal funding is being curtailed. Overall, R&D industrial expenditures for the petroleum industry remain near the bottom among all industry sectors. As more acces-

sible resources are produced, the need grows for the R&D that taps more elusive reserves.

Unfortunately, the business strategies of major multinational oil companies direct much of their R&D dollars to resources that reward shareholders in the short term. Services company R&D is directed principally toward maximizing the marketability of proprietary technologies. Independent producers cannot justify large R&D expenditures, and even the U.S. Department of Energy oil and gas R&D expenditures have fallen steeply in recent years.

One consequence of under-funding R&D is that the United States will no longer lead the world in exploration and production (E&P) technology development. The country lacks qualified oil field professionals and researchers. Although this trend is slowly reversing itself, the impact appears long term.

A strong domestic energy policy demands a strong R&D component. As the largest holder of domestic oil and gas resources, the nation benefits from their production. Domestic production creates wealth for other royalty owners, contributes significantly to state, federal and local economies and tax bases, offsets imports on a barrel-per-barrel basis, and cuts into trade deficits that are running at record rates.

We ask "who will fund our energy future?" The answer is not clear. The IOGCC, however, will encourage the use of public funds for cutting-edge R&D for domestic oil and gas production that can be deployed by the backbone of the domestic industry – the independent producers. We believe it is effective government policy to ensure our resources are not abandoned and to encourage the environmentally sound production of energy that touches every citizen in every state.

R&D Expenditure Trends by Industry Segment

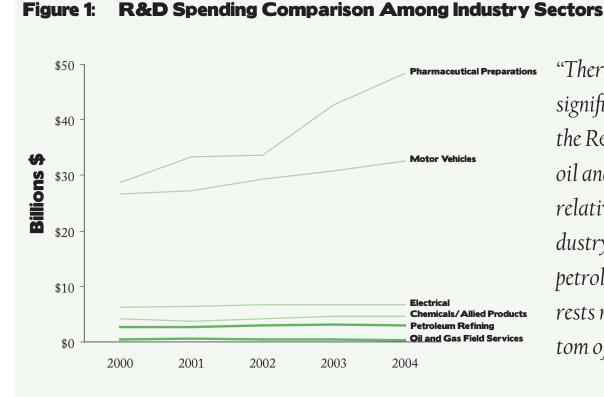
For the last half century the United States has benefited from the world's strongest research and development position according to Batelle's 2006 Research and Development Funding Forecast. In contrast to the 2002 update report, economic pressures are slowing domestic growth of R&D, while foreign R&D expenditures are increasing.

In updating the earlier editions of this report, there has been no significant change in the R&D expenditures in oil and gas sectors relative to other industry sectors: the petroleum industry rests near the bottom of the list. For the data available, the most significant indicator is the R&D expenditure-to-sales ratio.

The data used in this update was compiled by Schonfeld and Associates, Inc. in the 2005 edition of "Research and Development Growth Trends." Nineteen industry sectors are con-

sidered for this update that correspond to those in the 2002 update. Two sectors representative of the petroleum industry are included: the petroleum refining sector and the oil and gas field services sector. The refining sector includes all the major multi-national oil companies whose R&D expenditures include those for upstream, refining and other types of research. The oil and gas field services sector includes some of the oil field service companies, but does not include some others. However, the samples are satisfactory to be representative of trends in the overall segment but not absolute dollar levels.

The trend of overall R&D expenditures for these sectors is shown in Table 1 and illustrated in Figure 1 for six selected sectors. While the absolute R&D expenditure values are not reliable totals for each sector, they do give beneficial trend data since the companies in each sector are the same over the years included here.



"There has been no significant change in the R&D funding in oil and gas sectors relative to other industry sectors: the petroleum industry rests near the bottom of the list."

Table 1: Industry R&D Expense Summary (Billions \$)

Industry Name	2000	2001	2002	2003	2004	Average
Pharmaceutical preparations	28.793	33.267	33.687	42.734	48.391	37.374
Motor vehicles and car bodies	26.678	27.259	29.309	30.743	32.558	29.309
Semiconductor	14.489	14.686	14.838	15.281	16.197	15.098
Prepackaged software	12.843	13.564	14.083	14.882	15.698	14.214
Radio, TV broadcast, communication equipment	11.359	10.969	10.054	11.285	10.248	10.783
Computer and office equipment	7.083	7.018	7.037	7.006	6.947	7.018
Electrical	6.239	6.439	6.636	6.664	6.690	6.533
CMP integrated system design	6.913	5.925	4.818	3.872	2.989	4.903
Phone communication	4.643	4.708	4.673	4.868	4.963	4.771
Chemicals and allied products	4.159	3.777	4.187	4.605	4.575	4.261
Electronic computers	4.363	4.223	4.120	4.008	3.920	4.127
Household audio and video	3.617	3.759	3.925	4.062	4.179	3.908
Motor vehicle parts and accessories	3.804	3.747	3.668	3.828	3.900	3.789
Computer communication equipment	3.926	3.732	3.584	3.405	3.464	3.622
Petroleum refining	2.740	2.661	3.020	3.069	3.022	2.902
Photographic equipment and supply	1.792	1.904	2.026	2.163	2.325	2.042
Aircraft	1.951	1.757	1.420	1.299	1.334	1.552
CMP processing, data preparation service	0.463	0.476	0.505	0.491	0.495	0.486
Oil and gas field services	0.432	0.543	0.499	0.423	0.358	0.451
Total	146.287	150.414	152.087	164.687	172.250	157.145
Average	7.699	7.917	8.005	8.668	9.066	8.271
Maximum	28.793	33.267	33.687	42.734	48.391	37.374
Minimum	0.432	0.476	0.499	0.423	0.358	0.451

Data: "R&D Growth Trends: 2005 Edition," Schonfeld & Associates, Inc.

Table 2 presents the Schonfeld R&D expenditure to sales ratio data for the 19 industry sectors from 2000 through 2005. Pictorially, Figure 1 presents the same data for six selected sectors.

It is especially telling to note that the petroleum refining sector has declined as a percentage of sales. This sector is composed of the most profitable companies today. As discussed in a later section, the upstream R&D funding achieved a minimum in 2003 and increased on absolute terms in 2004 and beyond. However, as the price of oil and natural gas has increased along with record profits, R&D funding has consistently lagged behind and is one to two orders of magnitude less than other industries when compared to sales.

The oil and gas field service sector's R&D expenditures are

also growing in absolute terms, but as their profits have risen, R&D expenditures have slowed compared to sales.

In stark contrast is the trend of the pharmaceutical preparation sector that continues to show generally strong growth and increased sales. The computer communications equipment sector has similar behavior to the petroleum sectors.

Domestically, oil and gas production struggles against declining trends in accessible reservoirs. The United States possesses great oil and gas resources, but they are in small bypassed portions of producing reservoirs and in large untapped, unconventional reservoirs awaiting new technology to economically produce them. Thus, it is critical to make substantial investments in technologies for the development of remaining domestic oil and natural gas resources.

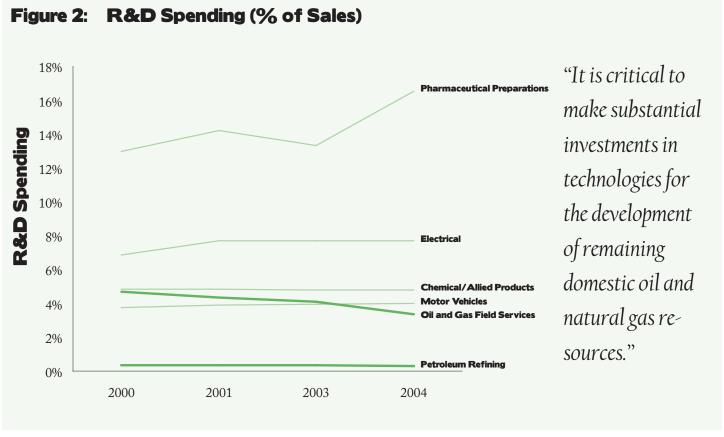


Table 2: Industry R&D as a Percentage of Sales Summary

Industry Name	2000	2001	2002	2003	2004	Average
Computer communication equipment	19.09%	19.12%	18.87%	17.89%	17.27%	18.45%
Prepackaged software	17.44%	17.25%	17.58%	17.91%	17.80%	17.60%
Semiconductor, related device	13.62%	16.45%	16.74%	16.06%	14.84%	15.54%
Pharmaceutical preparations	12.98%	14.20%	13.30%	16.50%	17.09%	14.81%
Radio, TV broadcast, communication equipment	10.78%	11.92%	11.22%	12.28%	10.38%	11.32%
CMP integrated system design	9.10%	8.68%	7.75%	6.72%	5.93%	7.63%
Electrical	6.85%	7.67%	7.70%	7.68%	7.62%	7.50%
CMP processing, data preparation service	7.04%	6.90%	6.98%	6.64%	6.54%	6.82%
Household audio and video equipment	6.41%	6.61%	6.78%	6.95%	7.12%	6.77%
Photographic equipment and supply	6.24%	6.52%	6.66%	6.71%	6.88%	6.60%
Electronic computers	5.42%	5.21%	5.00%	4.81%	4.69%	5.02%
Computer and office equipment	5.34%	5.13%	4.93%	4.76%	4.60%	4.95%
Chemicals and allied products	4.82%	4.81%	4.77%	4.77%	4.34%	4.70%
Motor vehicle parts and accessories	3.92%	4.12%	3.99%	4.13%	4.04%	4.04%
Oil and gas field services	4.69%	4.36%	4.08%	3.36%	3.20%	3.94%
Motor vehicles and car bodies	3.73%	3.88%	3.95%	4.02%	4.06%	3.93%
Aircraft	4.75%	3.89%	3.47%	3.47%	3.45%	3.81%
Phone communication	1.66%	1.71%	1.65%	1.63%	1.44%	1.62%
Petroleum refining	0.35%	0.34%	0.35%	0.31%	0.26%	0.32%
Average	7.59%	7.83%	7.67%	7.71%	7.45%	7.65%
Maximum	19.09%	19.12%	18.87%	17.91%	17.80%	18.45%
Minimum	0.35%	0.34%	0.35%	0.31%	0.26%	0.32%

 ${\it Data:~"R\&D~Growth~Trends:~2005~Edition,"} {\it Schonfeld~\&Associates,Inc.}$

Upstream Oil and Gas R&D Investments

The Energy Information Administration's Financial Reporting System provides a comprehensive look at the principal domestic R&D-funding oil and gas producing companies and where they spend their research and development dollars. Table 3 provides that data. Of special note is the consolidated R&D spending for upstream oil and gas recovery shown in Figure 3.

Twenty-nine companies reported information for 2004, including all of the major multinational companies and the largest independent producers. The year 2003 was the low water mark for R&D funding by producing companies. Private communications indicate that upstream R&D spending continues to grow, consistent with the data in Table 1.

Of interest is the distribution of R&D funds as reported by the companies. The bulk of R&D is divided into three large portions in upstream, other petroleum and non-energy R&D.

Non-energy related R&D finally has eclipsed upstream in company expenditures. This distribution provides a clearer understanding of how R&D funds are split in the petroleum refining sector in Figures 1 and 2. 'Other Petroleum' is a euphemism for refining and environmental categories.

A new trend has emerged in petroleum upstream funding, however, as illustrated in Figure 5.

The petroleum service companies' R&D expenditures have been increasing significantly since 1997, which has served to make up for the large decreases in upstream R&D expenditures by the producing companies. This analysis provided by Dr. Scott Tinker, director of the Texas Bureau

of Economic Geology, was principally derived from Cambridge Energy Research Associates.

There are two mitigating factors for this apparent upstream R&D spending increase. First, much of what is categorized as R&D is support to specific field projects and is not readily transferable to a more general knowledge base. Second, an increasing portion of company-funded external research (including academic research) is spent overseas near the producing companies' operations there.

Notable Quotes

"The remaining targets for the oil and gas industry are primarily unconventional resources and they are poorly understood. New understanding and technology will be required to unlock these resources. This endeavor will require significantly greater R&D expenditures than we have seen in the last two decades from all sources."

Scott W. Tinker, director of the Bureau of Economic Geology, University of Texas

Table 3: R&D Expenditures for Energy Information Administration Financial Reporting System Companies (2000-2004)

(Millions \$)

Sources of R&D Funds	2000	2001	2002	2003	2004
Internal Company	1316	1542	1742	1523	1508
Other Sources	10	28	11	11	37
Total Sources	1326	1570	1753	1534	1545

Breakdown of R&D Expenditures							
Oil and Gas Recovery (Upstream)	453	592	464	370	507		
Other Petroleum	327	376	656	357	267		
Other Nonconventional Energy	*	*	59	54	113		
Non-Energy	452	526	517	676	606		
Other Unassigned	94	76	67	77	52		
Total Expenditures	1326	1570	1753	1534	1545		

^{* =} Not Reported

Source: Energy Information Administration (EIA), Financial Reporting System. Major energy-producing companies based in the United States annually report their worldwide financial and operating data to the EIA on a uniform and standarized basis on FRS Form EIA-28. The FRS is designed to permit review of the functional performance of the major U. S. energy-producing companies in total, as well as by specific functions and geographic areas of operation. In 2003, 29 companies filed this information.

Figure 3: Upstream Oil and Gas Recovery R&D Spending

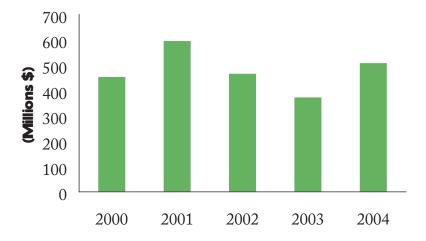


Figure 4: R&D Categories for FRS Reporting Companies

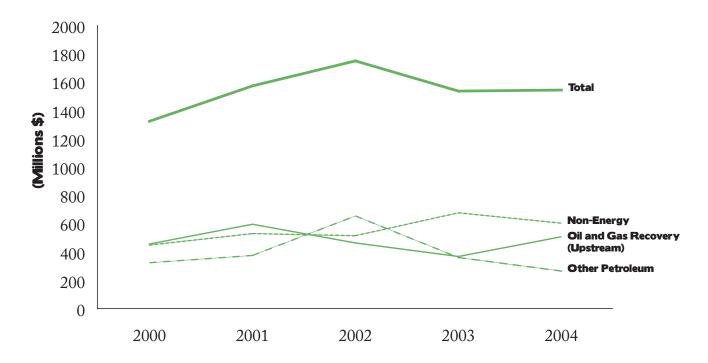


Figure 5: Upstream R&D Investments (2004 Dollars)



Figure from Dr. Scott Tinker, Texas Bureau of Economic Geology, private communication.

^{*} U.S. E&P firms and the U.S. R&D investments of international E&P firms; source Department of Energy, EIA, CERA analysis.

^{**} Traditional Oil Field Service companies (Baker Hughes, Halliburton, Schlumberger, Smith, Weatherford); source, company annual reports, CERA analysis.

Impact of Continuing Corporate Consolidation

Since the 2002 update, Conoco and Phillips merged to continue the shrinking pool of large multinationals. Several large independents have been acquired by the multinational oil companies, primarily to increase their reserve holdings, especially domestic natural gas reserves.

In the case of the 2004 ConocoPhillips merger, the upturn in upstream R&D expenditures hid any trend of R&D spending reductions. However, the shrinking pool of major multinational and large independent companies has taken a toll on consortia funding for domestic university research programs. Now there are only about half the number of companies active in funding those academic programs. The result is a continuing struggle for new funding mechanisms which has been compounded by shrinking federal petroleum R&D funding in academia.

Notable Quotes

"Major oil companies' R&D is targeted where they're spending money, which is mostly overseas and largely proprietary."

Lee Fuller, IPAA vice president for governmental affairs, Oil and Gas Journal, March 27, 2006

FOCUS ON: R&D Phases

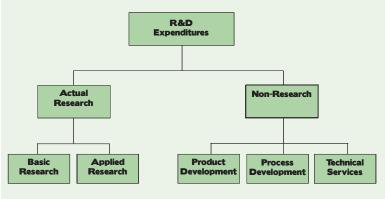
National Science Foundation Definitions of R&D Phases

<u>Basic Research</u>: In industry, basic research is defined as research that advances scientific knowledge but does not have specific immediate commercial objectives, although it may be in fields of present or potential commercial interest.

<u>Applied Research</u>: In industry, applied research includes investigations oriented to discovering new scientific knowledge that has specific commercial objectives with respect to products, processes or services.

<u>Development</u>: Development is the systematic use of the knowledge or understanding gained from research directed toward the production of useful materials, devices, systems or methods including the design and development of prototypes and processes.

Components of Industry R&D Expenditures Oil and Gas Industry Upstream



Source: Intek, Inc. study performed for U.S. DOE

Federal R&D Budget Trends

The American Association for the Advancement of Science (AAAS) in its "Congressional Action on Research and Development in the FY 2006 Budget," reports the federal fiscal outlook remains bleak and federal R&D investments are shrinking as a share of the U.S. economy.

The apparent bipartisan and widespread concern that the strong U.S. technology leadership position was being eroded by other growing economies was ineffective in boosting R&D investments.

Federal R&D increases in the last decade have been driven by the Department of Defense R&D appropriations and by the doubling of the National Institute of Health's budget. NIH is now the largest non-DoD R&D budget.

DoD's R&D budget is more biased toward development than ever as it reacts to challenges in the global war on terrorism and the war in Iraq.

Since the last update, the Department of Homeland Security, a monolithic organization, has been constituted. Its R&D budget has been growing and will likely continue to do so, providing even more competition for funds in a tight federal R&D budget.

The past two budget cycles have seen an increase in the amount of congressional R&D budget earmarks that have a significant impact on a few agencies and programs. According to AAAS in 2006, "R&D earmarks eat up whatever increases there are for most energy programs and cut deeply into core R&D programs."

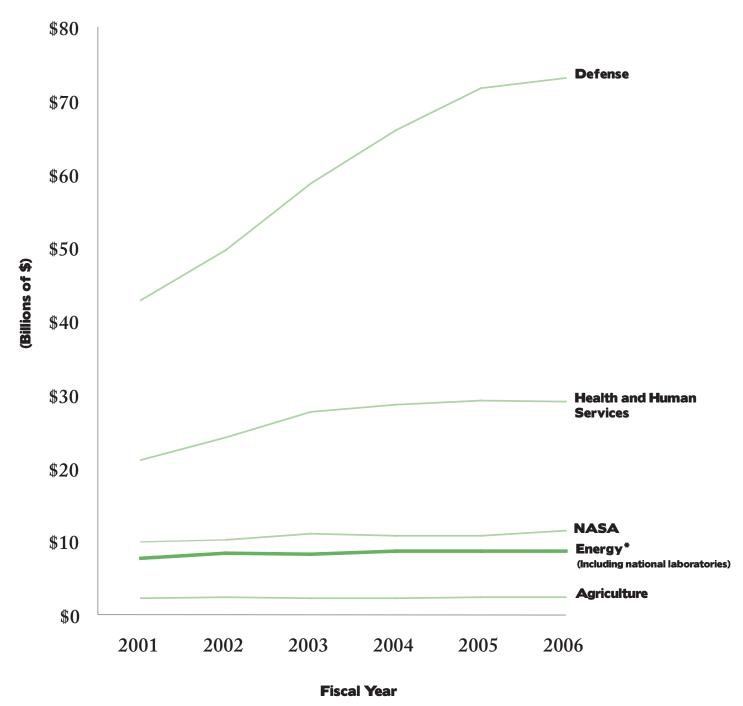
Table 4 and Figure 6 illustrate the large increases in the federal R&D budget authority since 2001. The Department of Energy's overall R&D budget, while showing some modest increases, resulted in reduced effectiveness in certain energy supply categories since 20 percent of the budget was earmarked in 2006.

Table 4: R&D by Federal Agency, 2001-2006, Budget Authority in Billions (\$)

	2001	2002	2003	2004	2005	2006
Defense	42.74	49.64	58.7	65.95	71.57	73.04
Health and Human Services	21.04	24.14	27.57	28.52	29.08	29.02
NASA	9.89	10.23	11	10.8	10.7	11.37
Energy	7.73	8.36	8.22	8.71	8.61	8.61
Agriculture	2.18	2.33	2.28	2.22	2.4	2.39
Homeland Security	0	0	0.67	1.03	1.24	1.28
Interior	0.62	0.66	0.63	0.63	0.62	0.63
EPA	0.57	0.59	0.64	0.66	0.57	0.57

Source: American Association for the Advancement of Science, AAAS Report XXVII: Research and Development FY 2003; AAAS report XXX: Research and Development FY 2006; AAAS Congressional Action on Research and Development in the FY 2004 Budget; Congressional Action on Research and Development in the FY 2006 Budget.

Figure 6: Budget Authority for R&D by Agency



^{*} Includes all sources of energy, with \$65 million budgeted for oil and natural gas RED in 2006.

U.S. Department of Energy R&D Funding

Table 5 indicates the overall DOE R&D budget has generally increased over the last half decade. The administration's FY 2007 congressional budget request proposes further increases in overall R&D spending for DOE, most notably in the Office of Science. These laudable increases support broad segments of the U.S. economic engine as well as prepare the nation for paradigm changing technologies needed for coming decades.

For conservation, solar, renewables, nuclear and fossil energy technologies where R&D is essential to gain maximum benefit from still vast domestic resources, the picture is less positive.

Fossil energy research and development activities have remained relatively constant with some fluctuations as shown in Table 6.

However, in the oil and natural gas area there has been a significant decline in overall funding, as illustrated in Figure 7, with the administration in essence proposing the elimination of federal oil and gas R&D for the last few budget requests.

Oil and gas R&D funding increased in response to historically low prices in 1999, but has dramatically decreased as prices have risen as much as six-fold.

Table 5: Department of Energy R&D (in Millions \$)

	2001	2002	2003	2004	2005	2006
Energy Supply R&D*	409	262	309	382	423	469
Fossil Energy R&D	306	446	483	547	448	474
Energy Conservation**	441	434	427	379	367	306
Science***	2,955	3,074	3,075	3,229	3,334	3,320
Atomic Energy Defense Activities	3,499	3,761	3,869	4,198	4,138	4,038
Radioactive Waste Management	45	60	62	75	63	22
Total DOE R&D	7655	8037	8225	8810	8773	8629

^{*} Energy Supply includes Solar and Renewables and Nuclear Energy

Source: American Association for the Advancement of Science, AAAS R&D Funding Update - DOE R&D in FY 2002, 2003, 2004, 2005, 2006.

Table 6: Fossil Energy R&D Budget 2001 – 2006 (in Millions \$)

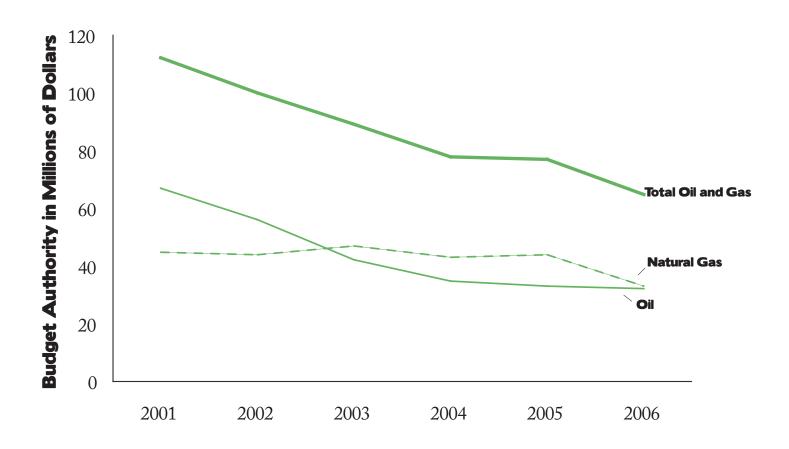
	2001	2002	2003	2004	2005	2006
Coal and Power	324	390	410	450	342	376
Oil	67	56	42	35	33	32
Natural Gas	45	44	47	43	44	33
Total	436	490	499	528	419	441

Source: U.S. DOE Office of Fossil Energy. Excludes Clean Coal Technology Program and other non-R&D funds.

^{**} In FY 2006 distributed energy R&D transferred from Energy Conservation to Electricity Transmission.

^{***} Science includes High Energy Physics, Nuclear Physics, Fusion Energy Sciences, Basic Energy Sciences, Advanced Scientific Computing Research, Biological and Environmental Research, Energy Research Analyses, and Multiprogram Lab Support.

Figure 7: DOE Oil and Gas R&D Budget History



The Energy Policy Act of 2005

Comprehensive energy legislation was enacted in 2005. While many R&D areas, including several related to fossil energy, were authorized, an entirely new mechanism for oil and gas research, development and demonstration was established. Fifty million dollars a year were set aside from royalties, rents and bonuses collected from federal offshore oil and gas leases, beginning in 2007 and continuing through 2017, for the Ultra-Deepwater and Unconventional Onshore Natural Gas and Other Petroleum Research and Development Program.

The Research Partnership to Secure Energy for America (RPSEA) – a non-profit consortium – has been selected to implement this program. The Department of Energy will oversee the program. Thirty-five percent of the funds go to the development and demonstration of exploration and production technologies in ultra-deep water (greater than 1500 meters). Nearly 33 percent of the funds focus on unconventional resources emphasizing natural gas, and 7.5 percent of the funds go to consortia organized for the benefit of small producers (less than 1000 barrels per day) addressing areas of complex geology, unconventional gas resources, and unconventional oil resources including oil shales and tar sands. The remaining 25 percent is reserved for inhouse R&D at the National Energy Technology Laboratory for oil and gas R&D complementary to the above 75 percent of funds. Ten percent of the funds are allowed for administration of the program. Additional funding for this program is authorized up to \$100 million per year from 2007 through 2016.

The program will allow RPSEA to provide much-needed funds for research in selected areas. There are, however, many additional possibilities for projects that focus on improving recovery processes and technology used for both more traditional and other unconventional resources.

Notable Quotes

"...oil and gas provide 60 times the amount of energy to our country than the renewable sources of wind, solar, biomass and geothermal do combined. In other words, a federal investment of \$1 in oil and gas research equates to the same energy output as \$1,200 invested in renewables and has for the past 20 years...The investment that the federal government makes to support ongoing oil and gas research is returned via taxes and royalties at significant multipliers. Instead of "corporate welfare," perhaps it should be called a wise federal investment."

Scott W. Tinker, director of the Bureau of Economic Geology, the University of Texas at Austin and Eugene M. Kim, research associate, Bureau of Economic Geology Oil and Gas Journal, Sept. 27, 2004

R&D Spending Outlook

While total research and development spending remains high, Batelle's "2006 Research and Development Funding Forecast" lists several important factors that will likely restrain future R&D spending:

- The federal deficit will have a major impact on discretionary government spending. The costs of the war in Iraq and hurricane relief programs are straining the federal budget. R&D is an opportune target.
- The global war on terrorism will demand more defense spending with a reduced emphasis on research.
- Major increases in foreign operations funding by industry will reduce domestic R&D expenditures.
- Industrial R&D spending in growing overseas markets, especially China and India, is increasing.
- The potential for shortfalls in availability of research scientists and engineers in the United States appears unavoidable.

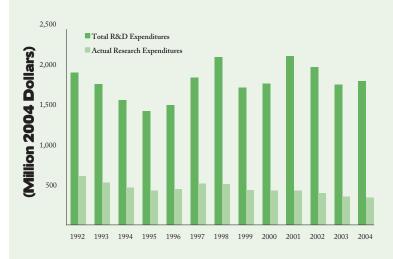
Battelle also warns that a faltering public understanding of science and the role of technology in the United States could be significant in reducing our technology leadership role.

These factors and the trends discussed foretell of increasing difficulty for advancing research and development in the United States. For energy R&D, especially oil and natural gas upstream R&D directed at the nation's domestic resources, the battle will be even more difficult.

FOCUS ON: Actual Research

A recent study commissioned by the U.S. Department of Energy and performed by Intek, Inc. shows that while industry "total" R&D expenditures are massive, "actual" research expenditures are about 19 percent of the total R&D Budget. The balance, is spent in non-research activities.

Total R&D Vs. Actual Research Expenditures Oil and Gas Industry (Upstream)



"Actual" research expenditures have decreased by 44 percent since 1992.

Source: Intek, Inc. study performed for U.S. DOE



P.O. Box 53127, Oklahoma City, OK 73152 Toll Free: 1.800.822.4015, Phone: 405.525.3556 Email: iogcc@iogcc.state.ok.us World Wide Web: www.iogcc.state.ok.us