

## INVESTMENT DECISION-MAKING IN THE OIL AND GAS SUPPLY SECTORS

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### INTRODUCTION

It is appropriate to begin this White Paper entitled “Investment Decision-Making in the Oil and Gas Supply Sectors” with the quote from Robert S. Pindyck, a well-known economics professor at MIT:

*“Despite its importance to economic growth and market structure, the investment behavior of firms, industries, and countries remains poorly understood. Economic models have had a limited success in explaining and predicting changes in investment spending”. . . .(Pindyck, 1991).*

The above comment by Pindyck is equally true today as it was in 1991, particularly on how “price foresight” is used in making investment decisions in the energy supply sector. Still, observations from over two decades of data on investments in oil, gas and coal supply help provide empirical evidence of how industry investments relate to prices, cash flow and other decision variables, as set forth in this White Paper.

### PURPOSE

The purpose of this White Paper is to provide an independent perspective on how industry makes capital investment decisions in the oil and gas supply sector. As such, this White Paper will address three topics:

1. *How are expectations about future market prices formed;*
2. *What factors are central to making investment decisions in the oil and gas supply sector; and*

3. *To what extent is “perfect foresight”, with respect to future prices, used in making investment decisions in the oil and gas supply sectors.*

The intended use of the information in this White Paper is to provide insights as to whether and how the National Energy Modeling System (NEMS) might be revised in the way the oil and gas supply modules incorporate price (and cost) expectations in formulating supply investment decisions.

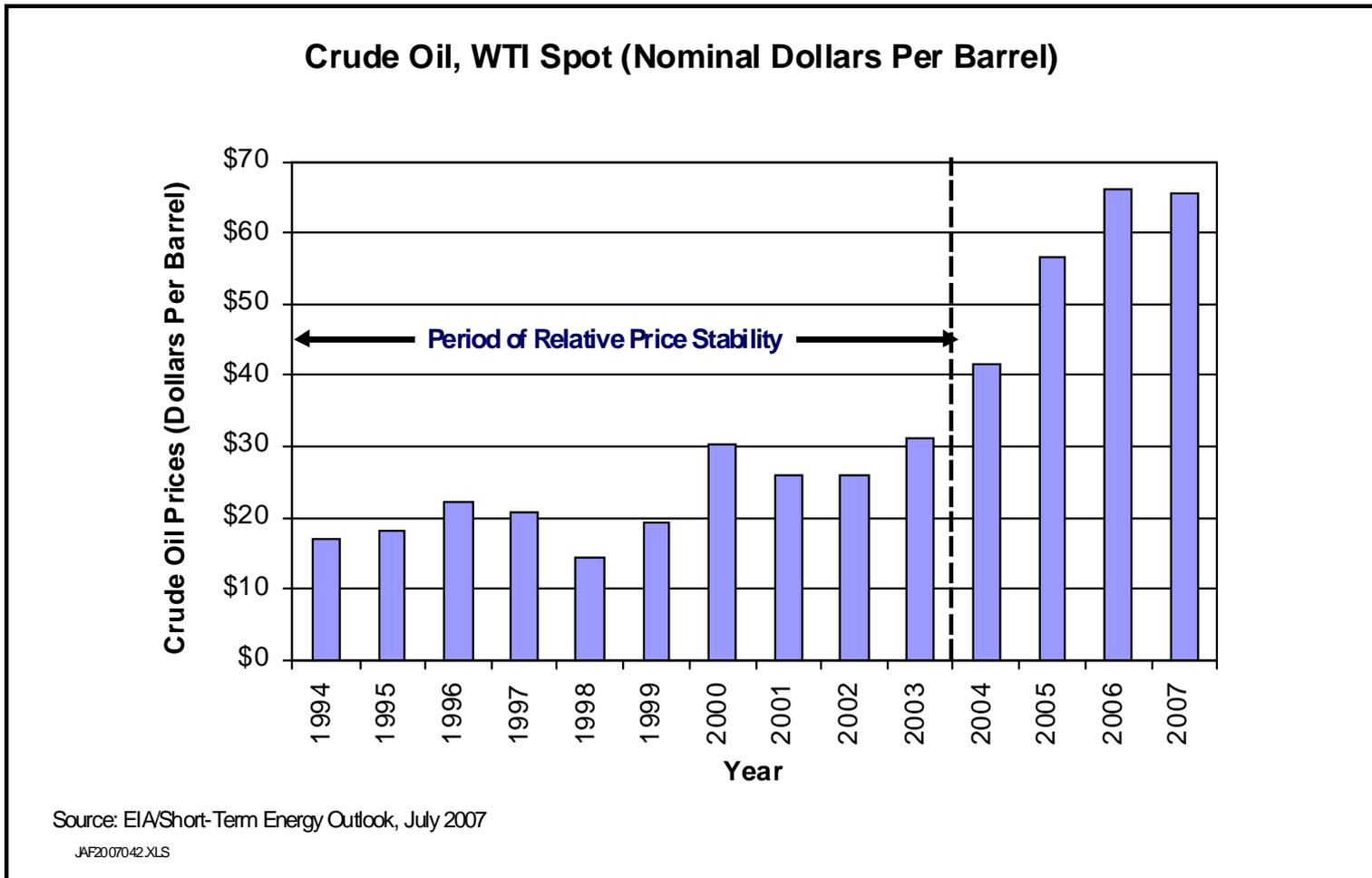
Currently NEMS, in general, uses the economic paradigm of “perfect foresight” in representing how the energy supply sector investment function operates. (However, the oil and gas supply models use the minimum of the current price and the five year average price for making investment decisions.) This theoretically convenient paradigm has been challenged, calling for a review of the validity of the use of “perfect foresight” in NEMS. A key aspect of the review is to provide information, supported by public literature and other verifiable data, on how overall capital investment decisions are made by the oil and natural gas supply sectors.

## **HISTORICAL REVIEW OF OIL AND GAS PRICES**

After years of relative stability, oil and natural gas prices began to fluctuate and then increase sharply in recent years, adding uncertainty as to what is the appropriate price track for making long-term investment decisions.

- Oil prices (WTI spot) were relatively stable for tens years, from the early 1990s to the early 2000s. During this time, oil prices ranged from \$20 to \$30 per barrel (nominal) with one sharp decline to below \$15 per barrel in 1998. Since 2003, oil prices have climbed steadily to over \$90 per barrel at the end of 2007, Figure 1.

Figure 1. Annual Average U.S. Crude Oil Prices

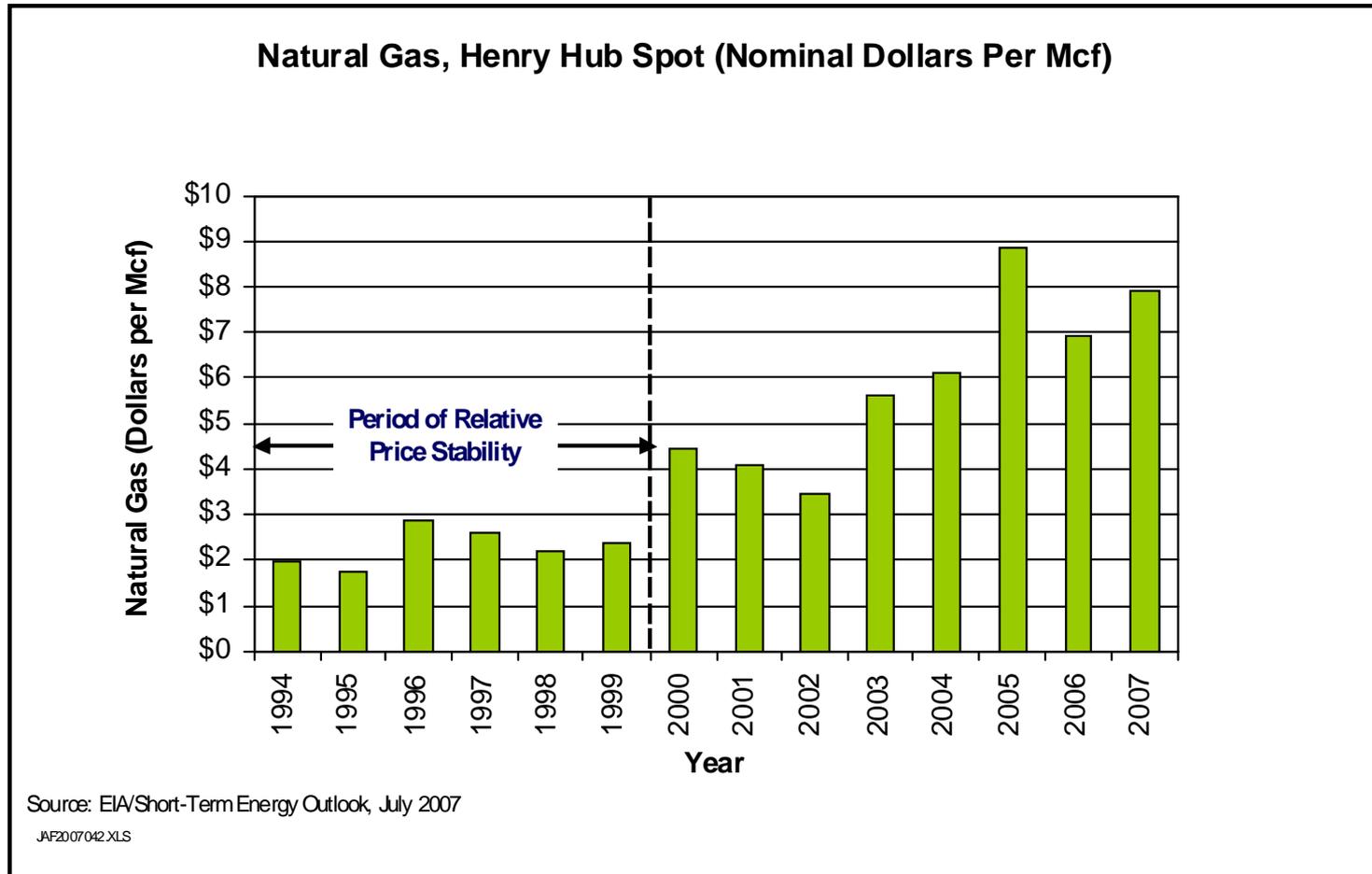


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- Natural gas prices (Henry Hub spot) had their own, more than a decade, period of price stability (from mid 1980s through 1999). During this time, natural gas prices averaged about \$2/Mcf, with a modest price spike in 1996/97. Since 1999, natural gas prices have experienced major volatility. Prices doubled from these historical levels in 2000, then declined, only to reach a new high of \$9/Mcf in 2005, Figure 2. Weekly natural gas prices experienced even more volatility, reaching a high of \$13/Mcf in the winter of 2005/2006 and a low of \$5/Mcf in the fall of 2006, Figure 3. Of particular interest is the recent sharp divergence of oil and natural gas prices, from their traditional relationships, adding further uncertainty to future price expectations for natural gas, Figure 4.

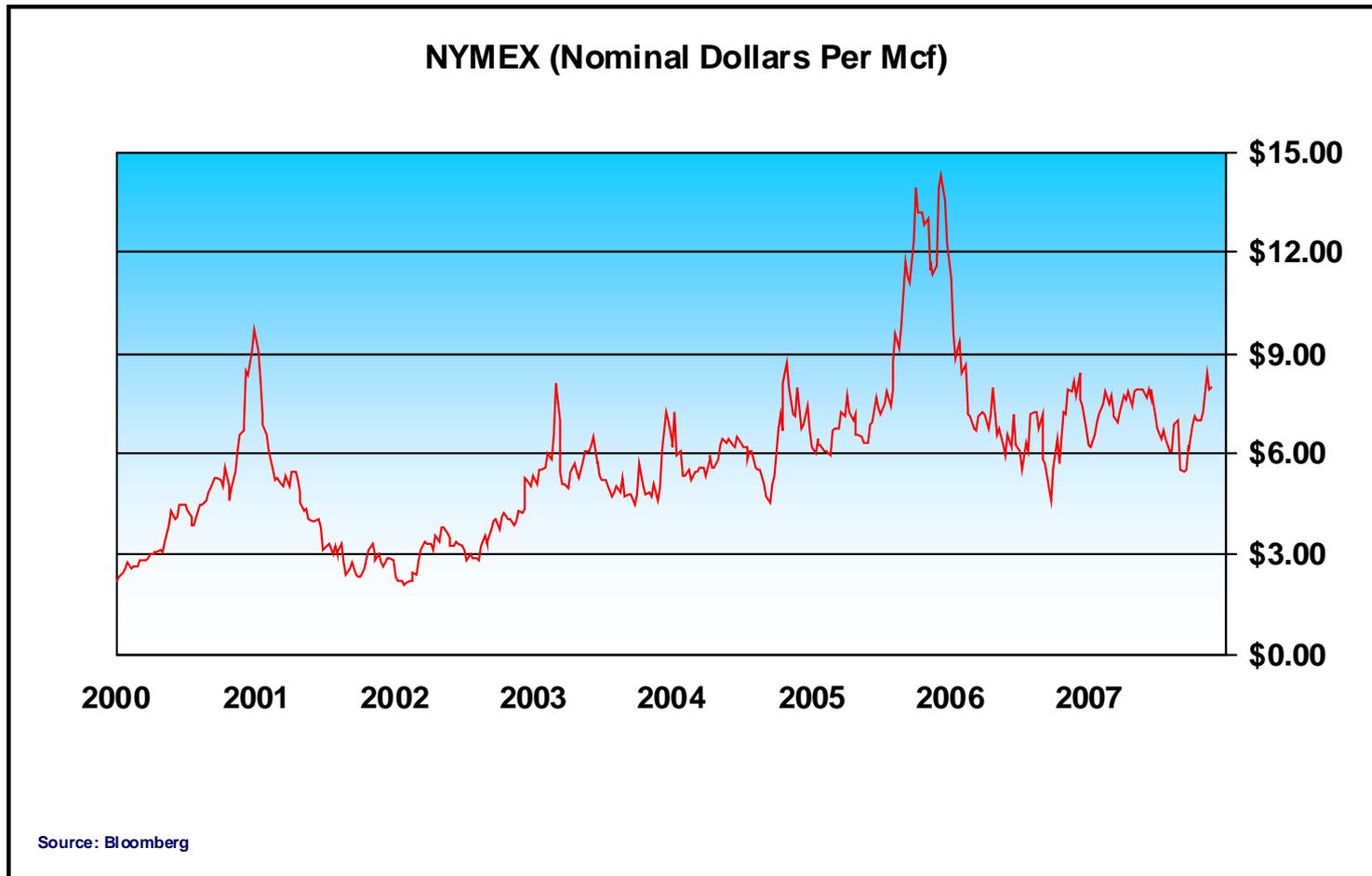
This historical review of oil and natural prices provides background and context for examining price expectations for capital investment decision-making in these two important energy supply sectors.

Figure 2. Annual Average U.S. Natural Gas Prices



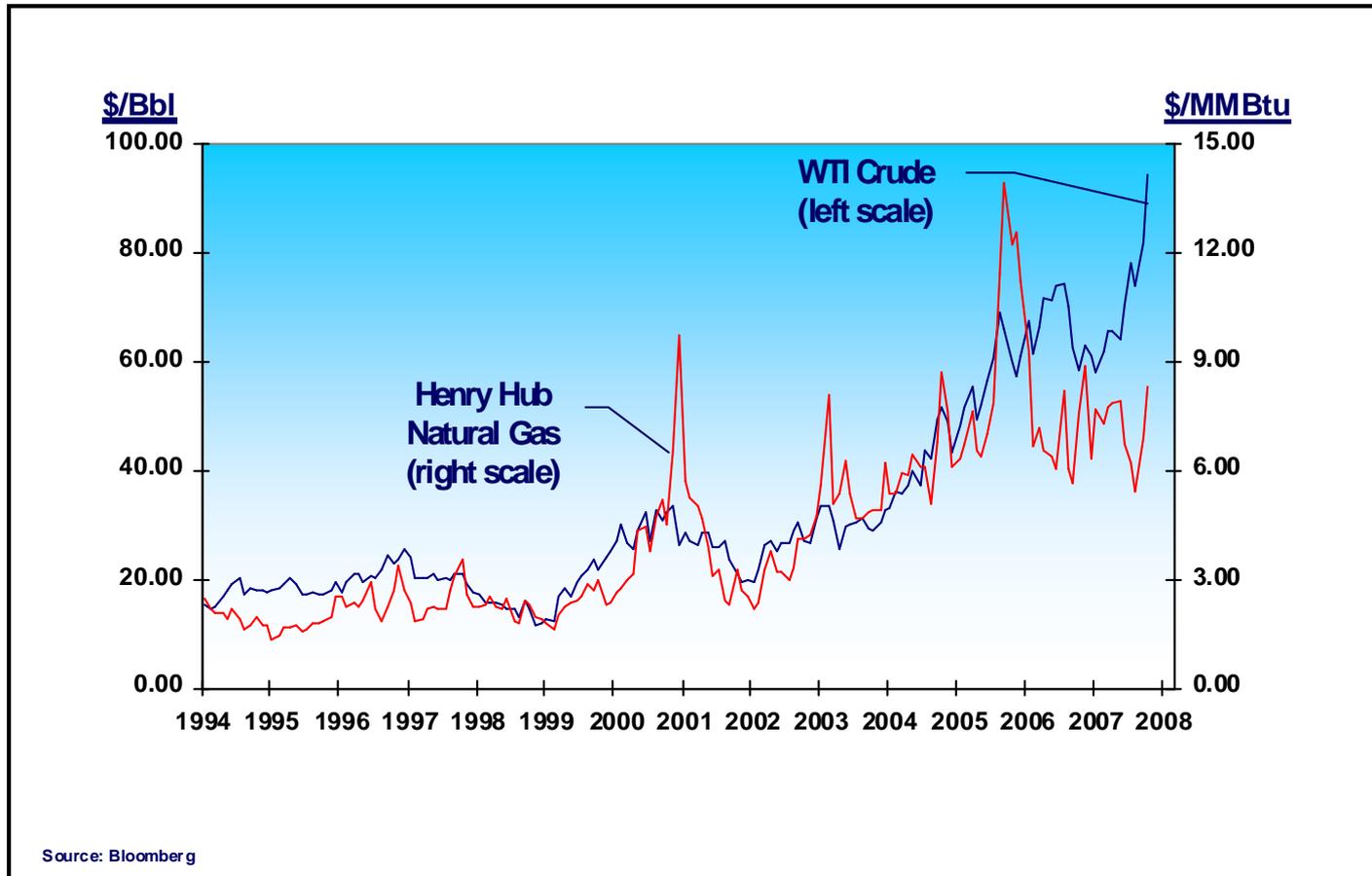
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Figure 3. Weekly U.S. Natural Gas Prices



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Figure 4. Relationship of Oil and Natural Gas Prices



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## ALTERNATIVE SOURCES FOR PRICE PROJECTIONS

In addition to the price projections in EIA's AEO, a variety of sources provide price forecasts, expectations and guidelines for making investment decisions by the oil and natural gas industry. These sources (whose price projections are regularly reviewed in the AEO), include firms such as GII (Global Insight, Inc.), EVA (Energy Ventures Analysis, Inc.), EEA (Energy and Environmental Analysis, Inc.), DB (Deutsche Bank), SEER (Strategic Energy and Economic Research, Inc.), and Altos (Altos Partners North American Regional Gas Model). In addition, numerous other firms provide private, confidential guidance on projections of energy prices, such as CERA (Cambridge Energy Research Associates).

Table 1, below provides a brief comparison of the oil and natural gas price projections for year 2025 in EIA's AEO 2007 and the range of price projections provided by other sources (listed above).

**Table 1. Comparison of Price Projections for Year 2025**

	<b>EIA AEO 2007 Reference Case</b>	<b>Other Sources</b>
<b>World Oil Prices</b> (2005 \$/Bbl)	\$55.72	\$39.95 - \$52.60
<b>Natural Gas Prices</b> (Lower-48 Wellhead, 2005 \$/Mcf)	\$7.51	\$5.61 - \$6.96

These various sources for price projecting each have their industrial constituencies. This variety of information helps shape and add complexity to the energy supply industry's investment decisions.

## REVIEW OF PAST OIL AND NATURAL GAS PRICE PROJECTIONS

One challenge industry faces in using oil and natural gas price projections (by AEO and other sources) is the significant differences that have occurred between projected and actual prices. EIA provides valuable information on this topic by examining the reliability of its own oil and natural gas price projections. While we have not undertaken a rigorous review of the price projections provided by other sources, we believe that the track record of these other price projection sources is similar to that of EIA.

The materials below provide a comparison of EIA AEOs expected and actual year 2005 prices for oil and natural gas.

**Crude Oil Prices.** World oil prices in the past ten AEOs have tended to be underestimated, leading to overestimation of consumption, Table 2. Even more severe price underestimations have occurred for 2007 world oil prices, currently at about \$95 per barrel.

**Table 2. World Oil Price Comparison (Nominal \$ per Barrel)**

AEO Year	Expected Year 2005 Price	Actual Year 2005 Price	% Difference
1996	\$29.87	\$48.85	-39%
1998	\$25.27	\$48.85	-48%
2000	\$23.23	\$48.85	-52%
2002	\$25.66	\$48.85	-48%
2004	\$24.45	\$48.85	-50%

**Natural Gas Prices.** Natural gas has had the largest difference between price projections and actual price data. In recent years, NEMS has severely underestimated future gas prices, as shown for five of the past AEOs projections of natural gas prices for year 2005 (nominal \$ per Mcf) compared to actual year 2005 price, Table 3.

**Table 3. Natural Gas Wellhead Price Comparison (Nominal \$ per Mcf)**

<b>AEO Year</b>	<b>Expected Year 2005 Price</b>	<b>Actual Year 2005 Price</b>	<b>% Difference</b>
1996	2.72	7.51	-64%
1998	2.69	7.51	-64%
2000	2.66	7.51	-65%
2002	3.04	7.51	-60%
2004	3.72	7.51	-50%

### **RELATIONSHIP OF PRICES AND COSTS**

One of the major considerations in deciding how to use future prices (price projections) for making investment decisions is judging how future costs will track future prices. Historical data, assembled by EIA as part of the FRS company reporting system, clearly shows that changes in oil and gas lifting costs as well as changes in upstream finding costs (finding costs also include well productivity) are closely related to changes in oil and natural gas prices.

When examining the oil and natural gas price expectations of the Independent Producers and Lenders (Bankers) made in year 2004, it is instructive to note that both groups anticipated increases in costs equal to or in excess of increases in prices, as shown in Table 5:

**Table 5. Long Term (Post 2008) Expectations for Prices and Costs**

<b>Annual Increases Post Year 2008</b>	<b>Natural Gas</b>		<b>Crude Oil</b>	
	<b>Bankers</b>	<b>Producers</b>	<b>Bankers</b>	<b>Producers</b>
▪ Prices of Fuel	1.25%	2.33%	1.25%	1.67%
▪ Costs of Production	1.50%	1.67%	1.50%	1.67%

The insight to be derived from these price and cost expectations are that Lenders (Bankers) expected costs increases to outpace oil and natural gas price increases. Producers expected costs and prices to track for crude oil but believed that for natural gas, higher future prices and an increasing economic margin might enable additional projects to meet an economic threshold.

Because costs have risen so dramatically in the past few years, it is useful to take a more in-depth look at the relationship of prices and costs and how this may be affecting investment decisions.

**1. Changes in Oil and Gas Well Drilling Costs.** After years of relative stability, the drilling costs for crude oil, natural gas and dry wells have increased sharply in recent years, Table 6 (real chained 2000 dollars).

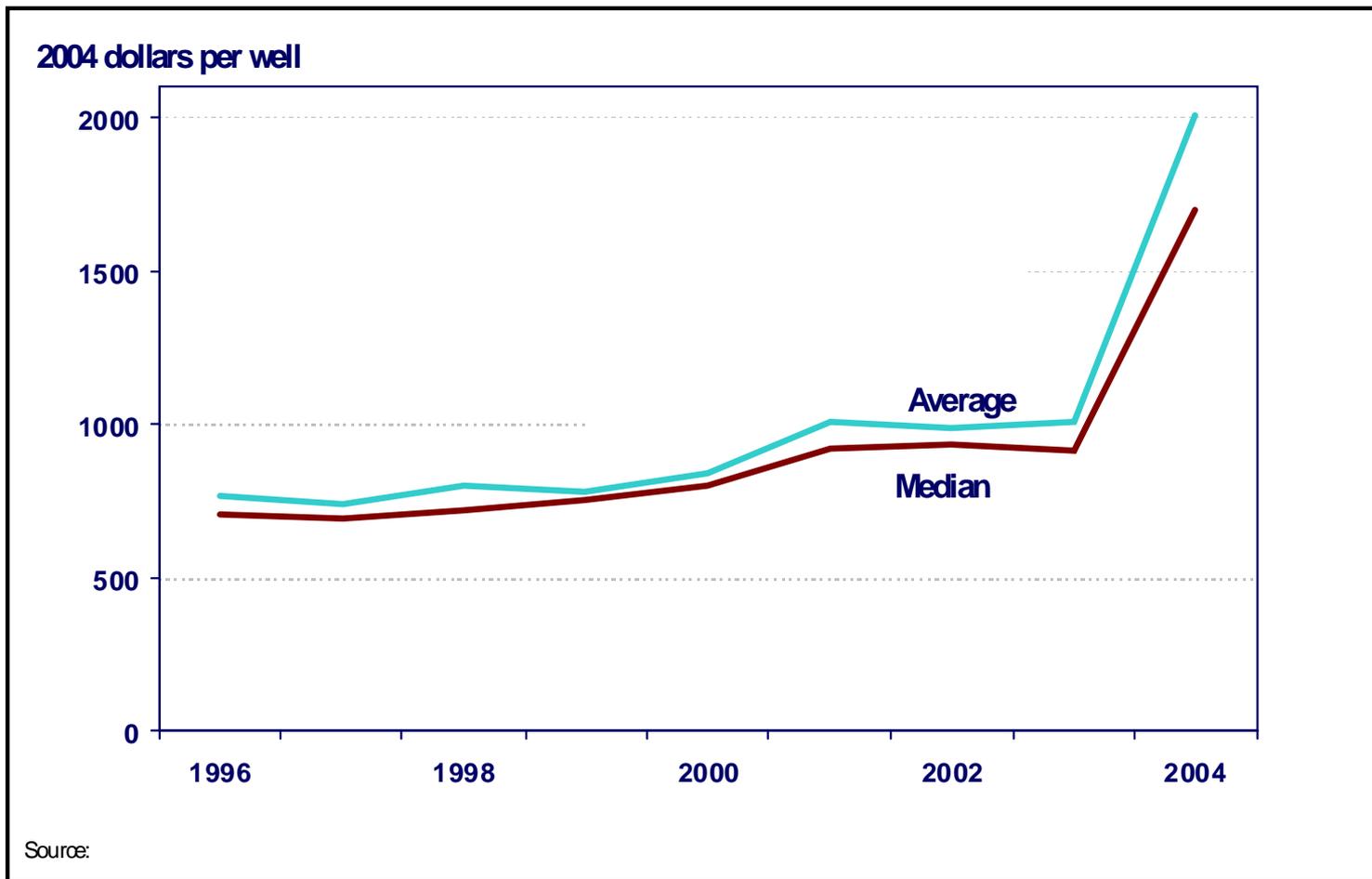
**Table 6. Changes in Oil and Gas Well Drilling Costs**

Year	\$/Well	Change (5 Years Increments)	
		Absolute Change	% Change
1985	501,200		
1990	470,200	(31,000)	-6.2%
1995	557,400	+87,200	+18.5%
2000	754,600	+197,200	+35.4%
2005	1,526,300	+771,700	+102.3%

The data show that since 1985, the drilling costs per well have more than tripled, in real dollars. Preliminary data for 2006 and 2007 indicate that the costs for well drilling have continued to increase, driven by high rig day rates, high prices for steel, and rapidly escalating costs of oil field services and labor.

Figure 5, from EIA AEO 2007, captures the sharp recent rise in drilling costs for onshore natural gas development wells (7,500 to 9,999 feet) from 1996 to 2004, in real 2004 dollars per well.

Figure 5. Drilling Costs for Onshore Natural Gas Development Wells at Depths of 7,500 to 9,999 Feet, 1996-2004



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**2. Examination of Cost/Price Relationships.** As shown on Table 7, in the past 10 years oil and gas well costs have increased as fast or faster than oil and natural gas prices.

**Table 7. Costs of Crude Oil and Natural Gas Wells Drilled and Annual Average U.S. Oil and Natural Gas Prices**

	Well Costs (All Wells)		Prices (Nominal)	
	Nominal*	Real **	Natural Gas (Henry Hub Spot)	Crude Oil (WTI Spot)
	(\$/Ft)	(\$/Ft)	(\$/Mcf)	(\$/Bbl)
1996	82.92	94.74	2.84	22.11
2001	181.94	177.68	4.08	25.95
2005	306.50	271.87	8.86	56.49
2006(e)*	360.00(e)	280.00	6.95	66.02

\*Nominal cost escalation of 17.5% for 2006

\*\*Real 2000 dollars

Source: Well costs, EIA data based on API 2005 JAB (June 2007). Prices, EIA Short Term Energy Outlook (July 2007).

The information on the relationship between oil and gas well costs and prices, presented in Table 7, is further evaluated and summarized below:

- For natural gas, well costs have risen faster than wellhead prices in both the most recent 10 year and the most recent five year time period (prices and costs in nominal dollars).

Time Period	Increase in Well Costs	Increase in Natural Gas Prices
10 Years (1996 – 2006)	X 4.0	X 2.4
5 Years (2001- 2006)	X 2.0	X 1.7

- For crude oil, well costs have risen about the same as oil prices in the most recent 10 year time period, but somewhat less than prices in the most recent five year period (prices and costs in nominal dollars).

Time Period	Increase in Well Costs	Increase in Crude Oil Prices
10 Years (1996 – 2006)	X 4.0	X 4.0
5 Years (2001- 2006)	X 2.0	X 2.5

The overall persistent and close relationship between increases in well costs and increases in oil and gas wellhead prices lead producers to use constant values for oil and gas prices and costs in making investment decisions.

## ESTABLISHING GUIDELINES FOR FUTURE PRICES

Significant differences exist among individual companies and types of companies in their formulation of price expectations for making long-term capital investment decisions. Major oil companies have Economics Departments that invest significantly in understanding market fundamentals, using this information to provide a corporate-wide “price deck” to be used for evaluating investment options. In contrast, the independent sector of the oil and gas industry relies much more on private “energy forecasting” firms and lenders for establishing their price outlook.

- Major Oil Companies.** The large, integrated oil and natural gas companies, such as BP, Chevron, ConocoPhillips and Shell, use an internally generated “price deck” for evaluating investment options and deciding which of these investment options to incorporate into the annual capital investment budget.

In general, although the actual “price deck” information is kept confidential, some of this information is divulged in public announcements. One common “price deck” model uses a lagging three year average of prices, held constant (in real terms) for future years. This provides a conservative, “backward looking” expectation for future

oil and natural gas prices. Another major company's "price deck" model relies on the principle of "revision to the mean". This model was popular in the late 1990s and early 2000s, leading to several of the major oil companies using much lower oil price expectations of \$15 to \$20 per barrel, even after oil prices exceed \$30 per barrel.

In recent years, major companies have steadily increased the values used in the "price deck", either by incorporating newer (and higher) price data into the three year average or by benchmarking a higher value for the "mean."

- **Independent Oil and Gas Companies and Banks.** To a large extent, the independent oil and gas companies, net borrowers of capital, rely on oil and gas price forecasts and expectations provided by outside firms and bankers.

In general, the price outlook by bankers is less optimistic than by independent producers. For example, the OGJE/Madison Energy Advisors' pricing poll (in early 2004) shows the significant differences in the expectations by Bankers and by Producers for future natural gas and crude oil prices, Table 8 and Table 9.

**Table 8. Natural Gas Price Expectations (\$/MM Btu, Henry Hub Spot)**

	<b>Bankers</b>	<b>Producers</b>	<b>Difference</b>
Current Year (2004)	\$4.00	\$4.85	-\$0.85
2007	\$3.63	\$4.34	-\$0.71
2008	\$3.65	\$4.40	-\$0.75
Price Cap	\$4.25	\$6.00	-\$1.75

**Table 9. Crude Oil Price Expectations (\$/Bbl, WTI Spot)**

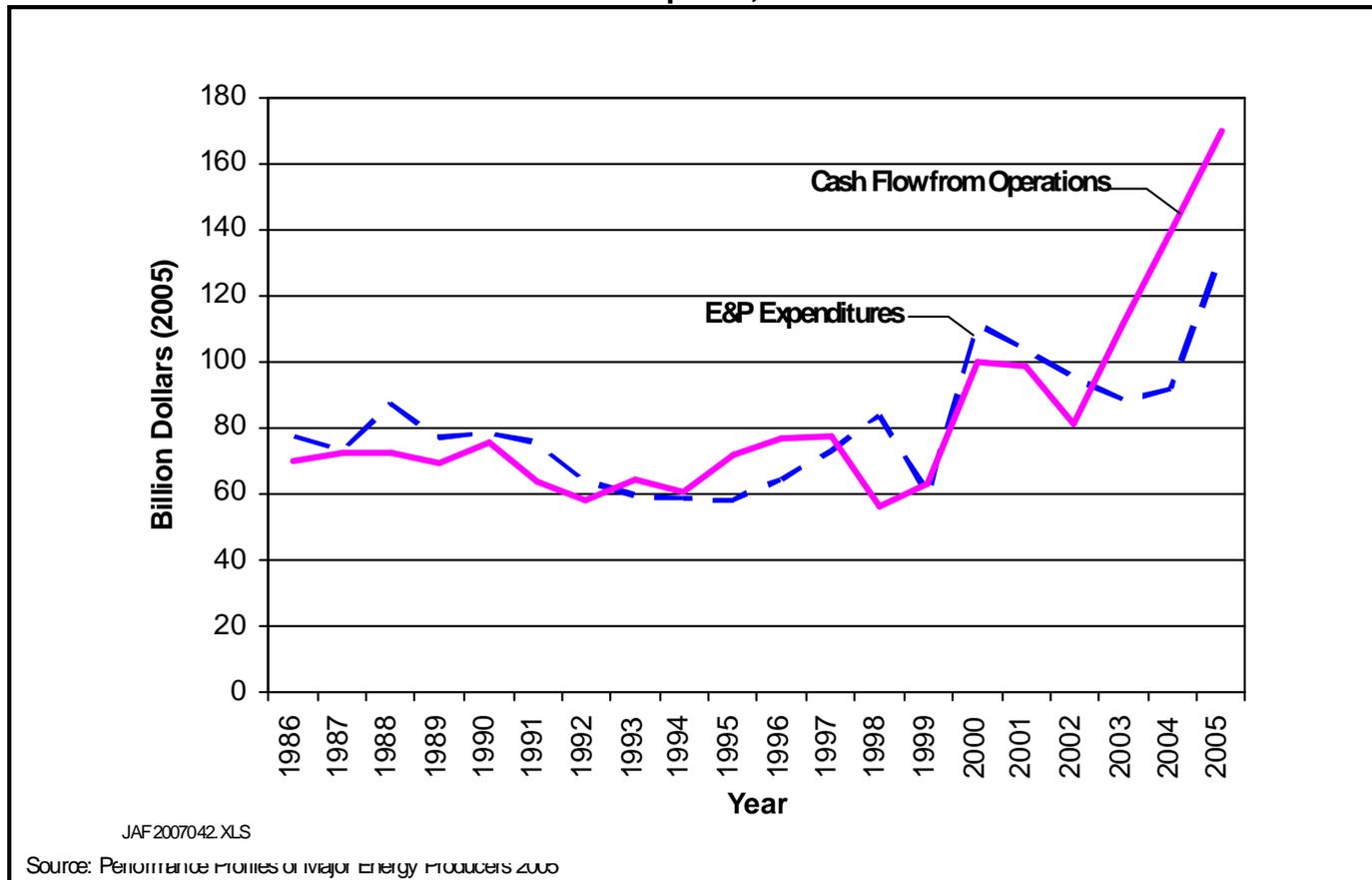
	<b>Bankers</b>	<b>Producers</b>	<b>Difference</b>
Current Year (2004)	\$24.61	\$26.45	-\$1.84
2007	\$23.65	\$25.18	-\$1.54
2008	\$23.96	\$25.35	-\$1.39
Price Cap	\$32.50	\$32.50	-

## FACTORS CENTRAL TO INVESTMENT DECISION-MAKING FOR ENERGY SUPPLY

The above review of price forecasts and expectations provides a useful starting point for understanding how expectations about future market prices are formed. However, price expectations are only of the factors that help form investment decisions in the energy supply sector. Other key factors central to investment decision-making in the energy supply sector include:

- **Cash Flow.** The amount of annual investment that a company makes is governed greatly by its cash flow (and the borrowing capacity this cash flow will support). Figure 6 shows that the annual cash flow from operations track closely with the E&P investment decision made by major oil and gas companies
- **Cost and Margin Expectations.** The key variable for evaluating return on investment is the economic margin, the difference between prices and costs. As such, in addition to price expectations, an equally central investment factor is expectations for changes in costs.
- **Portfolio of Opportunities.** A third factor central to investment decisions in the energy supply sector is the portfolio of upstream opportunities available to individual companies, as well as to the overall industry. In recent years, a number of major companies have used their cash flow to “buy back” company stock, implying a lack of investment opportunities that would provide a higher return on investment than their existing portfolio of past investments.
- **Other Factors.** In addition to the above, a number of other factors enter an investment decision in energy supply, including market demand, access to resources, and acceptable risk.

**Figure 6. Cash Flow from Operations and Exploration and Production (E&P) Expenditures for FRS Companies, 1986-2005**



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## **USE OF “PERFECT FORESIGHT” FOR INVESTMENT DECISION-MAKING**

Given the information assembled and presented on the energy supply industry’s investment decision-making, it appears that “perfect foresight”, while a convenient, unifying paradigm, is not a guiding principle in actual investment decisions.

- Examination of past price productions shows a wide disparity between projected and actual prices,
- Changes in costs, often equal to changes in prices, argue that the economic margin for justifying investments can be approximated reliably by using similar escalation factors for costs as used for prices,
- Few, if any, significant energy supply companies use models based on “perfect price foresight” for making energy investments. Bankers and other industry analyses would view those who use such price expectations, particularly to justify investing in projects requiring a rising price to make the investment economic, to be overly aggressive and insufficiently prudent.

## CONCLUDING DISCUSSION AND RECOMMENDATIONS

Based on the above review and information, the White Paper makes the following recommendations for improving the modeling of investment decisions in the oil, natural gas supply industry.

**Recommendation #1. Relate Annual Investment to Actual/ Expected Cash Flow.** The historical data, plus considerable prior experience, show that the oil and natural gas supply industry scales its annual investment to actual and expected cash flow.

- For large energy companies (particularly the high market cap FRS companies, listed in Attachment 1), annual investment has traditionally ranged from 70% to 90% of cash flow, Table 10, including profits from operations, cash from depreciation/amortization, plus net new borrowings and equity offerings, after distribution of dividends. Table 11 provides additional detail on the source and uses of cash by FRS companies.

**Table 10. Relationship of Annual Investment to Annual Cash Flow, FRS Companies**

	<b>Cash Flow</b>	<b>Additions to Investment</b>	<b>% Cash Flow Used for Investment</b>
2003	105.1	80.0	76%
2004	135.8	86.5	64%
2005	169.9	132.9	78%
2006	193.3	194.7	101%
<b>TOTAL (2003-2006)</b>	<b>604.1</b>	<b>494.1</b>	<b>82%</b>

**Table 11. Sources and Uses of Cash for FRS Companies, 2003-2006 (Billion Dollars)**

	2003	2004	2005	2006
<b>MAIN SOURCES OF CASH</b>				
<b>Cash Flow from Operations</b>	<b>105.1</b>	<b>135.8</b>	<b>169.9</b>	<b>193.6</b>
Proceeds from Long-Term Debt	26.4	18.5	29.6	87.1
Proceeds from Disposals of Assets	16.1	19.7	35.9	41.6
Proceeds from Equity Security Offerings	8.4	8.1	10.5	22.6
<b>MAIN USES OF CASH</b>				
<b>Additions to Investment in Place</b>	<b>80.0</b>	<b>86.5</b>	<b>132.9</b>	<b>194.7</b>
Reductions in Long-Term Debt	26.2	18.4	33.3	55.2
Dividends to Shareholders	42.8	36.5	39.7	38.5
Purchase of Treasury Stock	6.1	14.0	31.8	41.7
Other Investment and Financing Activities, Net	-	-5.5	6.3	-21.8
<b>Net Change in Cash and Cash Equivalents</b>	<b>8.8</b>	<b>21.2</b>	<b>14.4</b>	<b>-7.0</b>

Source: Energy Information Administration, Form EIA-28 (Financial Reporting System).

- For mid-size energy companies, capital investment for E&P has traditionally been in excess of 100% of cash flow, as borrowing and issuance of equity (often equal to cash flow from operations) has been used to drive growth. Figure 7 provides net cash flow and capital investment information, for years 2006 and 2007, for a mid-size oil and gas company, showing annual investments equal to more than twice the internal cash flow.

Figure 7. Relationship of Capital Investment to Cash Flow -- A Mid-Size Energy Company

	<u>2006 Actual</u>	<u>2007 Guidance</u> <u>NYMEX Price Assumptions</u>
	<u>\$7.23 Gas</u> <u>\$64.74 Oil</u>	<u>\$7.00 Gas</u> <u>\$70.00 Oil</u>
➤ Net Income	\$162.6 MM	\$200 - \$205 MM
➤ EPS	\$0.95	\$1.16 - \$1.19
➤ Operating Income	\$246.3 MM	\$355 - \$360 MM
➤ Net Cash Flow <sup>(1)</sup>	\$413.5 MM	\$610 - \$620 MM
➤ EBITDA <sup>(1)</sup>	\$414.5 MM	\$630 - \$640 MM
➤ CapEx	\$942.4 MM	\$1,455 MM

Note: Guidance updated as of October 31, 2007. 2006 oil and gas prices include actual last-day NYMEX closing prices.

(1) Net cash flow is net cash flow before changes in operating assets and liabilities. Net cash flow and EBITDA are non-GAAP financial measures. See explanation and reconciliation of non-GAAP financial measures on pages 41 and 42.

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**Recommendation #2. When Calculating Expected Cash Flow Include an Algorithm That Relates Future Prices to Future Costs.** The historical data shows that the costs of developing oil and natural gas are closely linked to prices, as discussed above. As such, we make two suggestions within Recommendation #2:

- Develop a rigorous relationship between costs and prices in the NEMS model, including accounting for the energy component of oil and natural gas field development (e.g., diesel fuel for drilling; natural gas for compression, etc.) and the relationship of higher (or lower) prices on anticipated industry activity and available capacity (e.g., rig utilization).
- Build a series of sectoral models, for oil and gas E&P, that provide estimates of economic margins and cash flow, using expectations of future prices and future (price related) costs.

**Recommendation #3: Use Conservative Estimate for Future Prices.** The price decks and price guidelines used by industry are heavily weighted by “backward looking” rather than “forward looking” information. The price declines of the mid-1980s and late 1990s, when oil prices (WTI Spot) dropped below \$15 per barrel, are still fresh reminders of the pain and bankruptcy that optimistic price expectations can yield.

Instead of using “perfect foresight” price projections in the NEMS model, which themselves have a mixed record of accuracy, industry uses a variety of relatively conservative price projection models for making investment decisions. An important note is that, in general, companies have more investment opportunities than investment dollars (see above discussion on cash flow). As such, industry is comfortable in using a conservative price with which to screen investment opportunities, selecting the ones that give them the more favorable financial returns or help position them strategically for future opportunities.

The price projection models used by industry fall into three groupings, depending on the size and nature of the company:

- Aggressive – These companies tend to use the NYMEX Strip (Table 12) for the near-term (next 3 to 5 years), with hedging, and a constant price thereafter.

**Table 12. NYMEX Futures for Oil and Natural Gas Prices**

	<b>NYMEX Futures (Light Sweet Crude Oil, \$Bbl)</b>	<b>NYMEX Futures (Henry Hub, \$/Mcf)</b>
December, 2007	\$95.10	\$7.79
December, 2008	\$86.94	\$8.87
December, 2009	\$83.36	\$8.85
December, 2010	\$82.86	\$8.64
December, 2011	\$82.98	\$8.47
December, 2012	\$83.31	\$8.32

- Moderate – These companies tend to use a weighted three year average of latest prices, escalated for inflation
- Conservative – These companies tend to use the lowest price value from the past three years of prices, escalated for inflation.

Attachment 1



[Home](#) > [Energy Finance](#) > [The FRS Survey](#) > FRS Respondent Companies

## FRS Respondent Companies

Major energy-producing companies based in the United States annually report their worldwide financial and operating data to the EIA on a [uniform and standardized basis](#) on the Financial Reporting System (FRS) [Form EIA-28](#). These companies (the FRS companies) occupy a major position in the U.S. economy. For the 2005 reporting year, 29 companies filed this information. In aggregate, their sales equaled about 15 percent of the \$9.1 trillion in sales of the Fortune 500 corporations. The 2005 reporting companies are:

Amerada Hess Corporation	Kerr-McGee Corporation
Anadarko Petroleum, Inc.	Lyondell-CITGO Refining, L.P.
Apache Corporation	Marathon Oil Corporation
BP America, Inc.	Motiva Enterprises, L.L.C.
Burlington Resources Inc.	Occidental Petroleum Corporation
Chesapeake Energy Corporation	Premcor, Inc.
Chevron Corporation	Shell Oil Company
CITGO Petroleum Corporation	Sunoco, Inc.
ConocoPhillips Petroleum Company	Tesoro Petroleum Corporation
Devon Energy Corporation	Total Holdings USA, Inc.
Dominion Resources, Inc.	Unocal Corporation
El Paso Corporation	Valero Energy Corporation
EOG Resources, Inc.	The Williams Companies, Inc.
Equitable Resources, Inc.	XTO Energy, Inc.
Exxon Mobil Corporation	

## ATTACHMENT 1