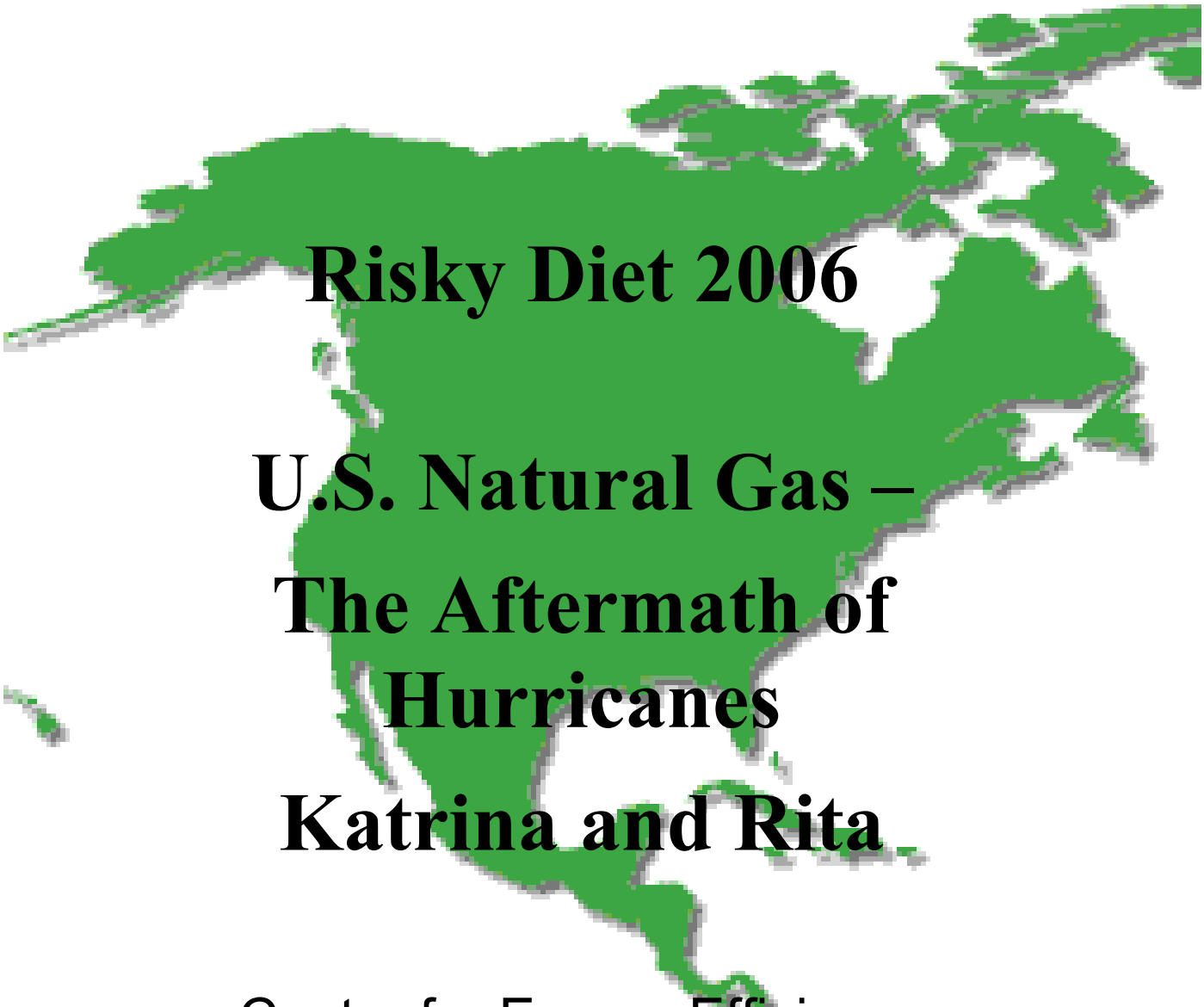

Risky Diet 2006

U.S. Natural Gas – The Aftermath of Hurricanes Katrina and Rita

Center for Energy Efficiency
and
Renewable Technologies

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May, 2006

Introduction

Two surprising developments occurred in the US natural gas situation during the last year.

- Surprise #1 – Hurricanes Katrina and Rita hammered the Gulf of Mexico in 2005, severely damaging important oil and natural gas facilities and shutting in 700 billion cubic feet of US natural gas production, about 3% of annual US consumption. Nevertheless, by the end of the winter heating season on April 1, 2006, natural gas in storage stood at record levels, some 63% above the prior 5-year average for the date.
- Question #1 – Why is there a surplus of natural gas in storage despite the substantial loss of supplies from the Gulf of Mexico?
- Surprise #2 – Natural gas prices have remained quite strong despite the large surplus in storage and reported increases in underground reserves. At the end of the 2005-2006 heating season, gas prices were comparable to those seen in the summer of 2005 before the storms hit the Gulf.
- Questions #2 – What is supporting natural gas prices in the face of apparently bearish fundamentals?

As discussed in this 2006 edition of CEERT's *Risky Diet* series, answers to these questions are also surprising and provide valuable insight into the dynamics of US natural gas markets and important clues about the future.

US Natural Gas Balance

Two major hurricanes, Katrina and Rita, raised havoc in 2005, severely damaging important energy infrastructure in the Gulf of Mexico which in normal years accounts for 10% of US natural gas production. Gas[1] producing and processing facilities were affected by the storms, and fears of shortages in the winter ahead drove prices to record levels. However, gas *consumption* in the region also was reduced due to damage to oil refineries, power plants, businesses and homes. In addition, sharply higher prices lowered consumption nationwide as consumers throughout the US conserved energy or switched from natural gas to alternate fuels.

After the storms, weekly reports surprisingly showed that gas storage levels continued to climb rapidly until the winter heating season began in November. Now, even at the end of the heating season, gas storage is at record levels for the date, despite the loss of supplies from the Gulf. Reductions in US gas consumption more than compensated for the production lost due to the storms.

Natural gas consumption data is now available for the five months following the storms which provide a quantitative picture of the impact of the hurricanes. Some analysts have attributed the gas storage surplus to lower demand for heating fuel, since the winter of 2005-2006 was one of the mildest in history. However, the mild winter weather was only partly responsible for the gas storage surplus. The reduction in industrial consumption and other uses unrelated to weather in the aftermath of the hurricanes is the primary cause.

Dramatically lower rates of consumption have created the potential for an *oversupply* of natural gas in the months ahead. Gas production in the Gulf region has almost returned to normal, and given the already high levels of gas in storage, there may not be enough room to accommodate the additional gas that would usually be stored between April and October. It is fascinating that the hurricanes, which caused such highly publicized damage to energy production facilities, have resulted in a *surplus* of natural gas by decreasing consumption more than production.

As a result of the expected gas surplus, prices may fall in 2006to levels not seen in several years. This situation is expected to be temporary, lasting only until supplies and consumption are balanced again and the storage surplus is worked off.

Natural Gas Storage

During times in which natural gas is not needed to meet consumer demand, excess gas is stored underground for later use. Storage levels increase from about the first of April to the first of November. From November to March, gas is taken out of storage to meet heating demand.

Figure 1 shows that prior to Hurricane Katrina, storage levels were running well above average, but loss of production in the Gulf initially decreased additions to storage and the surplus vanished. However, by mid-November, storage levels had rebounded back above average. Mid-November to mid-December was exceptionally cold, and the storage surplus declined, only to grow again dramatically through the end of March. By that time, storage levels were 63% above the prior 5 year average, an excess of about 650 bcf.

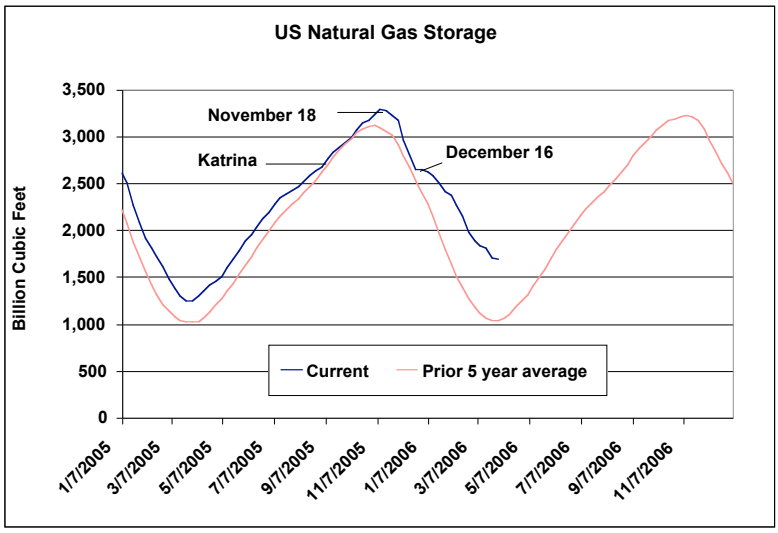

Figure 1 US Natural Gas Storage Levels

Analysts generally have attributed the large amount of gas remaining in storage at the end of the heating season to a mild winter after mid-December. During this period, heating demand was indeed considerably below normal. However, the decrease in gas used for heating during the winter of 2005-2006 cannot explain the current storage surplus,

especially considering the loss of 700 bcf of supply due to the hurricanes. As discussed below, consumption unrelated to heating is primarily responsible.

US Natural Gas Supplies

Total US gas supplies are the sum of US domestic gas production and net imports, for which monthly data are available from the US Energy Information Administration with a delay of about 60 days.[2] Data since January, 2004 are shown in **Figure 2**. Note the sudden decrease of 200 bcf in September, 2005, due to the hurricanes. Note also that supplies had returned to normal by December, 2005. As of the first of April, 2006, the US Minerals Management Service reports that cumulative production lost in the Gulf of Mexico due to the storms totaled about 700 bcf.

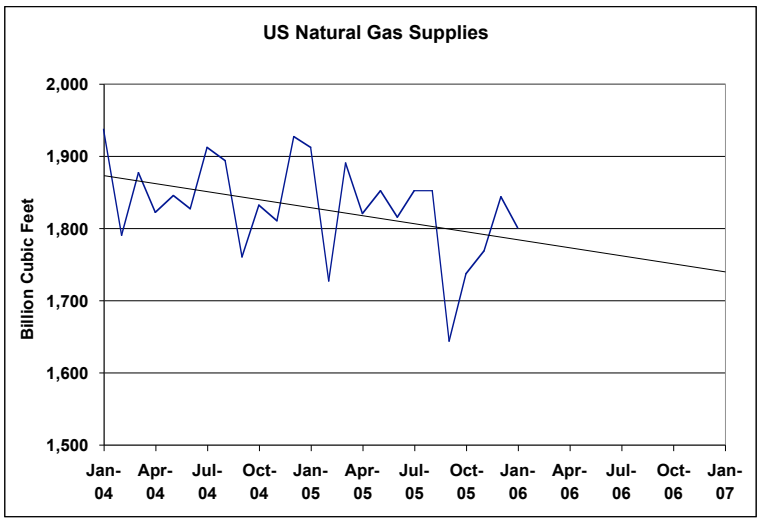

Figure 2 US Total Natural Gas Supplies

Annual supply data for the last several years show that previous trends continued in 2005, as shown in **Figure 3**. Numerical data for 2004 and 2005 are shown in **Table 1**.

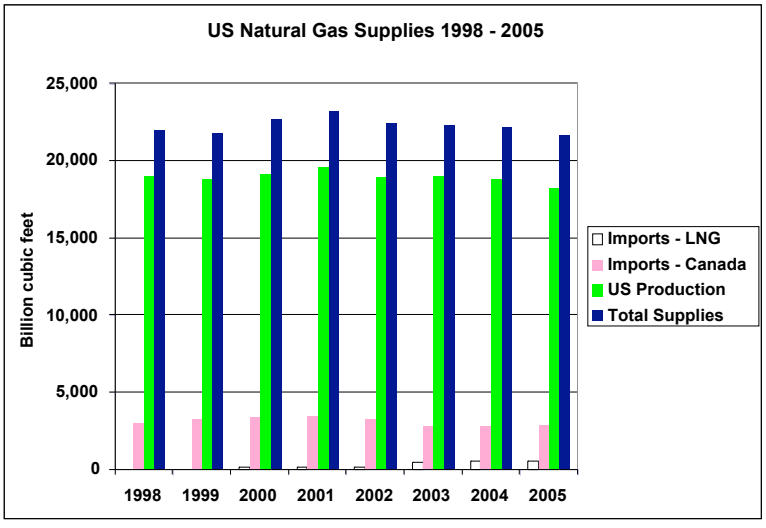

Figure 3 Components of US Natural Gas Supplies

Table 1 US Natural Gas Supplies, 2004-2005 (bcf)

	Imports LNG	Change	Imports Canada	Change	US Production	Change	Total Supplies	Change
2004	590		2,815		18,830		22,234	
2005	566	-4.1%	2,932	+4.2%	18,215	-3.3%	21,713	-2.3%

The drop in US gas production was almost entirely due to disruptions in the Gulf region from the storms. However, production in other regions also fell despite aggressive drilling activity. Imports from Canada rose somewhat[3], while imports of liquefied natural gas, which had been increasing rapidly in recent years, fell slightly. Note that total US gas supplies, including imports, have been declining since 2001. Claims that the use of natural gas in the US has been increasing are false.

US Natural Gas Consumption

In the aftermath of the hurricanes, analysts were puzzled by the large amount of gas going into storage. Storage levels were increasing much more rapidly than expected, considering the decrease in supplies. It was clear that gas consumption had also declined markedly.

At the end of the heating season, April 1, 2006, storage levels are very high, 63% above the 5-year average for the date. Some analysts attribute the storage surplus to mild temperatures in January, 2006. However, data now available indicate that consumption unrelated to weather and temperatures, i.e. temperature *independent* consumption, declined twice as much as temperature *dependent* consumption.

Natural gas is widely used for heating in the winter and is also used as fuel for electric power plants, especially during the summer to meet air conditioning loads. About one-third of all US gas consumption depends on the weather, i.e., it is temperature *dependent*. The other two-thirds of total consumption is *independent* of temperature and meets a variety of industrial and other demands that usually change little from month to month.

The Center for Energy Efficiency and Renewable Technologies (CEERT) has developed a computer model that uses weather data from major US metropolitan areas to estimate temperature dependent gas consumption with a high level of accuracy. By subtracting from EIA total consumption data, consumption that does *not* depend on temperature can also be computed. Now that data is available for the first 5 months after the hurricanes, the sharp decline in consumption can be quantified, as shown in **Figure 4** and **Figure 5**.[4]

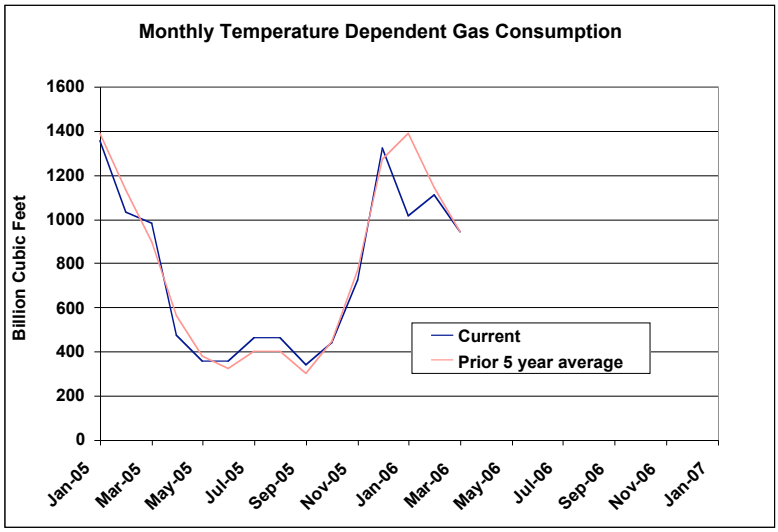

Figure 4 Temperature Dependent Gas Consumption

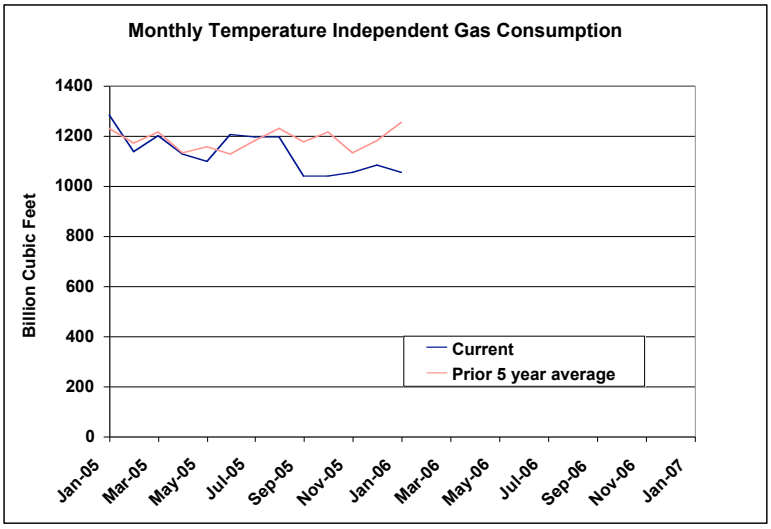

Figure 5 Temperature Independent Gas Consumption

In **Figure 4** above, note the unusually low consumption in January due to mild weather, nearly 400 bcf lower than average for the month. In **Figure 5**, note that temperature independent consumption dropped in September, 2005, when the storms hit and remained lower than average through January, 2006. The reduction in temperature independent consumption was much larger than the reduction due to mild weather in January. Totals for the 5 months following the storms are shown in **Table 2**.

Table 2 US Natural Gas Consumption, September 2005 – January 2006 (bcf)

	Total	Temperature dependent (TDC)	Temperature independent (TIC)
Prior 5 year average	10,137	4,177	5,960
Current	9,105	3,836	5,269
Difference	1,032	341	691

Total gas consumption in the 5 months following the hurricanes was more than one trillion cubic feet lower than average which more than compensated for the loss of production in the Gulf and accounts for the large amount of gas in storage. But only one third of the drop in consumption was weather related; industrial and other temperature independent consumption fell twice as much.

The magnitude of the drop in temperature independent consumption is quite remarkable. Should TIC continue at this level for twelve months, *total* US gas consumption would be expected to decrease by over 1,600 bcf – an astounding 7.6%.

Projections for 2006

Gas storage levels will begin to climb again now that the heating season has ended. If industrial demand remains as low as it was in the 5 months following the storms, remaining storage capacity may be inadequate to accommodate all the surplus gas that ordinarily would be stored during the coming months. **Table 3** shows the outlook for November 1, 2006, if current trends for supply and temperature independent consumption continue, and temperature dependent consumption follows historical averages.

Table 3 Gas Supply/Demand Balance (Projected) April-October 2006 (bcf)

Supply (1)	TDC (2)	TIC (3)	Total Consumption	Surplus
12,320	2,814	7,375	10,189	2,131
			Storage level April 1, 2006	1,695
			Projected storage level November 1, 2006	3,826

Projection notes:

(1) Supply is projected from trend line in **Figure 2**.
(2) Temperature dependent consumption equals historical average.
(3) Monthly temperature independent consumption equals average of September 2005 through January 2006.

Currently, US working storage capacity is approximately 4,000 bcf. The projection above shows that storage levels could approach this value this year.

Natural Gas Prices

Despite the large amount of gas in storage, gas prices have shown surprising strength. Historically, the natural gas trades on the New York Mercantile Exchange (NYMEX) at approximately 75% of the crude oil price on an energy basis,[5] as shown in **Figure 6**. As of April 1, crude oil was trading at about $11 per million British Thermal Units (MMBtu) corresponding to a gas price of about $8.25/MMBtu. The large amount of gas in storage has depressed gas prices below this level; on April 7, the gas contract for delivery in May traded at $6.74/MMBtu. The average of prices for delivery over the next twelve months, stood at a robust $8.66/MMBtu, however.

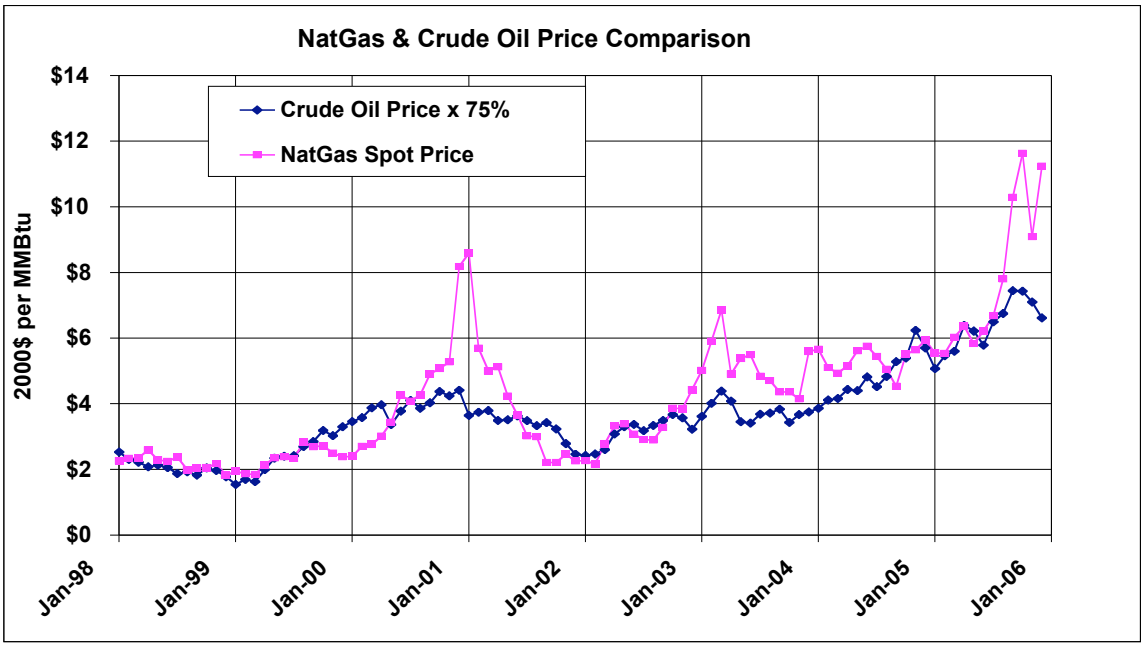

Figure 6 US Oil and Gas Prices (Energy Basis)

If storage levels increase as projected above, prices are likely to continue their recent downward trend unless the price of crude oil continues to rise. If prices fall, producers will increasingly restrict production and leave more gas underground for future sales when prices improve. Imports of gas, including liquefied natural gas (LNG) also would be expected to decline. Lower prices will also encourage consumers to use more gas, perhaps reversing the trend in recent years. By decreasing supplies and increasing consumption, market forces will prevent the storage surplus from becoming too large.

Assuming that the price of crude oil stabilizes at current levels, the question for gas market participants is how rapidly prices will fall and how low they will go. The marginal cost of US production is now in the range of $5/MMBtu, so it appears unlikely that gas prices will drop below that level, since lower prices would result in a significant loss of production.

Longer Term Considerations

Contrary to many media accounts, US natural gas consumption has *not* been increasing in recent years. Consumption *declined* in 2005 for the fourth consecutive year. Production also declined in 2005, as **Figure 7** shows. (In any year, the difference between consumption and production is filled by imports and changes in storage.) The decrease in production in 2005 was due primarily to the hurricanes. However, consumption declined more than production as industrial users cut back substantially after the hurricanes due to higher prices. It is too early to tell whether these reductions will be maintained in the longer term.

Some observers suspect that the gas industry may be withholding gas from the market to drive up prices, but other causes appear to be responsible for the rise in prices over the last few years. The most significant development is the depletion of the large gas deposits

in the Gulf region. Even before the storms, production in the Gulf had dropped significantly. The decline in Gulf production has been offset by an increase in production from so-called "unconventional" resources. Gas is now being extracted from coal seams, deposits of shale, and highly compacted "tight" sands, but these resources, although plentiful, require many more wells to be drilled, as shown in **Figure 8**.

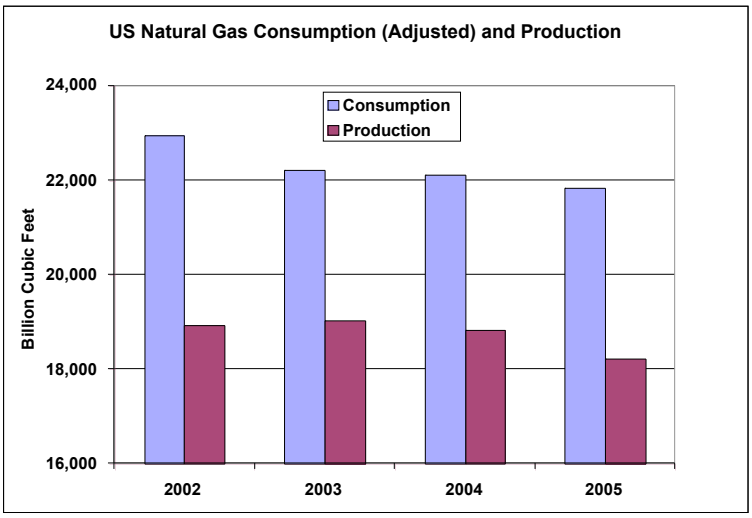

Figure 7 US Natural Gas Consumption and Production

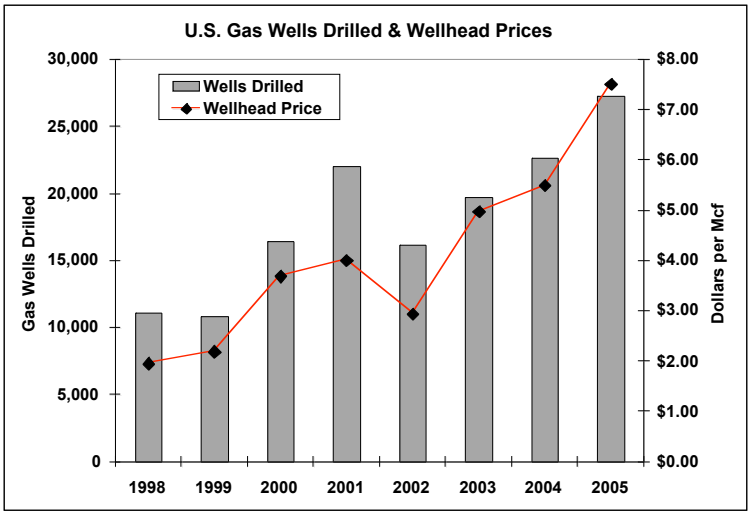

Figure 8 US Gas Drilling Activity and Wellhead Prices

Projections from the U.S. Energy Information Administration – Despite the decrease in U.S. gas production in recent years, the ever-optimistic EIA projects that production will increase significantly in the next decade and that increases of imported liquefied natural gas will more than offset expected declines in pipeline imports from Canada. EIA supply projections are shown in **Figure 9**.[6]

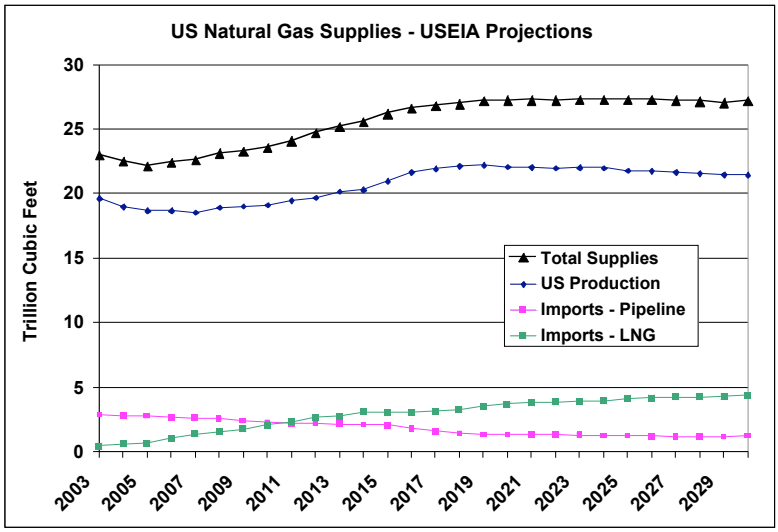

Figure 9 – EIA Projected US Natural Gas Supplies

Curiously, EIA projects supplies will increase, despite the projected decline in natural gas prices, as shown in **Figure 10**. The projected decrease in natural prices from EIA has important consequences, since many state and federal agencies rely on these price projections when planning infrastructure developments such as electric power plants. Reliance on these projections is tantamount to gambling that gas prices will go down substantially over the next decade, a bet that many analysts believe is foolish.

The EIA project is based on a computer model which assumes that the price of natural gas is normally equal to the marginal cost of production.[7] In recent years, the price has been much higher than the cost of production – EIA forecasts made 5 years ago were woefully wrong. Nevertheless, the EIA forecast shows that, for reasons unknown, EIA believes that the "scarcity rents" which have increased prices above the cost of production in the last few years will rapidly disappear and prices will fall.

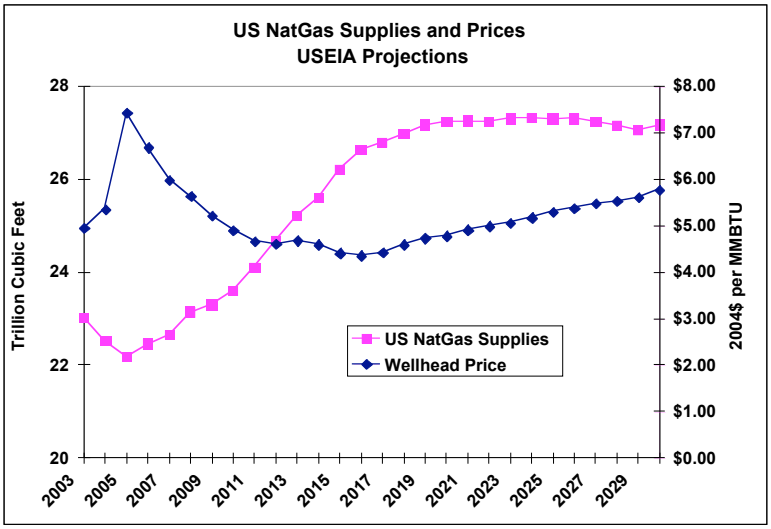

Figure 10 – EIA Projected Gas Supplies and Prices

Before relying the EIA price forecast, readers are advised to seriously evaluate the assumptions that EIA has made.

Crude Oil Prices - The major uncertainty in forecasting natural gas prices is the future price of crude oil, and whether gas prices will continue to be linked to oil prices as they have in the past (refer to **Figure 6**.) Some analysts believe oil prices may rise dramatically to as much as $20/mmBtu or higher.[8] If so, natural gas prices would be expected to rise as well.

LNG Imports - Another wild card in the future gas supply situation is the amount of natural gas that will be imported as liquefied natural gas (LNG) and the resulting impact on US gas prices. The US now has five LNG terminals, including a new one in the Gulf of Mexico that came on line in 2005, with a total capacity of 5.2 billion cubic feet of gas per day (9% of average daily US consumption.) However, despite high gas prices and increased receiving capacity, net US LNG imports in 2005 totaled only 1.6 bcf/day (2.6% of US consumption,) a slight decline from 2004 as **Figure 11** shows.

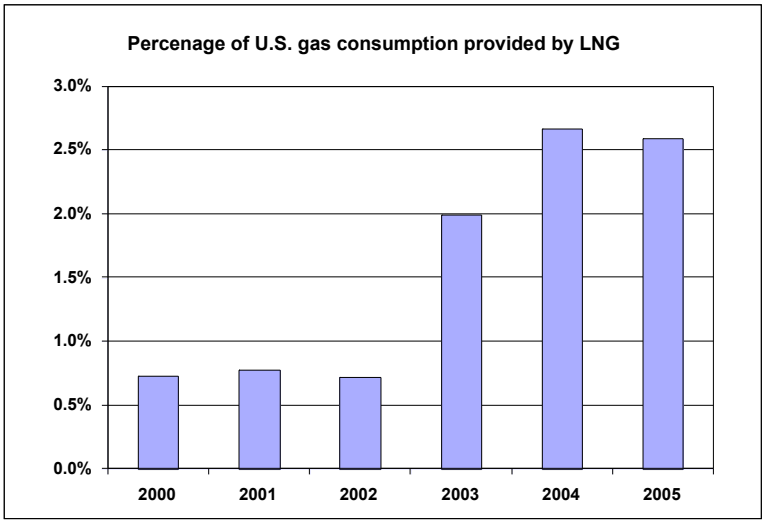

Figure 11 US LNG Imports as Percentage of Consumption

LNG receiving capacity was underutilized in 2005 for reasons that remain unclear. Disruption due to the hurricanes does not appear to be a factor, since LNG import rates were approximately the same before and after the storms. There have been reports that some LNG cargoes were diverted from US to European ports where prices were even higher.

Imported natural gas has not had a significant moderating impact on US prices to date. However, some 38 additional terminals are being planned in the US[9] and major exporting countries are rapidly increasing liquefaction capacity. EIA projects that by 2015, 3.1 trillion cubic feet will be imported annually, about 12% of the projected total consumption as shown in **Figure 9**.[10]

Meanwhile, however, major industrial countries worldwide are also expected to expand LNG imports. The US increasingly will be competing in rapidly expanding global gas

markets, and the international price is impossible to predict. The impact of imports on US domestic production and prices is also uncertain.

Until large quantities of inexpensive LNG flood the US market, US natural gas prices will continue to be determined by the balance between North American gas production and consumption together with the price of crude oil.

Value of the Dollar - Still another factor influencing the price of oil is the value of the dollar, the currency used worldwide for oil trading. In recent years, the value of the dollar has seriously eroded compared to other world currencies due to US trade and budget deficits. As the dollar diminishes in value, oil producers must raise prices (in dollars) to compensate for the dollar's reduced purchasing power. The dollar has lost about 33% of its value compared to the euro since the beginning of 2002. Consequently, as shown in **Figure 12**, oil prices in dollars have increased much faster than prices in euros. Some of the increase in the US price of oil is widely attributed to the weakness of the dollar. A continued slide in the value of the dollar, as many analysts expect, will continue to put upward pressures on oil prices.

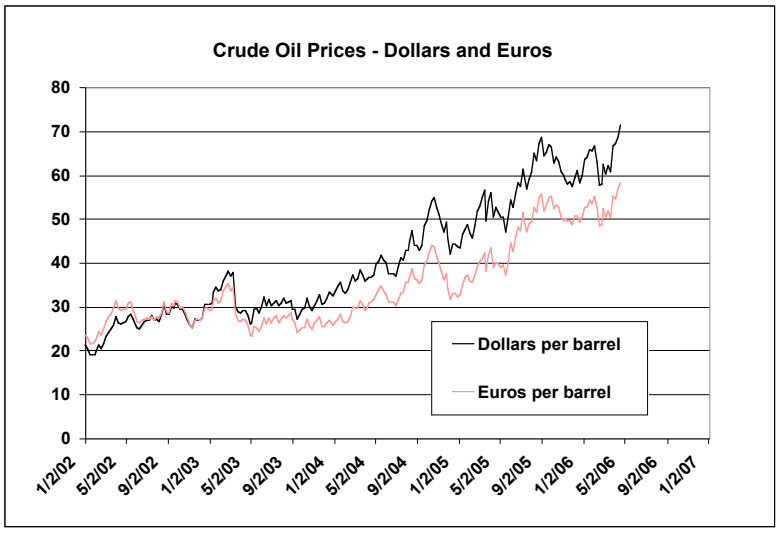

Figure 12 Crude Oil Prices in Dollars and Euros

Global Climate Change Responses - Another major uncertainty is the world's response to global climate change for which scientific evidence continues to mount.[11] There is nearly universal scientific consensus that combustion of fossil fuels is largely responsible for changes in Earth's climate which are projected to create temperatures higher than our planet has experienced for millions of years.

To produce the same amount of energy, burning coal produces twice as much carbon dioxide, the major "greenhouse" gas, as natural gas. Until the coal industry develops technology to sequester the carbon dioxide, i.e., to permanently prevent it from entering the atmosphere, natural gas will remain the environmentally preferred fuel for electric generation and other energy intensive industries. If major industrialized nations decide to address global warming by reducing emissions of carbon dioxide, demand for natural gas could increase and further tighten global gas markets.

Conclusions

Answer #1 – The current surplus of natural gas in storage is primarily a consequence of a dramatic decline in industrial consumption and other uses that are independent of temperature since the hurricanes. Mild weather in January, 2006, was a contributing factor. The decline in total consumption more than compensated for the drop in production from the Gulf of Mexico caused by the storms.

Answer #2 – US gas prices remain strong due to:

1. The rise in the price of crude oil;
2. The continuing decline in US gas production; and
3. Continued weakness in the value of the dollar.

These factors evidently outweigh downward pressures on gas prices arising from:

1. The dramatic drop in temperature independent gas consumption;
2. The resulting large surplus of gas in storage; and
3. Future prospects of increasing imports of liquefied natural gas.

The future price of crude oil remains the most important unknown and is expected to continue to dominate energy prices of all kinds. The value of oil is expected to continue to climb, and the likely continued fall in the value of the dollar will further exacerbate US prices. Unless the price of gas breaks its historical link to oil prices or oil prices fall, continued upward long term pressure on natural gas prices is projected. In the near term, the surplus of gas in storage will tend to keep gas prices less than 75% of the crude oil price, the historical relationship.

The slide in US gas production may be stabilized if production from unconventional resources offsets depletion in mature conventional basins. *Risky Diet 2006* expects little or no increase in total domestic production, despite the rosy projections from EIA. Significant increases in LNG imports also appear unlikely in the near future.

Risky Diet 2006 rejects the assumptions made by EIA and concludes that the combination of global forces discussed above will keep natural gas prices well above the $6/mmBtu range in the long term, although prices may fall from current levels in the near term if the storage surplus persists. Because the arrival of plentiful and inexpensive LNG remains speculative at the present time and future domestic production appears unlikely, *Risky Diet 2006* projects that long term gas prices will remain at or above current levels in the foreseeable future.

[1] The work “gas” used in this report refers to natural gas, not to gasoline.
[2] http://www.eia.doe.gov/oil_gas/natural_gas/info_glance/natural_gas.html.
[3] Figures cited for Canadian imports are net pipeline imports, net of exports to Mexico.
[4] Temperature dependent consumption data are computed from weather data available daily and are complete through March, 2006. Calculations of temperature independent consumption require EIA total consumption data which are available only through January, 2006.
[5] In some applications, natural gas competes against residual fuel oil and users can switch between these fuels depending on price. Therefore, the price of residual fuel oil and gas tend to remain close to each other except in unusual circumstances. The price of residual fuel oil is approximately 75% of the price of crude. One barrel of crude oil supplies about 5.8 million Btu (mmBtu), so a crude oil price of $58/bbl corresponds to an energy price of $10/mmBtu.
[6] EIA projections are from the Annual Energy Outlook 2006.
[7] See Risky Diet 2005 for a discussion of the equilibrium model used by EIA.
[8] See Risky Diet 2005 for a thorough discussion of factors which could cause high oil prices. On April 18, 2006, oil prices hit a record high (in nominal dollars) above $71/bbl.
[9] See http://www.ferc.gov/industries/lng/indus-act/terminals/exist-prop-lng.pdf.
[10] http://www.eia.doe.gov/oiaf/aeo/pdf/trend_4.pdf.
[11] See, for example, several articles in Science, 24 March, 2006.