Natural Gas Markets in 2006

-name redacted-
Specialist in Energy Economics

December 12, 2006

Congressional Research Service
7-....
www.crs.gov
RL33714

CRS Report for Congress
Prepared for Members and Committees of Congress

Summary

The Energy Information Administration (EIA) in its *Short Term Energy and Winter Fuels Outlook* (STEWFO) provided good news for residential natural gas consumers. EIA projected that natural gas winter home heating costs might decline by as much as 13% from last year's record-setting levels, even though consumption is expected to increase this winter. The STEWFO sees prices for natural gas lower than last year as a result of weak market fundamentals.

Analyses of natural gas market demand and supply conditions seem to be consistent with the EIA STEWFO. Aggregate consumption of natural gas over the first seven months of 2006 has declined compared to 2005. U.S. production, as well as imports, have also declined over the same time period, likely in response to the decrease in consumption. On a sectoral level, the decline in consumption has included all consumer groups except electric power generators, whose consumption rose. Storage of natural gas, the factor that balances yearly demand and supply, is at an all time record high level, and is approaching the maximum physical capacity of the system. There does not appear to be any fundamental imbalance between demand and supply in the 2006 natural gas market, making a stable, or even declining, price level likely.

The price of natural gas is actually many prices. Small, residential, consumers typically pay the highest prices per unit of natural gas, and large industrial and electric power consumers pay the lowest prices per unit. Taken in this context, the 2006 price outlook may be less favorable than the EIA suggests, across different sectors. Residential prices had not responded to falling wellhead prices as of July 2006. The past several years of high gas prices have yielded a 14% decline in industrial consumption, and that demand may not return to the market.

Risk factors, including weather conditions, movements in the price of crude oil, and developments in the futures markets all could affect the market balance in the natural gas market. Because these factors have caused price volatility in the past, the EIA outlook may best be considered as conditional on outcomes in these areas.

This report will be updated.

Contents

Tables

Contacts

The Energy Information Administration (EIA), in its October 2006 *Short-Term Energy and Winter Fuels Outlook* (STEWFO), provided encouraging news for residential natural gas consumers.[1] Their 2006-2007 winter heating bills were projected to decline by an average of about $119 per household, or 13%, from 2005-2006 levels.[2] This anticipated decline in consumer costs is related to market conditions in 2006 that have been quite different from those observed a year ago.

This report analyzes the key factors affecting prices in the U.S. natural gas market, including consumption, production, reserves, and storage levels. The current environment of declining prices is compared to last year, as well as near-term future projections that continue to show a tight market and high prices.

Background

The U.S. natural gas market is a regional market, drawing supplies from domestic sources as well as imports, via pipeline, from Canada. In addition, a small part of domestic supply is imported in the form of liquefied natural gas (LNG) which is part of a small, but growing, world market. As a result of the regional nature of natural gas markets around the world, prices may differ across the various regions.[3]

Within the U.S. market, different groups of consumers pay different prices for natural gas. Residential, commercial, industrial, and electric power consumers are the largest groupings, with transportation uses the newest category. Cost of distribution, as well as scale of quantity purchased, determine price paid, although in some cases state regulatory commissions can determine some prices. In general, residential consumers constitute the largest customer base (over 62 million in 2004), purchase the smallest quantities per customer, and pay the highest prices. Electric power generators consume large quantities, and pay the lowest per unit price. Historically, industrial consumers were the largest consumers of natural gas, although their aggregate consumption has declined in recent years.

On the supply side, in 2005, domestic production provided about 83% of consumption, imports via pipeline from Canada accounted for approximately 16%, and LNG, mostly from Trinidad, accounted for about 2%.[4] Production represents a draw from the reserve base. In the U.S., the reserve base, measured by the reserve to production ratio, has been growing, increasing from 8.8 years in 1997 to 10.4 years in 2004.[5]

[1] Energy Information Administration, *Short-Term Energy and Winter Fuels Outlook*, October 2006.

[2] The winter heating season runs from November to March.

[3] A large, worldwide, LNG spot market could reduce these price differentials. At present, most LNG is traded through long-term contracts that have the effect of perpetuating the regional character of the markets.

[4] Total does not add up to 100% because of rounding.

[5] The reserve to production ratio measures the number of years then current production can be sustained. If this ratio is increasing, more natural gas is being added to the reserve base through discovery than is being drawn down due to production and consumption. However, the new gas added to the reserve base may be more expensive to produce.

Storage is an important component of natural gas supply because while production tends to be relatively constant throughout the year, consumption tends to peak during the winter heating season (November through March) as home heating use rises and tends to moderate in the other seasons.[6] For this reason, the industry injects gas into storage facilities to prepare for winter heating season demand peaks. In recent years, the industry has established a target of over 3 trillion cubic feet (tcf) of gas in storage for this purpose.

While price is an important determinant of consumption and production in the market at the aggregate level, the weather is perhaps even more important in consumption decisions by residential consumers. The primary use of natural gas by residential consumers, home heating, tends to be quite price inelastic; consequently, the onset of cold temperatures causes demand peaks largely independent of the level of prices.

Market Conditions 2006

Consumption

Aggregate consumption of natural gas in the United States for the first seven months of 2006 was 4.1%, or 551 billion cubic feet (bcf), lower than the comparable period in 2005.

Table 1 shows how this decrease in consumption, for comparable time periods, was divided between the consuming market segments. Residential consumption declined by the largest amount in both percentage and volume terms. Commercial demand also decreased by more than the average for the market. Industrial demand decreased by more than the average for the market, but this decline may be part of a long term fall in industrial demand of approximately 19% over the period 2000 to 2005. Consumption by electric power generators is a derived demand in the sense that their demand for natural gas is dependent on, and derived from, consumers' demand for electric power, which has been growing. The use of natural gas in transportation vehicles is a very small, but growing portion of the total market.

The key factors in explaining the observed reductions in natural gas consumption over the past year are price and the weather. Although these two factors affect all market segments, their relative effects vary across the market segments.

[6] Recently, however, because of the increasing use of natural gas in electric power generation, summer use rates have increased as air conditioning demand increases.

Table 1. U.S. Natural Gas Consumption

(in billion cubic feet)

Sector	2005	2006	% change
Residential	3,225	2,863	-11.2
Commercial	1,968	1,827	-7.1
Industrial	3,996	3,788	-5.1
Electric Power	3,254	3,433	5.5
Vehicles	12	13	8.8
Total	12,457	11,926	-4.2

Source: Energy Information Administration, available at http://www.eia.doe.gov.

Note: Data for each year is for the period January to July in each year.

Average U.S. residential natural gas prices were $14.64 per thousand cubic feet, (mcf) in the winter of 2005-2006, a peak price for the decade, 57% above the average residential price for the period 2000-2005, and an increase of 32% over the previous winter heating season. Probably more important, the winter heating season in 2005-2006 was also warmer than normal for the United States as a whole, as measured by population weighted heating degree days. These two factors, warm weather, coupled with high prices, likely accounted for a large portion of the reduced demand observed in the residential sector.

Commercial demand is, like residential demand, largely used for space heating. As a result, this sector's consumption is also likely to be relatively insensitive to changes in price, and quite sensitive to weather variations.

Industrial consumption of natural gas is likely to be more sensitive to price variations, and less sensitive to weather variations than residential or commercial consumption. Natural gas is used in production processes both as a raw material, for example, in the nitrogenous fertilizer industry, and as a source of process heat, as in the steel industry. Many of the domestic industries that use large quantities of natural gas cannot easily pass cost increases on to final consumers because they face competition from overseas producers who have access to cheaper sources of natural gas. As a result of this inability to remain competitive in the face of increased natural gas prices in the United States, some firms have either ceased domestic production, or moved their facilities overseas, accounting for the decrease in U.S. industrial natural gas consumption.

The electric power sector's consumption of natural gas depends on the demand for electricity, which itself is dependent on the price of electricity and the weather in the short term. Consumption is also affected by the primary fuel choice for the mix of power generators in the supply base, fuel switching capability, and how production is divided between baseload and peak power generation.

The use of natural gas in transportation vehicles is largely for commercial purposes, for example, city bus fleets. As such, this sector's consumption might be expected to be relatively insensitive to the price of natural gas as well as weather conditions.

Production and Imports

Aggregate dry natural gas production in the United States for the first seven months of 2006 was 2.8%, or 307 bcf, lower than in the comparable period in 2005. Production data for the first seven months does not, however, provide a complete picture of the 2005-2006 winter fuels market from the producer's side, because the effects of hurricanes Katrina and Rita were felt largely in the fourth quarter of 2005, and into 2006. The hurricanes disrupted natural gas production and deliveries from the Gulf Coast region by about 6.7 bcf per day, or about 11% of average daily U.S. consumption. The effect of the hurricanes on natural gas production continued to be important during the first quarter of 2006 and persisted through the summer of 2006.

Imports of natural gas come mainly from Canada through pipelines. Comparing the period January to July 2006 and 2005, imports from Canada declined by about 3.5%, a smaller decline than that of U.S. consumption of natural gas. LNG imports into the United States come mainly from Trinidad, which supplied almost 70% of U.S. consumption, as well as Nigeria, Algeria, and other nations. However, the quantities are small in the aggregate. LNG supplied only 2.8% of total U.S. natural gas consumption in 2005. Over the first seven months of 2006, imports of LNG have declined by 2.7%.

Storage

Consumption of natural gas is governed by two weather related cycles; one somewhat predictable, the other less so. The first cycle is yearly; average consumption rises during the winter heating season (November to March), and is lower in the spring and fall seasons. The second pattern, less predictable as to timing, is that extremely cold weather conditions yield sharp increases in consumption. Taken together with a relatively constant rate of production, these patterns create the need for natural gas storage capacity.

The typical yearly pattern is that stored gas is withdrawn during the winter heating season, and replenished with storage injections during the following spring, summer, and fall seasons. A relatively new development in this process is that summer storage injections can be interrupted by periods of extremely hot weather. As peak electric power generating capacity has become fired by natural gas to a greater extent, the summer gas injection season can become disrupted by peak electricity demand conditions.

The industry ideally plans to carry an average natural gas storage inventory of approximately 3.3 to 3.5 tcf at the start of the winter heating season. The estimated maximum storage capacity in the United States is 3.6 tcf. On December 1, 2006 the amount of natural gas in storage was 3.406 tcf, which was 232 bcf more than at the comparable time in 2005, and 282 bcf above the five year average quantity in storage at the end of November 2006. The EIA estimates that stored natural gas will amount to 1.69 tcf by the end of the 2006-2007 winter heating season. This level of stored gas is above the five year average.[7]

The high levels of stored gas attained as the winter 2006-2007 heating season begins suggests that the market is well supplied, unlikely to experience physical shortages, and is likely to experience moderate price levels.

[7] Energy Information Administration, *Short-Term Energy Outlook*, December 12, 2006.

Prices

A number of prices are monitored by analysts of the natural gas industry. There is a spot market price set at the Henry Hub in Louisiana, and a futures market price set at the New York Mercantile Exchange (NYMEX) in New York City. The wellhead price is paid to producers of natural gas, while various classes of consumers, residential, commercial, industrial, and electric power generators each have their own pricing structure. The city gate price reflects the delivered price of natural gas to various major consuming markets as it is delivered to large distributors. The import price of natural gas is paid to those suppliers who deliver natural gas to the United States either by pipeline, or in the form of LNG.

Historically, the ratio of the price of a barrel of crude oil to the price of one thousand cubic feet (mcf) of natural gas has been 6:1, based on equivalent heat content. During the last three years of elevated crude oil prices, the ratio has risen as high as 13:1, suggesting that customary linkages between the two markets may have weakened as factors such as political risk affected the world oil market.

Table 2 shows the comparative wellhead price of natural gas from January to July, for 2006 and 2005.

Table 2. U.S. Wellhead Natural Gas Price

(in dollars per mcf)

	January	February	March	April	May	June	July
2005	5.52	5.59	5.98	6.44	6.02	6.15	6.69
2006	8.66	7.28	6.52	6.59	6.19	5.80	5.82

Source: Energy Information Administration, available at http://www.eia.doe.gov.

The average U.S. wellhead price for the first seven months of 2006 was $6.69 per mcf, compared to $6.05 per mcf for the comparable period in 2005, a 10.5% increase. However, the average prices in June and July 2006 were lower than the corresponding prices in 2005, suggesting that while prices were heading upward in the last five months of 2005, they may be turning downward as we approach the last five months of 2006.[8] The wellhead price for January to March 2006 is the second half of the winter 2005-2005 heating season, and reflects record setting price levels due to supply disruptions associated with hurricanes Katrina and Rita.

In general, 2006 has seen declining wellhead prices for natural gas, compared to 2005, and a relatively weakening market, as shown by the generally declining differences between the monthly prices, a difference which became negative in June and July of 2006.

While wellhead prices began to moderate in 2006, **Table 3** shows that residential prices did not follow the pattern set by wellhead prices.

[8] The average wellhead price of natural gas over the period August to December 2005 was $9.54 per mcf, the highest average price in the EIA data set going back to 1976.

Table 3. U.S. Residential Natural Gas Price

(dollars per mcf)

	January	February	March	April	May	June	July
2005	11.00	10.98	10.95	11.98	12.83	13.88	14.96
2006	14.92	13.99	13.10	13.26	14.37	14.96	15.63

Source: Energy Information Administration, available at http://www.eia.doe.gov.

Residential prices for the last five months of 2005 averaged $15.86 per mcf and consumers paid record costs for natural gas during the 2005-2006 winter heating season. The estimated decline of 13% in natural gas heating costs projected by the EIA for the winter 2006-2007 heating season, are from record high prices the previous year. Residential prices continued to increase in June and July 2006, even as wellhead prices were beginning to moderate. If the margin between wellhead and residential natural gas prices widens, it is possible that consumers will not benefit fully from the weakening of market fundamentals.

As shown in **Table 4**, commercial prices for natural gas were lower than residential prices, and were slowly moderating from the peak levels attained earlier in the year.

Table 4. U.S. Commercial Natural Gas Price

(dollars per mcf)

	January	February	March	April	May	June	July
2005	10.17	9.96	10.07	10.41	10.55	10.48	10.83
2006	14.26	13.11	12.11	11.63	11.76	11.30	11.28

Source: Energy Information Administration, available at http://www.eia.doe.gov.

Table 5 shows the comparative movement of natural gas prices for industrial consumers for the period January to July, 2005 and 2006.

Table 5. U.S. Industrial Natural Gas Price

(dollars per mcf)

	January	February	March	April	May	June	July
2005	6.96	7.06	7.03	7.65	7.11	6.84	7.35
2006	10.84	9.30	8.24	7.92	7.66	6.85	6.69

Source: Energy Information Administration, available at http://www.eia.doe.gov.

Industrial consumers use natural gas both as a raw material in production processes (nitrogenous fertilizer industry) and as a process heating fuel (some primary metals industries). Many industrial consumers face an internationally competitive market for their products and find it difficult to pass cost increases along to consumers. Because the natural gas market is not worldwide, but regional in scope, different prices for natural gas can coexist in different parts of the world, without market forces that might tend to equalize them. As a result, an industry that faces high natural gas prices, and for whom natural gas is a large element in the cost structure of their products could ultimately face the choice of keeping prices at competitive levels and suffering reduced profits, or even losses, or closing domestic plants, and moving production capacity overseas.

Once an industrial consumer of natural gas makes a decision to either go out of business because of low profits resulting from high costs, or decides to move production capacity overseas to take advantage of lower costs, it is not likely return to the domestic production base if natural gas costs merely decline. It is likely that the relative price structure of natural gas would have to invert before the firm decided to return to producing in the domestic economy. Although U.S. natural gas prices have risen and fallen over time, the North American market has been, and remains, a relatively high cost region.

Table 6 shows the extent of the decline in industrial consumption of natural gas in the United States since 1997.

Table 6. U.S. Industrial Consumption of Natural Gas

(in billions of cubic feet per year)

1997	1998	1999	2000	2001	2002	2003	2004	2005
8,511	8,320	8,079	8,142	7,344	7,507	7,150	7,250	6,608

Source: Energy Information Administration, available at http://www.eia.doe.gov.

Industrial consumption of natural gas in the United States has declined by a total of 22% over the period 1997 to 2005. This decline may have been accompanied by a decline in U.S. jobs and tax base, and an increase in imports of the associated mined and manufactured goods. For the first seven months of 2006, industrial consumption of natural gas fell by 5.2% compared to the same period in 2005.

The period August to December, 2005 was one of high natural gas prices for industrial consumers: $7.93 per mcf in August, $10.11 per mcf in September, $11.94 per mcf in October, the year's peak of $12.00 per mcf in November, and $10.98 per mcf in December, followed by high but moderating prices through 2006.

Table 7 shows the natural gas prices paid by electric power generators in 2006 compared to 2005. The period August to December, 2005 was also one of high natural gas prices for electric power generators: $8.59 per mcf in August, $10.94 per mcf in September, the year's peak of $11.88 per mcf in October, $9.82 per mcf in November, and $11.33 per mcf in December. Although this price pattern is similar to that observed in the industrial sector the effects are likely to be different.

Table 7. U.S. Electric Power Generator Natural Gas Price

(in dollars per mcf)

	January	February	March	April	May	June	July
2005	6.61	6.41	6.82	7.25	6.81	7.07	7.55
2006	9.09	7.99	7.34	7.28	6.84	NA	NA

Source: Energy Information Administration, available at http://www.eia.doe.gov.

The demand for natural gas by electric power generators is a derived demand, dependent on electricity demand in the short term, and dependent on investment in generating capacity and technology in the longer term. Consumers are likely to have an inelastic demand for electricity in the short term.[9] This insensitivity of electric power demand translates into an insensitivity in generators demand for natural gas to produce the electric power.[10] Electric power generators, to the extent that market forces are able to work in the market, are likely to be able to pass cost increases on to consumers. Electric power generators are also not as readily subject to the possible entry of new foreign competitors into the market as a result of cost differentials, nor can they move their production facilities outside the North American region.

In the longer term, electric power capacity investment decisions could be determined by the price of natural gas that electric power generators face. If the relative price of natural gas increases sufficiently, new capacity in the form of coal fired power plants could become an economically viable competitor to gas, even though coal is not as clean burning as natural gas and requires higher emission control expenditures.

In summary, price increases in the natural gas market have likely had an effect on the relative demand structure for natural gas. While most sectors (e.g. residential, commercial, and electric power generators) are likely to exhibit inelastic demand, which supports their consumption in times of rising prices, the industrial sector has greater price sensitivity to natural gas price increases and reduces its consumption in the face of higher prices. As a result, the aggregate decline in U.S. natural gas consumption only gives a partial picture of the effect of high prices.

Short-Term Forecast

The EIA projects a tightening natural gas market in 2007. Aggregate consumption is expected to increase by 2.9% compared to 2006. Residential and industrial consumption are expected to increase by 8.7% and 2.7%. Consumption by electric power generators is expected to decline by 2.3% from 2006 levels.

U.S. production of natural gas is projected to increase by 0.8% in 2007 as the disruptions in production due to hurricanes Katrina and Rita are repaired. Imports of LNG from Africa are expected to rise by 41% in 2007.

[9] Elasticity is a concept used to measure the sensitivity of the relationship between price and consumption. Demand is said to be inelastic when a specified percentage change in price leads to a smaller percentage change in demand.

[10] Inelastic consumer demand for electricity is thought to exist because consumers consider electricity to be an essential good, its price per unit is low relative to income, and because of a lack of real time information consumers may not be aware of the cost implications of their electricity consumption decisions.

Risk Factors

Analyses in this report are consistent with the EIA base case in the STEWFO, that consumers might expect to see lower natural gas prices and heating costs during the winter 2006-2007 heating season. However, the EIA's projection is dependent on conditions which may, or may not, materialize. This section of the report analyzes risk factors in the 2006-2007 market outlook.

Weather

Weather is a key factor in determining natural gas consumption in the residential and commercial sectors, and to a lesser extent in the electric power sector. The industrial sector generally is unaffected by weather.

The EIA STEWFO baseline weather case is from the National Oceanic Atmosphere Administration (NOAA), and assumes a winter that is 5.9% colder compared to last winter, but 2.1% warmer than the average from 1971 to 2000. Periods of cold weather can have effects on natural gas prices. For example, it was reported that November 2006 natural gas future prices rallied on the news of a cold weather pattern that developed in late October, even though gas storage was approaching an all-time high level, and most analysts saw downward pressure on price.[11] If the NOAA weather forecast significantly overestimates the average temperatures this coming winter, natural gas prices could move upward.

Oil Prices

Recent research carried out by the EIA finds that there is a significant relationship between oil prices, measured by the West Texas Intermediate (WTI) crude oil price and the price of natural gas at the Henry Hub. The researchers found that a one-month, temporary, increase in the price of WTI of 20% leads to a 5% contemporaneous increase in natural gas prices, which declines to 2% in two months. If the 20% price increase of WTI is permanent, this is found to lead to a 16% increase in Henry Hub natural gas one year out.[12]

The WTI crude oil spot price reached its 2006 peak of $74.41 per barrel in July. By September 2006, the price had declined to $63.80 per barrel, a decline of over 14%. This decline in oil prices likely contributed to the declining prices in the natural gas market. However, a contributor to the decline in oil prices was thought to be the lessening of political tensions in the Middle East following the withdrawal of Israeli forces from Lebanon, and the potential for a decline in tensions with the Iranian government concerning nuclear weapons development. As in the past, the Middle East and the Persian Gulf regions remain politically volatile, making volatile oil prices likely.

[11] Lammey, Alan, "Analysts Fear Gas Prices Have Peaked for Winter After Cold Snap," *Oil Daily*, Vol. 56, No. 203, October 23, 2006, p. 2.

[12] Villar, Jose A., and Joutz, Frederick L., *The Relationship Between Crude Oil and Natural Gas Prices*, Energy Information Administration, Office of Oil and Gas, October 2006.

Futures Markets

Although the effect of futures prices for natural gas traded on the NYMEX on commodity prices traded on the Henry Hub is uncertain, an increased interest in long positions by financial traders is likely to affect the futures price of natural gas.[13] Depending on the perspective, an increasing long position by traders could translate into an increasing price for natural gas consumers.[14] However, in late October, it was reported that the market was "over-bought" and it was more likely that a sell-off might emerge and put further downward pressure on the natural gas price.[15]

Conclusion

The EIA STEWFO's conclusion that residential consumers might expect to see reduced natural gas heating costs during the winter of 2006-2007 sees consumption rising, but price falling by a greater proportion. Indeed, some analysts see the price of natural gas already having peaked for the winter season. The market fundamentals of consumption, production and storage reserves are likely to be consistent with a weakening market price. However, a contributor to the overall reduced consumption in the market is falling industrial consumption.

Because the natural gas price has been so volatile in recent years there is a chance that the STEWFO has over or underestimated the natural gas price for the winter heating season.

Author Contact Information

(name redacted)
Specialist in Energy Economics
-redacted-@crs.loc.gov, 7-....

[13] A long position is one where the trader owns the right to buy the commodity in the future, contrasted to a short position where the trader has the right to sell the commodity in the future.

[14] See Energy Information Administration, Office of Oil and Gas, *An Assessment of Prices of Natural Gas Futures Contracts As A Predictor of Realized Spot Prices at the Henry Hub*, October 2005. The EIA found that futures prices are poor predictors of realized spot prices for any given month, and that futures prices are relatively poor at anticipating realized spot prices.

[15] Lammey, Alan, op. cit.