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Natural Gas Prices and Market Fundamentals

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Summary

Intermittently high, volatile natural gas prices since 2000 have raised concern among all types of consumers. Residential customers have seen gas bills increase dramatically during the heating season. Industrial consumers have seen costs increase, which reduces their competitiveness. Because the price of natural gas at the consumer level is a mixture of market forces and regulation, explaining the behavior of price can be difficult.

Debate in the 108th Congress concerning the energy bill (H.R. 6), considered provisions which are intended to improve long term natural gas supplies in the United States. Other issues are likely to be brought before the 109th Congress for consideration. This paper analyzes the short term forces which influence the natural gas market.

The Energy Information Administration has developed a metric called the effective capacity utilization rate as a framework for analyzing the economics of the natural gas market. This measure has been shown to be correlated with the price of natural gas. When as the effective capacity utilization rate attains high levels (90% and above) it becomes increasingly likely that tight market conditions will yield high prices.

As a result of the Natural Gas Policy Act of 1978 (P.L. 95-621) and subsequent legislation in 1989 and 1992 (P.L. 101-60 and P.L. 102-486) the wellhead price of natural gas is market determined. Pipeline rates are federally monitored and distribution charges are regulated at the state level. Price variability centers on the wellhead price as well as the price determined in futures markets.

Price spikes have occurred in two of the past three heating seasons. Whether severe weather causes price increases depends on the tightness of the market as measured by the effective capacity utilization rate. The same level of demand could lead to very different price results if the effective capacity utilization rate is high or low.

A variety of factors can affect the effective capacity utilization rate. Since short run supply adjusts to meet demand, the weather will be an important determinant. The relationship between natural gas prices and investment in exploration, development and production is an important factor in determining productive capacity. The availability of stored gas and imported gas become vital to price stability as the effective productive capacity exceeds 90%.

In the very short term there appears to be little that can be done from a policy perspective to alter the fundamental economics of the natural gas market. In the longer term, policies that slow demand growth and/or encourage the growth of supply, either from domestic or foreign sources could be effective.

This report will be updated as events warrant.

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After a decade of low natural gas prices, market prices spiked during the winters of 2000-01 and 2002-03 and remained high through the winter of 2003-04. Prices averaged $4.97 per thousand cubic feet (mcf) for the year 2003, and rose to an average level of $5.41 for the first eight months of 2004. Futures prices observed through November, 2004 suggest that natural gas prices might remain high during the winter heating season of 2004-05. Natural gas price trends through 2003 suggested that the market might be experiencing greater volatility than in the past. The sustained high prices observed in 2004 suggest that the period of volatility might be over and prices might remain at levels over $5.00 per mcf for the next year, or more.

The wellhead price of natural gas is market determined, the result of a complex interaction of forces which influence both the demand and supply of gas. Among those forces are such imponderables as winter weather as well as the actual amount of surplus producible natural gas, if any, and the availability of imported gas. Market dynamics are complicated because the same potentially destabilizing event may have very different effects on the price, depending on the initial state of the market.

The Energy Information Administration (EIA) has developed a metric to evaluate the effect of these complex interactive forces, based on effective productive capacity. Called the effective capacity utilization rate (ECUR), it establishes a conceptual framework with which to analyze the natural gas demand and supply balance and price.

This report analyzes the linkage between the concepts of effective productive capacity, the ECUR, increases in the price of natural gas, and the potential for higher prices in the 2004-05 heating season. Additionally, the report addresses policy options, both in the short and longer terms, that have been publicly discussed.

Background

The natural gas market is composed of three major components on the supply side; producers, pipelines, and local distribution companies. The price of natural gas paid by consumers is layered, in the sense that the wellhead price paid to producers forms a baseline. Pipeline transportation costs are then added, which yields the city gate price. Finally, local distribution companies add additional charges to yield the prices actually paid by consumers. Consumer markets themselves are divided into segments, each of which tends to pay a different, in many cases a significantly different, price. Residential consumers pay the highest prices, followed by commercial, industrial, and electricity users. **Table 1** shows the relationship between these prices in recent months.

The residential prices presented in **Table 1** represent an increase of 7% over residential prices for a comparable period in 2003. The most recent EIA natural gas price data available at the time of this report was August 2004. On the New York Mercantile Exchange (NYMEX), natural gas for delivery in December 2004 was trading at $6.80 per mcf and January and February 2005 natural gas was trading at over $7.50 per mcf.[1]

Table 1. Natural Gas Prices

	5/04	6/04	7/04	8/04
Wellhead Price	5.63	5.85	5.60	5.36
City Gate Price	6.48	6.92	6.68	6.45
Residential Price	11.60	13.05	13.41	13.78
Commercial Price	9.03	9.57	9.48	9.47
Industrial Price	6.27	6.70	6.24	6.19

Source: EIA Natural Gas Price Data, measured as dollars per mcf. Natural Gas Monthly, October, 2004, Table 4, p.8.

In addition to multiple prices faced by consumers, other prices are key variables for supply and policy decisions. The wellhead price of natural gas, as noted in this report, is competitively determined by market forces. This was not always the case. The process of natural gas price deregulation began in 1978 when the Natural Gas Policy Act (P.L. 95-621) became law. Under the Natural Gas Policy Act, nearly all price controls were phased out by the end of 1984.[2]

The spot price of natural gas is recorded at a transportation hub, the largest in the United States being Henry Hub in Louisiana, and is generally somewhat higher than the wellhead price because it includes some processing and transportation costs. Natural gas futures contract trading on the NYMEX establishes forward prices for natural gas, and allows market participants to hedge short and medium term price risk. The NYMEX future price is determined by the interaction of traders who have business interests in the real, physical natural gas market, and financial traders who speculate on the market. Natural gas is also traded by numerous brokers and other entities for physical delivery at a number of local markets.

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[1] Gas prices on the NYMEX are quoted for delivery at Henry Hub, Louisiana, and are not equivalent to wellhead prices. Henry Hub prices include some processing costs, as well as transportation costs to Henry Hub from the producing field.

[2] Additional legislation adopted in 1989 and 1992 completed the process of deregulation, (P.L. 101-60 and P.L. 102-486).

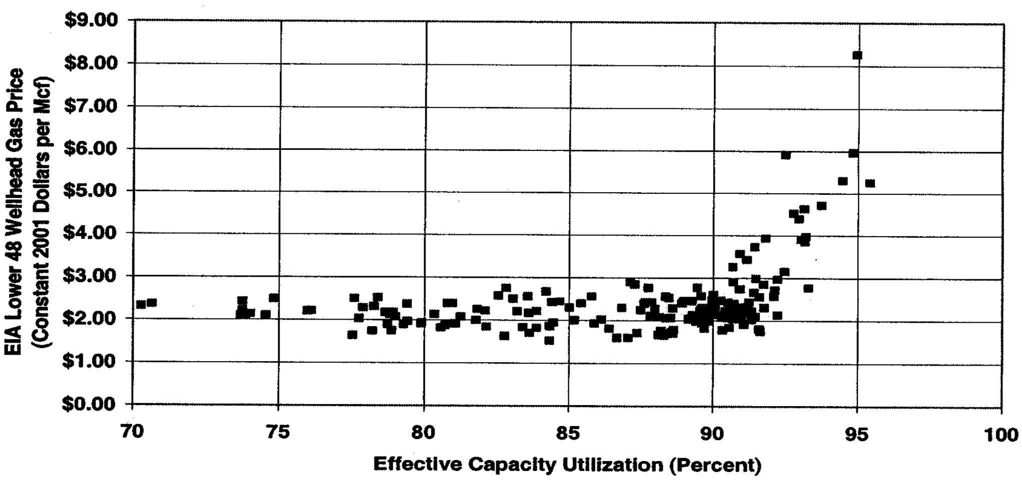
Interstate pipeline rates are not directly regulated and their pricing structure largely reflects open access for shippers and market pricing. The Federal Energy Regulatory Commission (FERC) monitors pipeline tariffs to assure "just and reasonable" pricing, and has intervened in a number of tariff situations. The city gate price includes the addition of these pipeline transportation charges.

Residential and small commercial consumers buy gas from a local distribution company, which delivers gas from a long-haul pipeline to the customer's premises. Local distribution companies are regulated by state public service commissions, who set distribution charges. The price data in **Table 1** indicates that residential prices have recently been almost double city gate prices in 2004. The price premium paid by residential and commercial consumers reflects the high fixed cost associated with distribution of their supply, as well as the added cost of small volume purchases.

Price Behavior

The EIA defines effective productive capacity as the maximum production available from natural gas wells, allowing for limitations in the production, gathering, and transportation systems.[3] The effective capacity utilization rate (ECUR) is the ratio of actual production to effective productive capacity. Surplus capacity is the difference between effective productive capacity and actual production.

Figure 1. Lower-48 States Effective Capacity Utilization and Gas Prices, 1987-2001



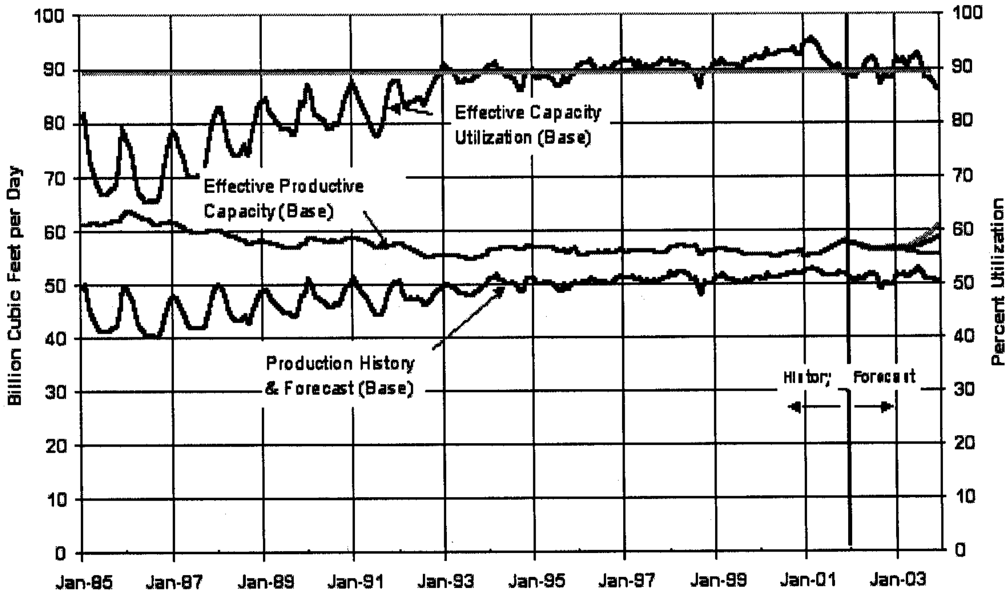
Source: Energy Information Administration, Office of Oil and Gas, Reserves and Production Division.

Figure 1 shows, for monthly data over the period 1987 to 2001, that the average wellhead price has stayed below $3.00 per mcf whenever the ECUR was below 90%. The data also show how upwardly volatile natural gas prices can be as the ECUR rises above 90%. The correlation between high values of the ECUR and high prices

[3] Energy Information Administration, *Natural Gas Productive Capacity for the Lower-48 States, 1985-2003*, 2003, p.1.

suggests that when the ECUR is above 90%, conditions are in place that are consistent with high, volatile natural gas prices.

Figure 2. Lower-48 States Monthly Dry Gas Production Rate and Effective Productive Capacity and Utilization, 1985-2003



Source: Energy Information Administration, Office of Oil and Gas, Reserves and Production Division.

Figure 2 shows the history of the ECUR, capacity and production since 1985. Several trends are noticeable in the data. Productive capacity has declined since the late 1980s, but appears to have remained stable since 1993. Actual production has trended up from 1985 to 1995 and has been relatively stable since then. These two trends, taken together, drove the ECUR to 90% or higher levels for almost all of the past eight years.

An ECUR in excess of 90% indicates that available natural gas output is nearly fully allocated to meeting demand. Any further increase in demand, or disruption of supply, can only be met through extraordinary draws on existing gas wells, increased draws from storage, or increased imports. All of these alternatives suggest that prices for the consumer are likely to rise. If these sources are unavailable for expansion the price could rise dramatically, and supply disruption might occur.

As part of the market adjustment to higher prices, increased development drilling could take place, but exploration and development does not immediately result in gas on the market. The EIA estimates that there is a lag of between 6 and 18 months between an increase in natural gas prices and an increase in developmental drilling and ultimately higher production.[4] The declining productivity of U.S. fields is also a factor. According to one industry observer, "it takes approximately 2.5 times more active rig capacity to produce the same amount of gas as just eight years

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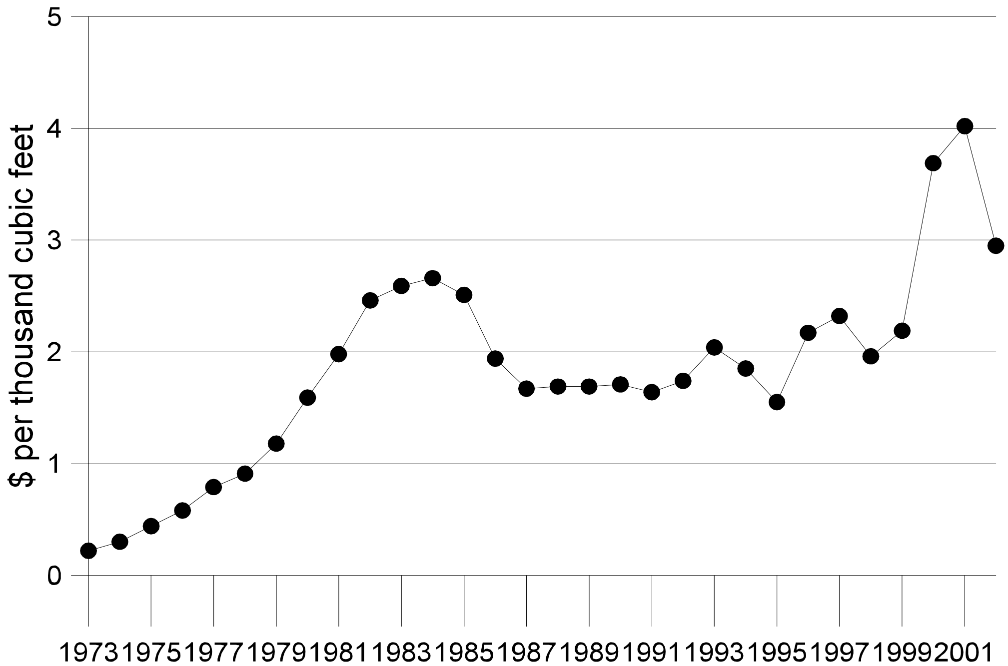
[4] Energy Information Administration, *U.S. Natural Gas Markets: Mid-Term Prospects for Natural Gas Supply,* December 2001, p.xiii.

ago."[5] Alternatively, when the ECUR is below 90%, any requirement for additional supply can be quickly brought to the market by increasing production from existing wells.

Figure 3. Wellhead Price of Natural Gas



Source: U.S. Energy Information Administration, derived from data available at [http://tonto.eia.doe.gov/dnav/ng/hist/n9190us3A.htm.]

Figure 3 shows the history of the wellhead price of natural gas from 1973 through 2003. Again, several trends are noticeable. The first run up in prices, from 1973 to the mid 1980s was the result of price deregulation in a market where supply was not abundant, demand–after years of regulated prices–was strong, and oil prices were high, as a result of the Arab oil embargo of the United States in 1973-74, and the Iranian political upheaval of the late 1970s. Prices declined after 1985–as did demand–and the United States entered a decade long period of relatively low, stable prices. During this period, use of natural gas as an abundant, cheap, clean fuel was promoted. Increasing demand, in conjunction with the supply trends shown in **Figure 2**, has resulted in the ECUR remaining at, or above, 90% since 1995. These conditions set the stage for the gas price increases and price volatility experienced since 2000.

An interesting break in the pattern of the **Figure 2** data is associated with the sharp price increases of the winter of 2000-01. As can be seen in **Figure 2**, the ECUR achieved very high values during this period. When coupled with the low temperatures of that winter, the result was high prices that set off a boom in exploration and drilling. While only 496 rotary drilling rigs, on average, were drilling for natural gas in 1999, that number increased to 720 in 2000 and rose to 939

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[5] Joseph P. Mathew, *LNG: What is it all About?*, Energy Pulse, November 27, 2002. p.4.

for 2001. As the resulting production entered the market in 2002 (6 to 18 months later) the ECUR fell below 90% in 2002 and the price of natural gas fell.[6] The lower price, however, resulted in lower developmental drilling and set the stage for sharp price increases in the winter of 2002-03. As prices declined in 2002, as seen in **Figure 3**, the drilling rig count also declined, to 691. The ECUR, reflecting the lower anticipated increments to production from reduced exploratory drilling, again rose above 90%, and price increases beginning during the winter of 2002-03 followed.

Drilling activity may be responding to 2003's higher prices. The EIA reported that the average monthly drill rig count for 2003 was 872, with the count running over 900 per month from June to December. The nine month average drilling rig count for 2004 is 1009, and has been on a path of steady monthly increases since January 2004.[7] Whether the recent increase in drilling activity results in large enough supply increases to allow the price of natural gas to fall depends on the exploration success rate, the size of the fields found, and the degree to which existing producing wells show output declines.

Factors Affecting ECUR and Price

Any factor that increases demand or decreases supply will increase the ECUR. When the ECUR is below 90% extra pressure on the market is likely to result in higher production. Once the ECUR rises to 90% or above, timely increases in production are less available and pressure on the market manifests itself as higher prices. Higher prices create incentives that eventually could cause price increases to moderate, although new sources may require higher prices to satisfy investment criteria.

Weather

The demand for natural gas exhibits a seasonal pattern even when the weather is normal. **Figure 4** shows the typical pattern, which is characterized by seasonal demand peaks. Since seasonal patterns are repetitive, suppliers, attempting to accommodate consumers, accumulate quantities of gas in storage facilities in the traditional off-peak season for release during the heating season.

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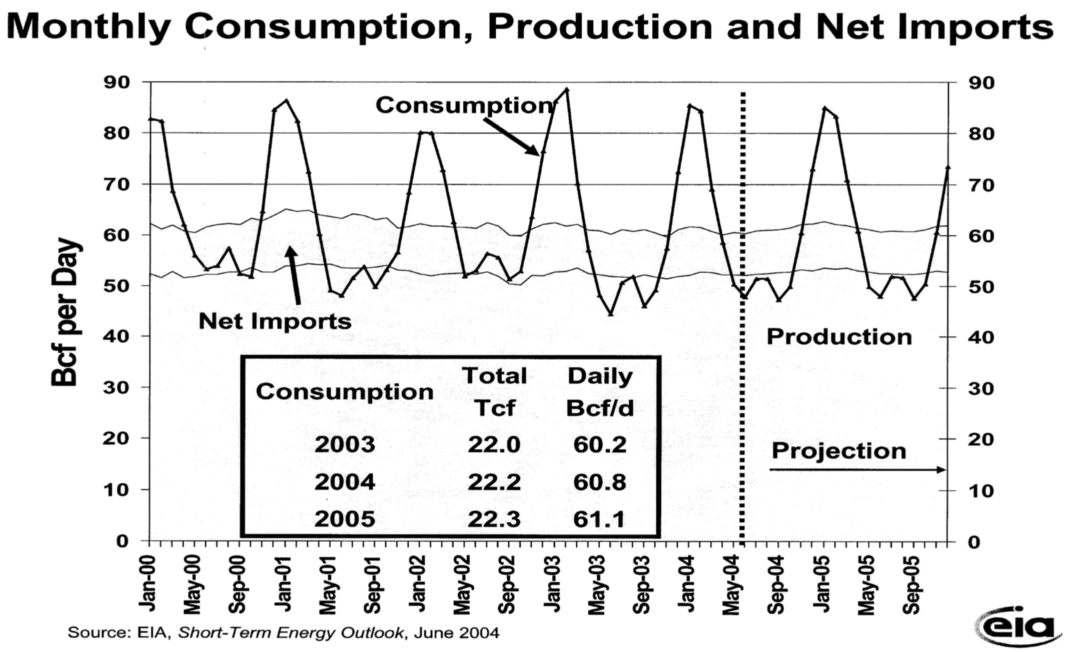
[6] Data for drilling rigs searching for natural gas was obtained from the Energy Information Administration, Monthly Energy Review, October,2004, Table 5.1, p.83.

[7] Ibid.

Figure 4. Natural Gas Seasonal Demand



Source: U.S. Energy Information Administration available at [http://www.eia.doe.gov/pub/oil_gas/natural_gas/presentations/2004/searuc/searuc_files/frame.htm]

If the seasonal demand pattern is accentuated by extreme weather conditions, the stored quantities of natural gas might not be sufficient, setting the stage for price increases if the ECUR is high. For example, as we approached the heating season of 2002-03, stored gas was at a normal level of approximately 3 trillion cubic feet (tcf). Below average temperatures early in the winter quickly drove stored quantities down to low levels, which set the stage for the price increases that followed.

If the ECUR remains high, as is likely, and a cold winter weather pattern repeats, the limited amount of stored gas, as well as the unresponsiveness of both supply and demand to real time price variations at the consumer level, could well bring about another price spike in the winter of 2004-05.

The seasonal pattern of natural gas demand is being altered by its growing use by electric power generators. Power generators expanded their demand for natural gas by 36% over the period 1997-2002. The EIA expects that over the long term forecast period, 80% of new electricity generation will be fueled by natural gas, continuing the strong growth of the last several years. Not only is electricity demand adding to total natural gas demand, but the pattern of peak demand might interfere with traditional gas demand cycles. The demand for natural gas for electricity generation peaks in the months June through October when space heating demand from residential and commercial customers is low, but when storage facilities replenish their stocks. As a result, it might be the case that the ECUR is pushed to higher levels, year round. Competition for summer supplies could cause short falls in storage quantities, create price pressures that squeeze out price sensitive industrial customers, or force higher electricity rates or even shortages to the system.[8]

Investment and Price

As discussed earlier in this report, when the ECUR is 90% or above, the ability of the industry to respond to increased demand with expanded supply from existing wells is limited, causing price to increase quickly. However, the higher prices do provide an incentive to begin the process of drilling new wells and exploring for new supplies. The resulting supply increase will tend to cause price to fall as productive capacity is enhanced, reducing the ECUR.

The nature of this relationship in the natural gas industry can, under some circumstances, lead to a cycle of unstable boom and bust feared by those investing in gas production. Taken to its extreme, this could lead to chronic under-investment in gas production and stagnant supply.

Higher prices for natural gas justify investment in exploratory drilling by increasing the value of the expected cash flow derived from the new production. In an efficiently operating market, a sustained, marginal increase in price is supposed to elicit a marginal increase in production. In natural gas, when the price rises, hundreds of extra rigs drill thousands of additional wells. Historical averages suggest that about 80% of these efforts will be successful and yield some new production. Once a well is brought into production, there is little economic rationale for not producing at full capacity. As a result, the market moves to a condition of excess supply as new production begins, causing a fall in the price. The reduced price brings a disincentive to invest in exploratory drilling, which leads to a period of stable supply setting the stage for a rising ECUR a tightening market balance and rising prices.

A key factor in the ability of the rate of investment in exploration to affect the ECUR is the degree to which existing wells deplete, or yield declining output levels. For example, the EIA expected that in 2003 the estimated effective productive capacity of the U.S. natural gas industry would be approximately 57 billion cubic feet per day (bcf/d). For 2003, production was expected to be approximately 51.4 bcf/d, leaving a surplus of 5.6 bcf/d, or about 10%. To demonstrate how this balance depends on new drilling and expansion of capacity, the EIA estimated that 25% of effective productive capacity comes from wells one year old or less. The two largest suppliers of U.S. natural gas, Texas and the Gulf of Mexico, derive 30% of their production from wells one year old or less. If drilling were to stop in the U.S., all surplus capacity would disappear in less than one year.

In 2001, the incentive of high prices led to 22,800 well completions that resulted in increased productive capacity. Only 17,800 wells were completed in 2002 and productive capacity declined. If, as this recent data suggests, the potential for a boom/bust investment cycle may be developing in the natural gas industry, the result

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[8] Long term forecast estimates are from the EIA , Annual Energy Outlook 2003.

will be brief periods of low prices and plentiful supply followed by periods of high prices and potential physical shortages.[9]

Gas Imports

The measures analyzed in the EIA study of effective productive capacity only refer to resources in the lower 48 states. As the U.S. natural gas market develops, this restriction will become less appropriate. The U.S. natural gas market is well integrated with the Canadian market. Imports of Canadian natural gas have long been an important supply source when U.S. consumption exceeded U.S. production and available stock draw down. Imports of natural gas from Canada, all via pipeline, reached over 3.7 tcf per year in 2001 and 2002, but declined to less than 3.5 tcf in 2003. Canadian gas fields, like those in the United States, may be unable to easily expand output without the development of new fields.

An additional source of imports might be liquefied natural gas (LNG).[10] The U.S. has four operational (or near operational) LNG receiving facilities with an annual operational send-out capacity of 1.4 tcf per year after all planned expansions are completed.[11] The critical issue concerning LNG is cost. Although the cost of a complete LNG facility has fallen substantially (30%) due to economies of scale and enhanced technology over the last decade, LNG cost is greater than most conventional gas from wells in the lower 48 states.[12] As a result, dependence on LNG may safeguard the nation from physical shortage by building a new, higher, baseline price into the market.

Stored Gas

The volume of gas held in storage is a critical element in evaluating the possibility of price volatility. If storage volumes are below normal as the winter heating season begins, and the ECUR is above 90%, the potential for elevated prices must be considered to be high.

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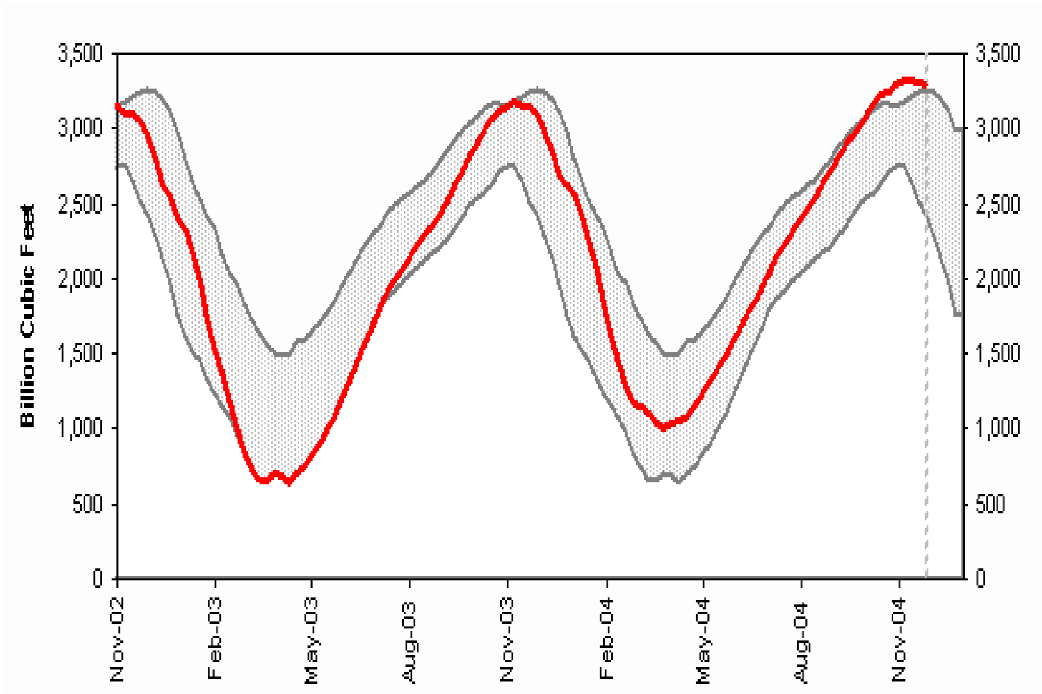
[9] Energy Information Administration, *Natural Gas Productive Capacity for the Lower-48 States, 1985-2003,* 2003, p.1.

[10] LNG is natural gas that has been chilled to a liquid state for shipping on a specially designed tanker. Once it reaches its destination it is heated to transform it back to a gas. At that point it is injected into the pipeline system, identical to natural gas from the wellhead.

[11] Energy Information Administration, *U.S. LNG Markets and Uses*, January, 2003, Table 1, p.6.

[12] James T. Jensen, *The LNG Revolution,* The Energy Journal, Vol. 24, No.2, 2003, p.31.

Figure 5. Working Gas in Underground Storage Compared With 5-year Range



Notes: A weekly record for March 8, 2002, was linearly interpolated between the derived weekly estimates that end March 1 and the initial estimate from the EIA-912 on March 15. The shaded area indicates the range between the historical minimum and maximum values for the weekly series from 1999 through 2003.

Source: Weekly storage values from March 15, 2002, to the present are from Form EIA-912, "Weekly Underground Natural Gas Storage Report." Values for earlier weeks are from the Historical Weekly Storage Estimates Database, with the exception of March 8, 2002.

Figure 5 shows the variability of storage volumes of working gas. Stored volumes totaled 2.7 tcf at the end of the 2000 refill season. The severe temperatures during the heating season of 2000-01 drew this down to a low of 742 billion cubic feet (bcf) in March of 2001. In contrast, at the end of the 2001 refill season, the stored volume was 3.1 tcf, but the heating season was characterized by more moderate temperatures and the stored volume did not fall below 1.5 tcf, double the quantity of the previous year. At the end of the 2002 refill season the stored volume was again 3.1 tcf, but by March of 2003 this had been reduced to 735 bcf, lower than the low point of the 2000-01 season. The 2003-04 refill season started with volumes almost 40% below their five year averages. Storage injection increased in the first six months of 2003, so that by mid-July 2003 storage volumes totaled 1.9 tcf, only 12% below the five year average. At the end of July 2003, total working gas storage was approaching 2.5 tcf. By November 2003, storage volumes approached the target of approximately 3.0 tcf in preparation for the onset of the heating season.

As shown in **Figure 5**, in November 2004 working gas storage levels were above their five year average, suggesting that adequate supplies were available. The EIA reported that by November 26, 2004 stocks in the lower 48 states totaled about

3.3 tcf, about 0.2 tcf more than at the same time in 2003.[13] Given this storage report, it would seem unlikely that the current high futures prices observed on the NYMEX could be supported by uncertainties related to available stocks.

Policy Considerations

The potential effects of high, volatile natural gas prices on both the national economy as well as individual consumers is not insignificant. High, sustained levels of natural gas prices can act as a drag on economic growth. As with oil price shocks in the past, high natural gas prices can constitute a classic supply side shock which reduces output and productivity growth. If severe enough, a shock of this type can increase unemployment and cause inflation in the short term.

On the level of individual consuming sectors, high natural gas prices negatively affect specific industrial users who make heavy use of natural gas in their production process, which makes them uncompetitive. Residential users might have difficulty paying their winter heating bills, forcing them to choose between adequate home heating and other necessities.

In the very near term little can be done to affect natural gas prices, except through market intervention in the form of price controls, mandatory conservation, and prioritized rationing. The conditions that will determine market balance for 2004 and 2005 are largely in place, with the major exception of the weather. To help mitigate the effects of possible price spikes this winter, aid to low income gas consumers through the Low Income Home Energy Assistance Program (LIHEAP) could be increased.[14]

Much can be done to alter the demand and supply characteristics of the natural gas market in the long term. Conservation, expansion of LNG use, access to areas not currently available for exploration, and new pipeline construction, among others can be debated. Any of these options will take significant time to implement and must be considered in a **long term** context. None of them are likely to have significant influence on prices over the next six months to one year.

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[13] Energy Information Administration, *Weekly Natural Gas Storage Report*, December 2, 2004.

[14] The American Gas Association reports that LIHEAP served abut 4 million households in 2003, only 15% of those eligible. Carl L. English, on behalf of the American Gas Association, testimony before the U.S. House of Representatives Energy and Commerce Committee, June 10, 2003, p.14.