# NATURAL GAS AND ENERGY PRICE VOLATILITY

***PREPARED FOR THE***
OAK RIDGE NATIONAL LABORATORY

*BY THE*

American Gas Foundation

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APPENDICES

# A

# APPENDIX A: GAS RATEMAKING FUNDAMENTALS

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*Gas Utility Rate Fundamentals*

*Revenue Requirement*

At the core of traditional cost-of-service regulation is the concept of the revenue requirement of the utility. The revenue requirement is the annual amount of revenue that is necessary to recover the utility's annualized costs plus a fair return on the capital investment.

There are five basic concepts central to the construction of the revenue requirement. These are:

- Base Period / Test Period – The specific period of time used to estimate representative costs for utility service. The costs can reflect a period of recent history, a forecasted period, or a combination of both.
- Rate Base – The capital investment in the distribution system upon which the LDC is allowed to earn a return. Generally the rate base is equal to the initial capital investment minus the cumulative depreciation incurred by those facilities since they were placed in service. Regulators can reduce the rate base if they decide that any facilities are not "used and useful."
- Rate of Return / Capital Structure – The rate of return is the annual percentage that regulators determine provides reasonable earnings. The rate is calculated by a weighted average of the cost of debt (a function of interest rates) and return on equity approved by the regulators. The capital structure of the utility or the utility holding company determines the weighting of these factors.
- Cost of Service – The cost of service is the sum of the following components:
  - Operating expenses – The annual expenses incurred by the LDC including salaries, benefits, administrative costs, and others. The cost of gas is also a major expense item. Often the cost of gas is considered separately using a cost of gas adjustment (CGA) mechanism.
  - Depreciation – The annual depreciation of the rate base.
  - Return on investment – The allowable earnings on the rate base.[1]

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[1] Actual earnings can be either less than or greater than the allowable earnings. Most often this occurs because the actual throughput volumes differ from those assumed in the ratemaking process, or the actual costs differ from the test period costs adopted in the rate proceeding. As a result, the actual rate of return can also be different from the allowable rate of return.

- Ratemaking and Pro-forma Adjustments – Adjustments for "known and measurable" differences between costs incurred in the test period and future costs. A change in an applicable tax rate is often a source of "known and measurable" adjustments. Similarly, one-time expenses are generally removed from the cost of service.

### *Cost Allocation*

Once the revenue requirement has been constructed, the utility allocates the costs to each customer class and individual service based upon a cost allocation study that identifies the cost to serve each customer class. The utility prepares an initial cost allocation study and submits the study to the state regulators for approval. The approval process can require a fully litigated proceeding before the regulatory body.

The cost allocation process involves three basic steps:

- Functionalization: Costs are divided into basic functions such as production, storage, transmission and distribution in accordance with the uniform system of accounts.
- Classification: Costs are assigned or prorated into categories, generally designated as demand, commodity, or customer costs.
- Allocation to customer classes: Functionalized and classified costs are further allocated to individual customer classes and services.

### *Rate Design*

Once all of the costs have been determined and classified, the utility calculates the rates for each service. This process requires an estimate or projection of the number of customers and the amount of consumption for each service. These estimates, called the "billing determinants," are subject to the same process of review in the state regulatory process as the revenue requirement and cost allocation determinations.

For the LDC to recover the revenue requirement, the rates are designed so that:

**Sum (Rate X Billing Determinant) = The Revenue Requirement**

Utility rates for firm service are not generally designed to recover costs exclusively on a volumetric bases. Rather, the tariff rate generally provides for a fixed monthly customer charge that recovers some portion of the LDC's fixed costs regardless of the level of consumption. The tariff generally recovers the remainder of the revenue requirement via a "per unit" charge applied to each unit of consumption.

It is important to note that ***it is extremely rare for the rate structure of an LDC to collect all of the fixed costs of the system from the customer charges***. Rather, most gas utilities collect 30 percent or more of the fixed costs from the volumetric portion of the rate. As a result, if actual throughput deviates substantially from the projected throughput implicit in the billing determinants, the actual recovered costs will also deviate from the projected revenue requirement. This can lead to over- or under-recovery of costs. However, as was noted earlier, in practice the risk is somewhat asymmetric, with greater risk of under-recovery.

Many utilities employ a block rate structure for their volumetric charges. Generally, the rate for the initial block is greater than the rate for subsequent blocks. The objective is to allow for the recovery of most of the fixed costs of the distribution system even if throughput is somewhat lower than expected. The block structure also limits the amount of over-collection should throughput be higher than expected.

Because the process of designing rates results in different cost burdens on various customer classes, rate design is influenced by political considerations. While the entire proceeding is documented according to accounting standards and consistent with case precedent within the state, the result of the rate design process must provide a fair and politically acceptable burden to the broad range of stakeholders.

### *Gas Cost Recovery*

Under the traditional cost of service model for gas utility rates, the cost of the gas and the cost of the transportation storage services needed to bring the gas to the LDC's Citygate are expenses that are directly recovered in the utility rates with no profit or earnings. Since these expenses represent a large percentage of the consumers costs, most state regulators create a separate "tracker" account for these charges, most often called cost of gas accounts (CGA). The specifics of these accounts may differ from state to state in terms of how often the consumers' cost of gas is adjusted (e.g., monthly, bi-monthly, quarterly, semi-annually). To the extent that the actual gas costs differ from those costs that are reflected in the rates, the positive or negative balances are accumulated in a "true-up" account and are surcharged or refunded to customers through adjustments to the CGA in a subsequent period.

#### *Gas Cost Recovery Before and After the Natural Gas Pipeline Act of 1978*

Prior to 1985, gas prices were relatively easy to forecast over the short-term. Prices were generally set under the terms of long-term contracts, the behavior of which was relatively well understood. However, as short-term and spot markets for gas developed, gas prices became much more volatile and harder to predict. As a result, there were significant increases in the dollars accrued in the CGA accounts.

Prior to the restructuring of the interstate pipeline industry that was implemented through FERC Orders 436/500 and 636, LDCs purchased virtually all of their gas supplies in the form of bundled Citygate service. Both the cost of wellhead gas supplies and the cost of transportation service were included in the bundled Citygate sale and included in the CGA mechanism. In the wake of pipeline unbundling, these costs were separated. Some states responded by creating separate trackers for transportation costs in their CGAs, while other states continued to combine the cost in a unified account.

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# APPENDIX B: GLOSSARY OF KEY ENERGY MARKET TRADING AND PRICE VOLATILITY TERMS

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|---|---|
| **Annualized Returns**: | Returns measured as a percent change in prices are annualized in order to compare volatility of price series with different time periods (e.g., daily spot price volatility vs. monthly bidweek price volatility). For daily prices, the annualization period is the number of trading days in a year. |
| **Arbitrage** | A trading strategy that takes advantage of two or more securities or time periods being mispriced relative to each other. |
| **Bidweek Transactions** | Firm commitments to buy or sell a uniform quantity of gas for each day in the following month. The term "bidweek" refers to the final days in the month when contracts for the next month's deliveries are signed. Trade publications collect data from the market participants and compile the prices for monthly firm contracts entered into in the last 5 days, and publish the midpoint and range of the transaction prices. |
| **Black-Scholes Model** | The Black-Scholes Model is used to estimate the value of an option, and hence can be used to determine the appropriate price that a rational investor would pay for that option. The key unknown in the Black-Scholes model is the expected standard deviation of daily returns for the asset. |
| **Coefficient of Variation** | A relative measure of price movement. Calculated as the standard deviation divided by the mean value. The coefficient is a useful comparative measure of price volatility for different commodities when prices are measured in different units, and with different baseline prices (e.g., electricity price volatility vs. natural gas price volatility). |
| **Crack Spread** | A commodity-product spread involving the purchase of crude oil futures and the sale of gasoline and heating oil futures, in order to establish a refining margin. |
| **Dual-Fired Capacity** | The ability of customers to convert to another fuel at short notice. Equipment with the capacity to switch from oil to natural gas. |

**Futures Contracts** Firm commitments to make or accept delivery of a specified quantity and quality of a commodity during a specific month in the future at a price agreed upon at the time the commitment is made. (Source: NYMEX)

**Gas Prices**

*Citygate Price* The price for gas delivered at the citygates. Citygates are the transfer point or measuring station at which upstream pipelines connect to the LDC's distribution system.

*Retail Price* The price charged to the ultimate consumer.

*Spot Prices* The price for a one-time, open market transaction for immediate delivery of the specific quantity of product at a specific location where the commodity is purchased "on the spot" at current market rates. (Source: EIA)

*Wellhead Price* The price of crude oil or natural gas at the mouth of the well. (Source: EIA)

**Hedging** A trade designed to reduce risk. Usually done by covering future commitments at a fixed price in the future, through an options or futures contract.

**Kurtosis** A measure of the degree of peakedness of a data distribution. Often referred to as the "excess" or "excess coefficient" relative to a normal distribution, Kurtosis is a normalized form of the fourth moment of a distribution.

**Marginal Prices** The price of the next increment of supply. In electricity markets, marginal prices are often calculated on an hourly basis. Published data generally presents daily averages for weekdays (excluding holidays).

**Non-commercial Open Interest** The net non-commercial open interest represents total "long" open interest contracts minus total "short" positions held by non-commercial customers. It represents a reasonable proxy for speculative positions in natural gas futures markets. Natural gas prices tend to increase when net non-commercial open interest is above zero and to decrease when net non-commercial interest is below zero.

**Open Interest** The number of open or outstanding contracts for which an individual or entity is obligated to an exchange because that individual or entity has not yet made an offsetting sale or purchase, an actual contract delivery, or in the case of options, exercised the option. (Source: NYMEX)

**Options** A contract between two parties in which one party has the right, but not the obligation, to buy or sell an underlying asset.

*Put Option* An option that gives the holder the right (but not the obligation) to sell a specified the futures contract at a fixed price, on or before a specified date. The grantor of the option has the obligation to take delivery of the futures contract if the option is exercised.

*Call Option* An option that gives the holder the right but not the obligation to buy a futures contract at a fixed price, on or before a specified date. The grantor of the option is obliged to sell the futures contract at the fixed price if the holder exercises the option.

*Strike Price* The price at which an option holder has the right to buy or sell an underlying commodity/derivative.

*Risk-free Rate* The rate of interest that can be earned without assuming any risk.

*Out-of-the-Money Option* An option which has no intrinsic value. A put option is out-of-the-money when its strike price is below the value of the underlying futures contract. A call option is out-of-the money when its strike price is above that of the underlying futures contract.

**Parkinson's Measure of Volatility**: A measure of volatility based on the difference between high and low prices within a given time period (such as a day, or over the bidweek). It is particularly useful for exchange-traded energy products where at any given moment, all trades are made at a single price. It is less useful for comparing volatility among different data series where prices may not be the same because they reflect different credit risk premiums or product differentiation. Changes in the Parkinson measure over time can be used as an indicator of changes in volatility between time periods.

**Price Collar** Contract between a buyer and seller of a commodity whereby the buyer is assured that he will not have to pay more than some maximum price and whereby the seller is assured of receiving some minimum price. (Source: NYMEX)

**Price Range** The spread in prices during a specific period. In markets with a uniform product and an open bidding process (e.g., the stock market), the range is often defined as the average spread between the bid price and the ask price during a specific time period. For markets without a uniform product, and where bid and ask prices are not typically available (such as natural gas markets for all locations with the possible exception of the NYMEX Henry Hub contract), the range is typically measured as the difference between the daily high price and the daily low price. When all else is equal, and where the product is uniform, an increase in the range typically indicates an increase in volatility, and/or a decrease in liquidity.

**Return** Measure of volatility as a percentage change in prices, rather than in absolute prices. Can be viewed as a measure of expected return on investment, e.g., a 10 percent increase in price represents a 10 percent return on the value of the underlying asset, regardless of whether the 10 percent return represents a \$0.20 increase from \$2.00 per MMBtu, or a \$1.00 increase from \$10.00 per MMBtu.

*Lognormal Return* Returns are calculated on a log-normal basis using the form:

$$\text{Return}(_a) = \ln(\text{Price}_a/\text{Price}_{a-1})$$

The lognormal form is used in order to create a more normal data distribution. Since prices are bounded by zero on the downside, and do not have a limit on the upside, the distribution of price data is often skewed unless evaluated using a logarithmic form.

**Skewness** A measure of the degree of asymmetry of a distribution. If the distribution has a longer tail on one side of the distribution than the other, the distribution is skewed. Variables such as price, which have a theoretical minimum value (zero) but no theoretical maximum value, typically would be expected to have a skewed distribution. Data skewness provides a measure of the asymmetrical market impact of directionally different effects. For example, an increase in demand due to colder than normal weather will typically have a larger upward impact on natural gas price than a similar decrease in demand due to warmer than normal weather.

**Spark Spread** The difference in value between marketed electricity and the cost of energy used to produce electricity.

**Standard Deviation** An absolute measure of the actual price movement over a specific period. The standard deviation represents the expected deviation from the average market price during a given period. A higher standard deviation represents greater price movement, and when looked at in absolute terms, a higher standard deviation represents greater price volatility.

**Wash Trading** Wash Trading exists when a market participant makes two or more offsetting trades that act to cancel each other out.

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# APPENDIX C: DESCRIPTIONS OF SELECTED COMMODITY MARKETS

With the exception of electricity, which is not traded on a commodity market, this appendix includes the descriptions of the traded commodities reviewed in this report as published by the market center trading the commodity.

## C.1 Henry Hub Natural Gas Market

***New York Mercantile Exchange Description and Specifications***
***Source: www.nymex.com***

Natural gas plays a major role in the United States energy profile, where it accounts for almost a quarter of total energy consumption. Its market share is likely to expand because of the favorable competitive position of gas in relation to other fuels, and the tightening environmental standards for fuel combustion. Industrial users and electric utilities together account for 59% of the market; commercial and residential users combined are 42%.

The industry has gone through a metamorphosis since the enactment of the Natural Gas Policy Act of 1978, changing from an almost totally regulated industry to one that today largely operates as a free market. The New York Mercantile Exchange, Inc. launched the world's first natural gas futures contract in April 1990. Volume and open interest have grown rapidly, establishing the contract as the fastest growing instrument in Exchange history.

The Exchange marked another milestone in the energy markets in October 1992 when it launched options on natural gas futures, giving market participants additional flexibility in managing their market risk.

Industry participation in the natural gas futures market comprises a wide cross-section of the industry from producers to end-users. Many natural gas and electric utilities either use the NYMEX Division natural gas futures and options contracts, or are considering doing so. A number of state utility regulators have given permission to utilities in their jurisdictions to use the NYMEX Division markets or are considering such proposals.

Recent legislation concerning air pollution control should only contribute to the market's further growth.

From a market of stable but controlled prices and long-term contracts, the natural gas market has emerged as a dynamic, highly competitive business with flexible pricing, an active spot market, and widespread use of short- to medium-term contracts. This is causing a fundamental change in the way each of the traditional segments of the industry operate: producers, pipelines, gas utilities, and industrial users.

The radical change has also led to the development and rapid growth of a business that did not exist a few years ago, the natural gas marketer who links buyers with sellers and often arranges pipeline transportation for his customers. The natural gas futures contract is especially well suited to manage the increasing price risk that has accompanied these market changes.

### Trading Unit

Futures: 10,000 million British thermal units (mmBtu).
Options: One NYMEX Division natural gas futures contract.

### Price Quotation

Futures and Options: Dollars and cents per mmBtu, for example, $2.850 per mmBtu.

**Trading Hours**

Futures and Options: Open outcry trading is conducted from 10:00 A.M. until 2:30 P.M. (natural gas futures and options will close at 2:45 P.M. on any futures termination day that falls on a Wednesday).

After hours futures trading is conducted via the NYMEX ACCESS® internet-based trading platform beginning at 3:15 P.M. on Mondays through Thursdays and concluding at 9:00 A.M. the following day. On Sundays, the session begins at 7:00 P.M. All times are New York time. Natural Gas futures and options will close at 2:45 P.M. on any futures termination day that falls on a Wednesday

**Trading Months**

Futures: 72 consecutive months commencing with the next calendar month (for example, on January 2, 2002, trading occurs in all months from February 2002 through January 2008).

Options: 12 consecutive months, plus contracts initially listed 15, 18, 21, 24, 27, 30, 33, 36, 39, 42, 45, 48, 51, 54, 57, 60, 63, 66, 69, and 72 months out on a March, June, September, December cycle.

**Minimum Price Fluctuation**

Futures and Options: $0.001 (0.1¢) per mmBtu ($10.00 per contract).

**Maximum Daily Price Fluctuation**

Futures: $1.00 per mmBtu ($10,000 per contract) for all months. If any contract is traded, bid, or offered at the limit for five minutes, trading is halted for 15 minutes. When trading resumes, expanded limits are in place that allow the price to fluctuate by $2.00 in either direction of the previous day's settlement price. There are no price limits on any month during the last three days of trading in the spot month.

Options: No price limits.

**Last Trading Day**

Futures: Trading terminates three business days prior to the first calendar day of the delivery month.

Options: Trading terminates at the close of business on the business day immediately preceding the expiration of the underlying futures contract.

**Exercise of Options**

By a clearing member to the Exchange clearinghouse not later than 5:30 P.M. or 45 minutes after the underlying futures settlement price is posted, whichever is later, on any day up to and including the options expiration.

**Option Strike Prices**

Twenty strike prices in increments of $0.05 (5¢) per mmBtu above and below the at-the-money strike price in all months, plus an additional 20 strike prices in increments of $0.05 per mmBtu above the at-the-money price will be offered in the first three nearby months, and the next 10 strike prices in increments of $0.25 (25¢) per mmBtu above the highest and below the lowest existing strike prices in all months for a total of at least 81 strike prices in the first three nearby months and a total of at least 61 strike prices for four months and beyond. The at-the-money strike price is nearest to the previous day's close of the underlying futures contract. Strike price boundaries are adjusted according to futures price movements.

**Delivery Location**

Sabine Pipe Line Co.'s Henry Hub in Louisiana. Seller is responsible for the movement of the gas through the Hub; the buyer, from the Hub. The Hub fee will be paid by seller.

**Delivery Period**

Delivery shall take place no earlier than the first calendar day of the delivery month and shall be completed no later than the last calendar day of the delivery month. All deliveries shall be made at as uniform as possible an hourly and daily rate of flow over the course of the delivery month.

**Alternate Delivery Procedure (ADP)**

An alternate delivery procedure is available to buyers and sellers who have been matched by the Exchange subsequent to the termination of trading in the spot month contract. If buyer and seller agree to consummate delivery under terms different from those prescribed in the contract specifications, they may proceed on that basis after submitting a notice of their intention to the Exchange.

**Exchange of Futures For, or in Connection with, Physicals (EFP) or Swaps (EFS)**

The commercial buyer or seller may exchange a futures position for a physical position or a swaps position of equal quantity by submitting a notice to the Exchange. EFPs and EFSs may be used to either initiate or liquidate a futures position.

**Quality Specifications**

Pipeline specifications in effect at time of delivery.

**Position Accountability Limits**

Any one month / all months: 12,000 net futures, but not to exceed 1,000 in the last three days of trading in the spot month or 5,000 in any one month.

**Trading Symbols**

Futures: NG
Options: ON

## C.2 Light Sweet Crude Oil

***New York Mercantile Exchange Description and Specifications***
***Source: www.nymex.com***

Crude oil is the world's most actively traded commodity. Over the past decade, the NYMEX Division light, sweet (low-sulfur) crude oil futures contract has become the world's most liquid forum for crude oil trading, as well as the world's largest-volume futures contract trading on a physical commodity. Because of its excellent liquidity and price transparency, the contract is used as a principal international pricing benchmark.

The contract's delivery point is Cushing, Oklahoma, the nexus of spot market trading in the United States, which is also accessible to the international spot markets via pipelines. By providing for delivery of several grades of domestic and internationally traded foreign crudes, the futures contract is designed to serve the diverse needs of the physical market.

Light, sweet crudes are preferred by refiners because of their relatively high yields of high-value products such as gasoline, diesel fuel, heating oil, and jet fuel.

**Trading Unit**

Futures: 1,000 U.S. barrels (42,000 gallons).
Options: One NYMEX Division light, sweet crude oil futures contract.

**Price Quotation**

Futures and Options: Dollars and cents per barrel.

**Trading Hours**

Futures and Options: Open outcry trading is conducted from 10:00 A.M. until 2:30 P.M.

After hours futures trading is conducted via the NYMEX ACCESS® internet-based trading platform beginning at 3:15 P.M. on Mondays through Thursdays and concluding at 9:00 A.M. the following day. On Sundays, the session begins at 7:00 P.M. All times are New York time.

**Trading Months**

Futures: 30 consecutive months plus long-dated futures initially listed 36, 48, 60, 72, and 84 months prior to delivery.

Additionally, trading can be executed at an average differential to the previous day's settlement prices for periods of two to 30 consecutive months in a single transaction. These calendar strips are executed during open outcry trading hours.

Options: 12 consecutive months, plus three long-dated options at 18, 24, and 36 months out on a June/December cycle.

**Minimum Price Fluctuation**

Futures and Options: $0.01 (1¢) per barrel ($10.00 per contract).

**Maximum Daily Price Fluctuation**

Futures: Initial limits of $3.00 per barrel are in place in all but the first two months and rise to $6.00 per barrel if the previous day's settlement price in any back month is at the $3.00 limit. In the event of a $7.50 per barrel move in either of the first two contract months, limits on all months become $7.50 per barrel from the limit in place in the direction of the move following a one-hour trading halt.

Options: No price limits.

**Last Trading Day**

Futures: Trading terminates at the close of business on the third business day prior to the 25th calendar day of the month preceding the delivery month. If the 25th calendar day of the month is a non-business day, trading shall cease on the third business day prior to the last business day preceding the 25th calendar day.

Options: Trading ends three business days before the underlying futures contract.

**Exercise of Options**

By a clearing member to the Exchange clearinghouse not later than 5:30 P.M., or 45 minutes after the underlying futures settlement price is posted, whichever is later, on any day up to and including the option's expiration.

**Options Strike Prices**

Twenty strike prices in increments of $0.50 (50¢) per barrel above and below the at-the-money strike price, and the next ten strike prices in increments of $2.50 above the highest and below the lowest existing strike prices for a total of at least 61 strike prices. The at-the-money strike price is nearest to the previous day's close of the underlying futures contract. Strike price boundaries are adjusted according to the futures price movements.

**Delivery**

F.O.B. seller's facility, Cushing, Oklahoma, at any pipeline or storage facility with pipeline access to TEPPCO, Cushing storage, or Equilon Pipeline Co., by in-tank transfer, in-line transfer, book-out, or inter-facility transfer (pumpover).

**Delivery Period**

All deliveries are ratable over the course of the month and must be initiated on or after the first calendar day and completed by the last calendar day of the delivery month.

**Alternate Delivery Procedure (ADP)**

An alternate delivery procedure is available to buyers and sellers who have been matched by the Exchange subsequent to the termination of trading in the spot month contract. If buyer and seller agree to consummate delivery under terms different from those prescribed in the contract specifications, they may proceed on that basis after submitting a notice of their intention to the Exchange.

**Exchange of Futures for, or in Connection with, Physicals (EFP)**

The commercial buyer or seller may exchange a futures position for a physical position of equal quantity by submitting a notice to the Exchange. EFPs may be used to either initiate or liquidate a futures position.

**Deliverable Grades**

Specific domestic crudes with 0.42% sulfur by weight or less, not less than 37° API gravity nor more than 42° API gravity. The following domestic crude streams are deliverable: West Texas Intermediate, Low Sweet Mix, New Mexican Sweet, North Texas Sweet, Oklahoma Sweet, South Texas Sweet.

Specific foreign crudes of not less than 34° API nor more than 42° API. The following foreign streams are deliverable: U.K. Brent and Forties, and Norwegian Oseberg Blend, for which the seller shall receive a 30¢-per-barrel discount below the final settlement price; Nigerian Bonny Light and Colombian Cusiana are delivered at 15¢ premiums; and Nigerian Qua Iboe is delivered at a 5¢ premium.

**Inspection**

Inspection shall be conducted in accordance with pipeline practices. A buyer or seller may appoint an inspector to inspect the quality of oil delivered. However, the buyer or seller who requests the inspection will bear its costs and will notify the other party of the transaction that the inspection will occur.

**Position Accountability Limits**

Any one month/all months: 20,000 net futures, but not to exceed 1,000 in the last three days of trading in the spot month.

**Margin Requirements**

Margins are required for open futures or short options positions. The margin requirement for an options purchaser will never exceed the premium.

**Trading Symbols**

Futures: CL
Options: LO

## C.3 Heating Oil

New York Mercantile Exchange Description and Specifications
Source: www.nymex.com

Heating oil, also known as No. 2 fuel oil, accounts for about 25% of the yield of a barrel of crude, the second largest "cut" after gasoline. In its early years, the heating oil futures contract attracted mainly heating oil wholesalers and large consumers. It soon became apparent that the contract was also being used to hedge diesel fuel, which is chemically similar to heating oil, and jet fuel, which trades in the cash market at a usually stable premium to NYMEX Division heating oil futures.

Today, a wide variety of businesses, including oil refiners, wholesale marketers, heating oil retailers, trucking companies, airlines, and marine transport operators, as well as other major consumers of fuel oil, have embraced this contract as a risk management vehicle and pricing mechanism. The recent imposition of strict federal sulfur standards for diesel fuel have the potential to increase price volatility in some markets.

Seasonal and economic factors influence the relative prices of heating oil, gasoline, natural gas, propane, and crude oil. By spread trading heating oil futures against other NYMEX Division energy futures contracts, businesses are able to fix margins among products. Marketers and traders can also lock in a return for carrying heating oil inventory by spread trading calendar months.

Because NYMEX Division heating oil futures are traded over 18 consecutive months, traders can implement hedging strategies that encompass two winter heating seasons.

**Trading Unit**

Futures: 42,000 U.S. gallons (1,000 barrels).
Options: One NYMEX Division heating oil futures contract.

**Price Quotation**

Futures and Options: In dollars and cents per gallon: for example, $0.7527 (75.27¢) per gallon.

**Trading Hours**

Futures and Options: Open outcry trading is conducted from 10:05 A.M. until 2:30 P.M.

After hours futures trading is conducted via the NYMEX ACCESS® internet-based trading platform beginning at 3:15 P.M. on Mondays through Thursdays and concluding at 9:00 A.M. the following day. On Sundays, the session begins at 7:00 P.M. All times are New York time.

**Trading Months**

Futures: Trading is conducted in 18 consecutive months commencing with the next calendar month (for example, on January 2, 2002, trading occurs in all months from February 2002 through July 2003).

Options: 18 consecutive months.

**Minimum Price Fluctuation**

Futures and Options: \$0.0001 (0.01¢) per gallon (\$4.20 per contract).

**Maximum Daily Price Fluctuation**

Futures: Initial limits of \$0.06 (6¢) per gallon are in place in all but the first two months and rise to \$0.09 (9¢) per gallon if the previous day's settlement price in any back month is at the \$0.06 per gallon limit. In the event of a \$0.20 (20¢) per gallon move in either of the first two contract months, limits on all months become \$0.20 per gallon from the limit in place in the direction of the move following a one-hour trading halt.

Options: No price limits.

**Last Trading Day**

Futures: Trading terminates at the close of business on the last business day of the month preceding the delivery month.

Options: Trading ends three business days before the underlying futures contract.

**Exercise of Options**

By a clearing member to the Exchange clearinghouse not later than 5:30 P.M., or 45 minutes after the underlying futures settlement price is posted, whichever is later, on any day up to and including the option's expiration.

**Options Strike Prices**

Twenty strike prices in one-cent-per-gallon increments above and below the at-the-money strike price, and the next ten strike prices in five-cent increments above the highest and below the lowest existing strike prices for a total of at 61 strike prices. The at-the-money strike price is the nearest to the previous day's close of the underlying futures contract. Strike price boundaries are adjusted according to the futures price movements.

**Delivery**

F.O.B. seller's facility in New York Harbor, ex-shore. All duties, entitlements, taxes, fees, and other charges paid. Requirements for seller's shore facility: capability to deliver into barges. Buyer may request delivery by truck, if available at the seller's facility, and pays a surcharge for truck delivery. Delivery may also be completed by pipeline, tanker, book transfer, or inter- or intra-facility transfer. Delivery must be made in accordance with applicable federal, state, and local licensing and tax laws.

**Delivery Period**

Deliveries may only be initiated the day after the fifth business day and must be completed before the last business day of the delivery month.

**Alternate Delivery Procedure (ADP)**

An alternate delivery procedure is available to buyers and sellers who have been matched by the Exchange subsequent to the termination of trading in the spot month contract. If buyer and seller agree to consummate delivery under terms different from those prescribed in the contract specifications, they may proceed on that basis after submitting a notice of their intention to the Exchange.

**Exchange of Futures for, or in Connection with, Physicals (EFP)**

The commercial buyer or seller may exchange a futures position for a physical position of equal quantity by submitting a notice to the Exchange. EFPs may be used to either initiate or liquidate a futures position.

**Grade and Quality Specifications**

Generally conforms to industry standards for fungible No. 2 heating oil.

**Inspection**

The buyer may request an inspection for grade and quality or quantity for all deliveries, but shall require a quantity inspection for a barge, tanker, or inter-facility transfer. If the buyer does not request a quantity inspection, the seller may request such inspection. The cost of the quantity inspection is shared equally by the buyer and seller. If the product meets grade and quality specifications, the cost of the quality inspection is shared jointly by the buyer and seller. If the product fails inspection, the cost is borne by the seller.

**Position Accountability Limits**

7,000 contracts for all months combined, but not to exceed 1,000 in the last three days of trading in the spot month or 5,000 in any one month.

**Margin Requirements**

Margins are required for open futures or short options positions. The margin requirement for an options purchaser will never exceed the premium.

**Trading Symbols**

Futures: HO
Options: OH

## C.4 COPPER

***New York Mercantile Exchange Description and Specifications***
***Source: www.nymex.com***

Copper, one of the oldest commodities known to man, is a product with fortunes which directly reflect the state of the world economy. It is the world's third most widely used metal, after iron and aluminum, and is primarily used in highly cyclical industries such as construction and industrial machinery manufacturing. Profitable extraction of the metal depends on cost-efficient high-volume mining techniques, and supply is sensitive to the political situation particularly in those countries where copper mining is a government-controlled enterprise.

Copper was first worked about 7,000 years ago. Its softness, color, and presence in nature enabled it to be easily mined and fashioned into primitive utensils, tools, and weapons. Five thousand years ago, man learned to alloy copper with tin, producing bronze and giving rise to a new age.

Thus copper was established as a commodity with commercial value.

By the mid-1800s, Britain, with superior smelting technology, controlled more than three-quarters of the world copper trade. As the proportion of metal to waste in rock declined, it became economical to position smelters and refiners adjacent to mining sites and ship the final product directly to market. The discovery, in the 19th century, of major copper deposits in North America, Chile, and Australia challenged England's preeminent position.

In the early 20th century, new mining and smelting techniques were developed in the United States which made it possible to process lower-grade ores, resulting in a dramatic global expansion of the copper market.

Since the 1950s, more often than not, the copper market has been in backwardation but has gone into contango for significant periods of time.

Copper market participants across the board use COMEX Division high-grade copper futures and options to mitigate price risk, and the copper contracts are used as investment vehicles, as well.

**Trading Unit**

25,000 pounds.

**Price Quotation**

Cents per pound. For example, 75.80¢ per pound.

**Trading Hours**

Open outcry trading is conducted from 8:10 A.M. until 1:00 P.M.

After-hours futures trading is conducted via the NYMEX ACCESS® internet-based trading platform beginning at 3:15 P.M. on Mondays through Thursdays and concluding at 8:00 A.M. the following day. On Sundays, the session begins at 7:00 P.M. All times are New York time.

**Trading Months**

Trading is conducted for delivery during the current calendar month and the next 23 consecutive calendar months.

**Minimum Price Fluctuation**

Price changes are registered in multiples of five one hundredths of one cent ($0.0005, or 0.05¢) per pound, equal to $12.50 per contract. A fluctuation of one cent ($0.01 or 1¢) is equal to $250.00 per contract.

**Maximum Daily Price Fluctuation**

Initial price limit, based upon the preceding day's settlement price is $0.20 (20¢) per pound. Two minutes after either of the two most active months trades at the limit, trading in all months of futures and options will cease for a 15-minute period. Trading will also cease if either of the two active months is bid at the upper limit or offered at the lower limit for two minutes without trading.

Trading will not cease if the limit is reached during the final 20 minutes of a day's trading. If the limit is reached during the final half hour of trading, trading will resume no later than 10 minutes before the normal closing time.

When trading resumes after a cessation of trading, the price limits will be expanded by increments of 100%.

**Last Trading Day**

Trading terminates at the close of business on the third to last business day of the maturing delivery month.

**Delivery**

Copper may be delivered against the high-grade copper contract only from a warehouse in the United States licensed or designated by the Exchange. Delivery must be made upon a domestic basis; import duties or import taxes, if any, must be paid by the seller, and shall be made without any allowance for freight.

**Delivery Period**

The first delivery day is the first business day of the delivery month; the last delivery day is the last business day of the delivery month.

**Exchange of Futures for, or in Connection with, Physicals (EFP)**

The buyer or seller may exchange a futures position for a physical position of equal quantity by submitting a notice to the Exchange. EFPs may be used to either initiate or liquidate a futures position.

**Grade and Quality Specifications**

Grade 1 electrolytic copper conforming to the specification B115 as to chemical and physical requirements, as adopted by the American Society for Testing and Materials, and of a brand approved and listed by the Exchange.

**Position Accountability Levels**

Any one month/all months: 6,000 net futures equivalent, but not to exceed 2,500 in the spot month.

**Margin Requirements**

Margins are required for open futures and short options positions. The margin requirement for an options purchaser will never exceed the premium paid.

**Trading Symbol**

HG

## C.5 COFFEE

***New York Board of Trade Description and Specifications***
***Source:*** *www.nybot.com*
Futures Contract on Coffee "C"

Calls for delivery of washed arabica coffee produced in several Central and South American, Asian and African countries.

**Trading Unit**

37,500 lbs. (approximately 250 bags)

**Trading Hours**

9:00 a.m. - 11:45 a.m.; NY Time.

**Price Quotation**

Cents per pound

**Delivery Months**

March, May, July, September, December

**Ticker Symbol**

KC

**Minimum Fluctuation**

5/100 cent/lb., equivalent to $18.75 per contract.

**Last Trading Day:**

One business day prior to last notice day.

**First Notice Day:**

Seven business days prior to first business day of delivery month.

**Last Notice Day:**

Seven business days prior to last business day of delivery month.

**Daily Price Limits:**

None

**Position Limits:**

Spot Month: 500 contracts as of the first notice day in the expiring month. Additionally, Position Accountability Rules apply to all futures and options contract months. Contact the Exchange for more information.

**Standards:**

A Notice of Certification is issued based on testing the grade of the beans and by cup testing for flavor. The Exchange uses certain coffees to establish the "basis" coffees judged better are at a premium those judged inferior are at a discount.

**Deliverable Growths: Country Differential**

Mexico, Salvador, Guatemala, Costa Rica, Nicaragua, Kenya, New Guinea, Panama, Tanzania, Uganda Basis

Colombia Plus 200 pts

Honduras, Venezuela, Peru  Minus 100 pts

Burundi, India, Rwanda Minus 300 pts

Dominican Republic, Ecuador Minus 400 pts

**Delivery Points:**

Exchange licensed warehouses in the Port of New York District (at par), the Port of New Orleans, the Port of Bremen/Hamburg[1] , the Port of Antwerp[1] , and the Port of Miami (at a discount of 1.25 cents/lb).

[1] The Ports of Bremen/Hamburg and Antwerp are effective commencing with the Dec. 2002 delivery.

# D
# APPENDIX D: DEREGULATION AND THE EVOLUTION OF PRICING STRATEGY

This appendix summarizes the deregulation of the telecommunications industry with respect to the impact on wholesale and consumer prices.

Wholesale Prices

The Telecommunication Act of 1996 required RBOCs to open their monopolized markets to competition by providing interconnection to new entrants. The RBOCs were required to provide unbundled network elements to competitors on a wholesale basis, giving competitors the ability to provide the network services to consumers under a different brand name.

This system is still tightly regulated to ensure a competitive environment. The Federal Communications Commission (FCC) and the state utility commissions utilize a pricing methodology that prices network elements using "forward looking long–run incremental cost pricing principles."[1] This approach is designed to simulate the price that would have been in effect if there were full competition and if the market were able to get the most efficient and cheapest means of service currently available. RBOCs are still fighting this, claiming that they originally made investments in universal telecommunications technologies based on monopoly protection and they should be compensated for this before the rules are changed.

## Consumer Prices: Local Service

The Telecom Act of 1996 was designed to force the baby Bells to give up their monopolies on local services and to open these markets to other competitors selling local and tolling services. The Act was also intended to position competitors to provide other value-added services in the future. Other telecommunications companies, cable companies, broadcasters, gas and electric utilities, and wireless services have entered the local services market. However, RBOCs still dominate local phone services and largely control the rollout of broadband access via digital service lines (DSL). Pricing of these services is still regulated.

State regulatory agencies oversee local rates, which vary greatly from area to area.[2] Pricing structures include flat rate, message-based and measured service plans. Flat rate service subscribers pay no additional fees for calls within their local calling area, regardless of the number of calls placed. Message services subscribers pay by call, regardless of the length of the

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1 Forward-looking cost methodology that postulates a hypothetical network based on near-term best practice technology and efficient engineering (Cave, p. 408).

2 Monitoring Report on Universal Service, FCC.

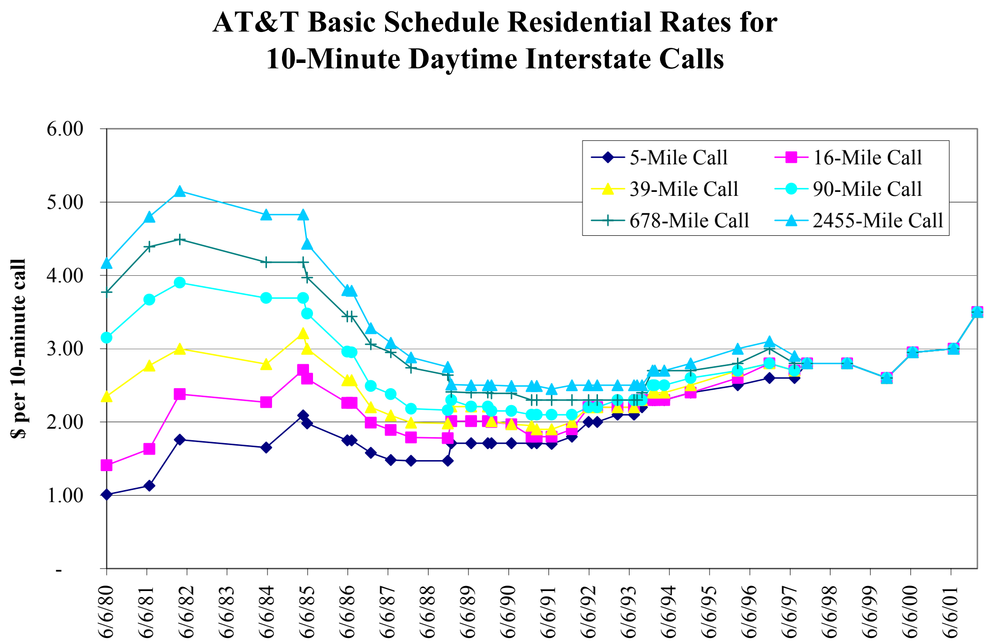
call. Measured service plans bill customers based on the length of the call. In addition to these fees, regulators authorize local carriers to levy other charges in order to give the carrier the opportunity to be fully compensated for the cost of providing services.

The emergence of competition in this segment of the telecom market has resulted in an increase in the number of calling plans and service packages available to consumers. Service providers are rebundling services to provide packages of communications services at attractive rates, rather than offering individually priced services.[3]

## Consumer Prices: Long Distance

Historically, regulators have overseen long distance rate setting. AT&T was subject to rate of return regulation until 1989. This was replaced by price cap regulation that lasted until 1995, when direct price regulation in the industry ended.

**Figure D-1**




However, as indicated in Figure D-1, the cost of placing long distance calls has dropped dramatically since 1984. The three key reasons for this are as follows:

- First, the reduction of implicit subsidies from long distance providers to local service providers has contributed to the decrease in rates. During the divestiture in 1984, the FCC came up with a system of access charges, a uniform method for local companies to charge for

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3 Cave, p. 668.

the origination and termination of interstate traffic on their local networks. This permitted the reduction in implicit subsidies from long distance service to local service.

Introduction of monthly subscriber line charges allowed recovery of a portion of the fixed costs of the local telephone companies' loops directly from end users and long distance carriers (on a per line basis). This resulted in a reduction in the per-minute access price that long distance carriers pay, contributing to the reductions in long distance prices for end consumers. Initially, the combined originating and terminating access charges amounted to $0.17 per minute and represented almost half of the total toll revenue collected by interstate carriers. However, regulators gradually reduced these access charges to $0.095 in 1989 and to $0.019 at the end of 2000.[4]

- Second, competition among long-distance providers has forced long distance providers to be more efficient and to reduce costs in order to compete effectively in the market.

- Finally, competition has increased due to the number of substitute products that have been developed in the past few years. The increased use of wireless communication and data services such as email and the Internet have lowered dependence on traditional long distance phone service.

Table D-1 below shows the average revenue per minute for interstate calls. It shows that billed revenue per minute has declined over time for both international and domestic services.

**Table D-1**

**Average Revenue per Minute for Interstate Phone Calls**

| *Year* | *Revenue per Minute* |
|---|---|
| 1992 | 0.15 |
| 1993 | 0.15 |
| 1994 | 0.14 |
| 1995 | 0.12 |
| 1996 | 0.12 |
| 1997 | 0.11 |
| 1998 | 0.11 |
| 1999 | 0.11 |
| 2000 | 0.09 |

Source: Federal Communication Commission

4 Cave, p 61.

*E*

# APPENDIX E: STATISTICAL RELATIONSHIP BETWEEN NATURAL GAS PRICES AND NATURAL GAS VOLATILITY

**Table A-1**
**Statistical Relationship Between**
**Natural Gas Prices and Price Volatility**

| | Intercept | Price Coefficient | Enron Collapse Coefficient | Adjusted r-square |
|---|---|---|---|---|
| Henry Hub | 0.237 | 0.086 | 1.034 | 0.635 |
| Katy Hub | 0.244 | 0.095 | 1.164 | 0.604 |
| Columbia, Appalachia | 0.212 | 0.091 | 1.062 | 0.601 |
| Chicago Citygates | 0.060 | 0.149 | 1.174 | 0.528 |
| PG&E Citygate | 0.283 | 0.166 | 1.185 | 0.347 |
| SoCal | 0.300 | 0.139 | 1.129 | 0.383 |
| Transco Zone 6 New York | (0.152) | 0.299 | 1.044 | 0.380 |

## Figure A-1
## Henry Hub Price and Price Volatility

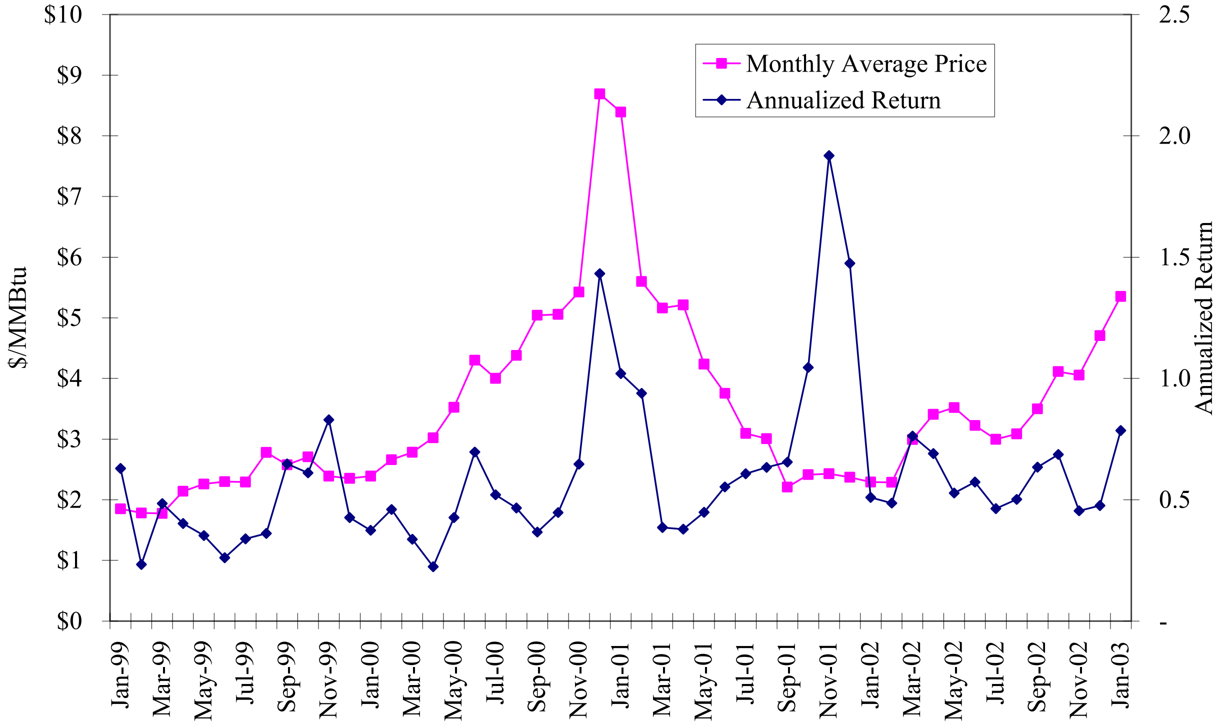



**Table A-1**
**Relationship Between Natural Gas Prices and Price Volatility at Henry Hub**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.806 |
| R Square | 0.650 |
| Adjusted R Square | 0.635 |
| Standard Error | 0.195 |
| Observations | 49 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 2 | 3.235 | 1.617 | 42.680 | 3.3026E-11 |
| Residual | 46 | 1.743 | 0.038 | | |
| Total | 48 | 4.978 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.237 | 0.074 | 3.216 | 0.002 | 0.089 | 0.386 | 0.089 | 0.386 |
| Monthly Average Price | 0.086 | 0.019 | 4.547 | 0.000 | 0.048 | 0.125 | 0.048 | 0.125 |
| Enron Collapse Dummy | 1.034 | 0.118 | 8.757 | 0.000 | 0.797 | 1.272 | 0.797 | 1.272 |

**Figure A-2**
**SoCal Price and Price Volatility**

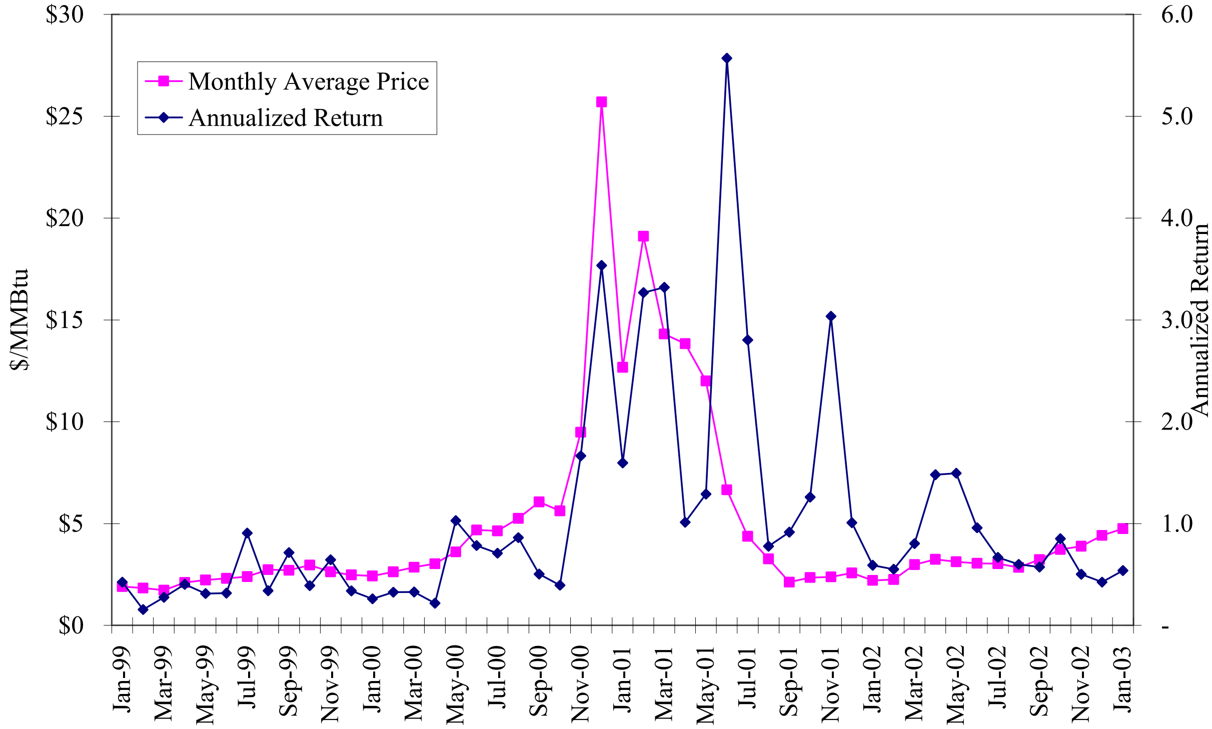



**Table A-2**
**Relationship Between Natural Gas Prices and Price Volatility at SoCal Gas**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.639 |
| R Square | 0.408 |
| Adjusted R Square | 0.383 |
| Standard Error | 0.844 |
| Observations | 49 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 2 | 22.619 | 11.309 | 15.872 | 5.7297E-06 |
| Residual | 46 | 32.777 | 0.713 | | |
| Total | 48 | 55.395 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| | 0.300 | 0.180 | 1.665 | 0.103 | (0.063) | 0.663 | (0.063) | 0.663 |
| Monthly Average Price | 0.139 | 0.026 | 5.429 | 0.000 | 0.087 | 0.190 | 0.087 | 0.190 |
| Enron - variable | 1.129 | 0.508 | 2.225 | 0.031 | 0.107 | 2.151 | 0.107 | 2.151 |

## Figure A-3
## PG&E City-gate Price and Price Volatility

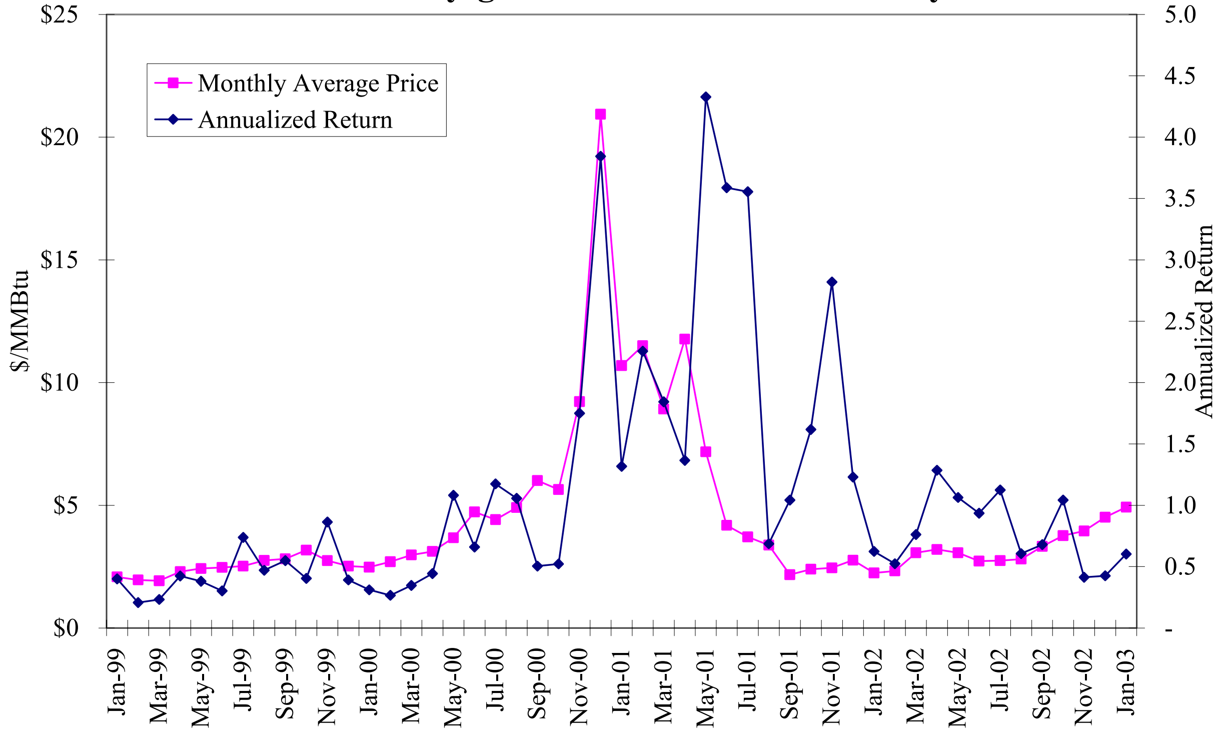



**Table A-3**
**Relationship Between Natural Gas Prices and Price Volatility at PG&E Citygates**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.612 |
| R Square | 0.374 |
| Adjusted R Square | 0.347 |
| Standard Error | 0.800 |
| Observations | 49 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 2 | 17.600 | 8.800 | 13.741 | 2.0954E-05 |
| Residual | 46 | 29.460 | 0.640 | | |
| Total | 48 | 47.060 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.283 | 0.192 | 1.469 | 0.149 | (0.104) | 0.670 | (0.104) | 0.670 |
| Monthly Average Price | 0.166 | 0.034 | 4.923 | 0.000 | 0.098 | 0.234 | 0.098 | 0.234 |
| Enron Collapse Dummy | 1.185 | 0.481 | 2.461 | 0.018 | 0.216 | 2.154 | 0.216 | 2.154 |

**Figure A-4**
**Chicago City-gate Price and Price Volatility**

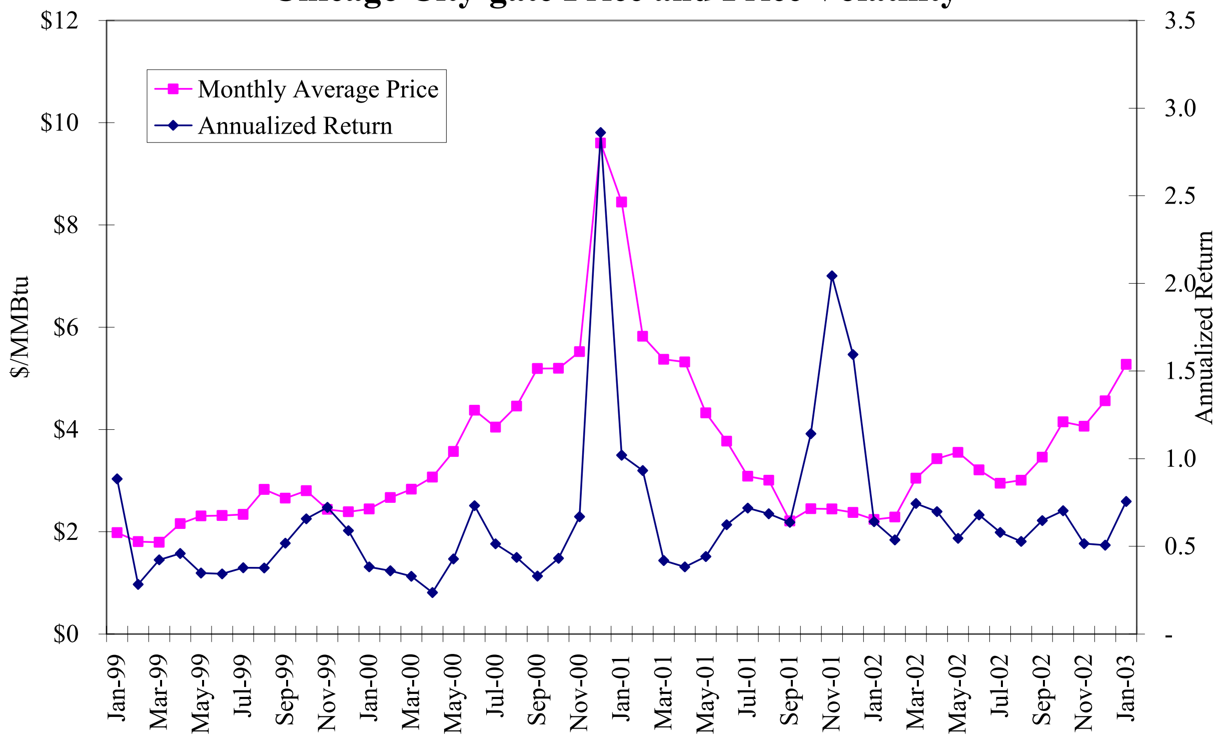



**Table A-4**
**Relationship Between Natural Gas Prices and Price Volatility**
**at Chicago Citygates**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.740 |
| R Square | 0.547 |
| Adjusted R Square | 0.528 |
| Standard Error | 0.310 |
| Observations | 49 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 2 | 5.364 | 2.682 | 27.824 | 1.2027E-08 |
| Residual | 46 | 4.434 | 0.096 | | |
| Total | 48 | 9.798 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.060 | 0.114 | 0.527 | 0.601 | (0.169) | 0.289 | (0.169) | 0.289 |
| Monthly Average Price | 0.149 | 0.029 | 5.180 | 0.000 | 0.091 | 0.206 | 0.091 | 0.206 |
| Enron Collapse Dummy | 1.174 | 0.188 | 6.234 | 0.000 | 0.795 | 1.553 | 0.795 | 1.553 |

## Figure A-5
## Transco Zone 6 - New York Price and Price Volatility

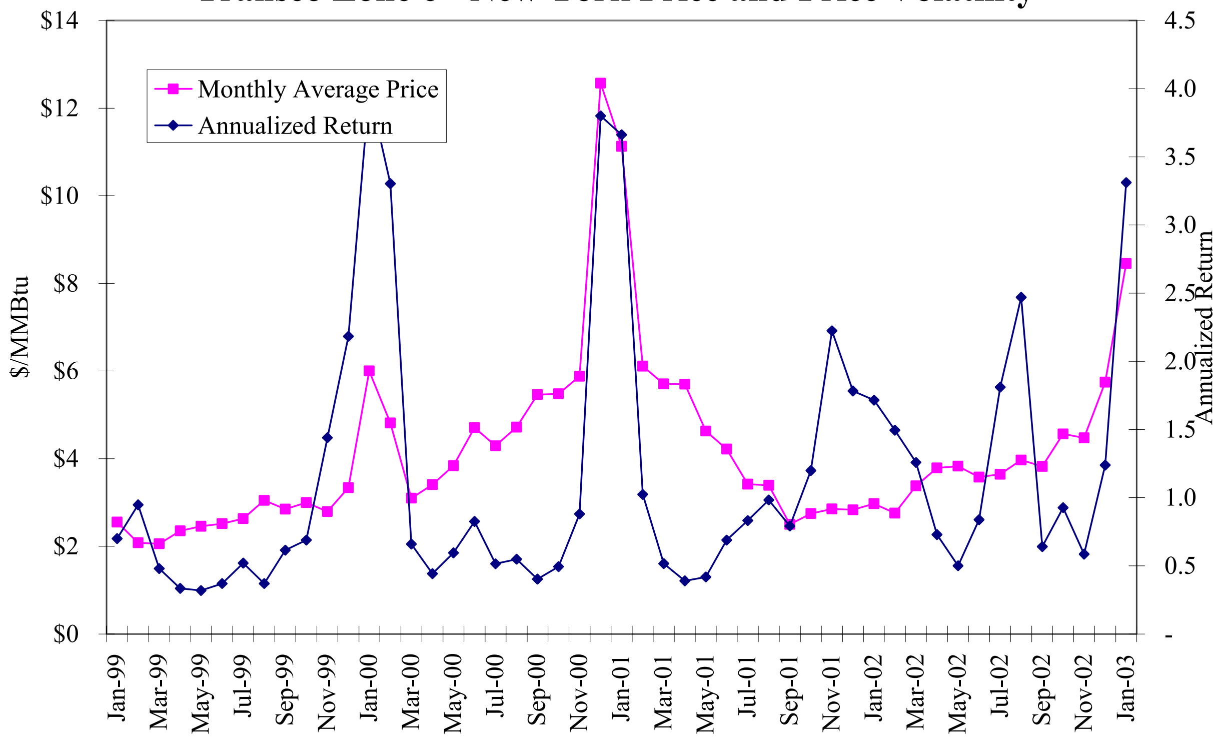



**Table A-5**
**Relationship Between Natural Gas Prices and Price Volatility**
**at Transco Zone 6, New York**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.637 |
| R Square | 0.406 |
| Adjusted R Square | 0.380 |
| Standard Error | 0.775 |
| Observations | 49 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 2 | 18.887 | 9.444 | 15.741 | 6.1932E-06 |
| Residual | 46 | 27.598 | 0.600 | | |
| Total | 48 | 46.486 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | (0.152) | 0.262 | (0.579) | 0.565 | (0.679) | 0.376 | (0.679) | 0.376 |
| Monthly Average Price | 0.299 | 0.055 | 5.459 | 0.000 | 0.189 | 0.410 | 0.189 | 0.410 |
| Enron Collapse Dummy | 1.044 | 0.469 | 2.228 | 0.031 | 0.101 | 1.988 | 0.101 | 1.988 |

## Figure A-6
## Katy Hub Price and Price Volatility

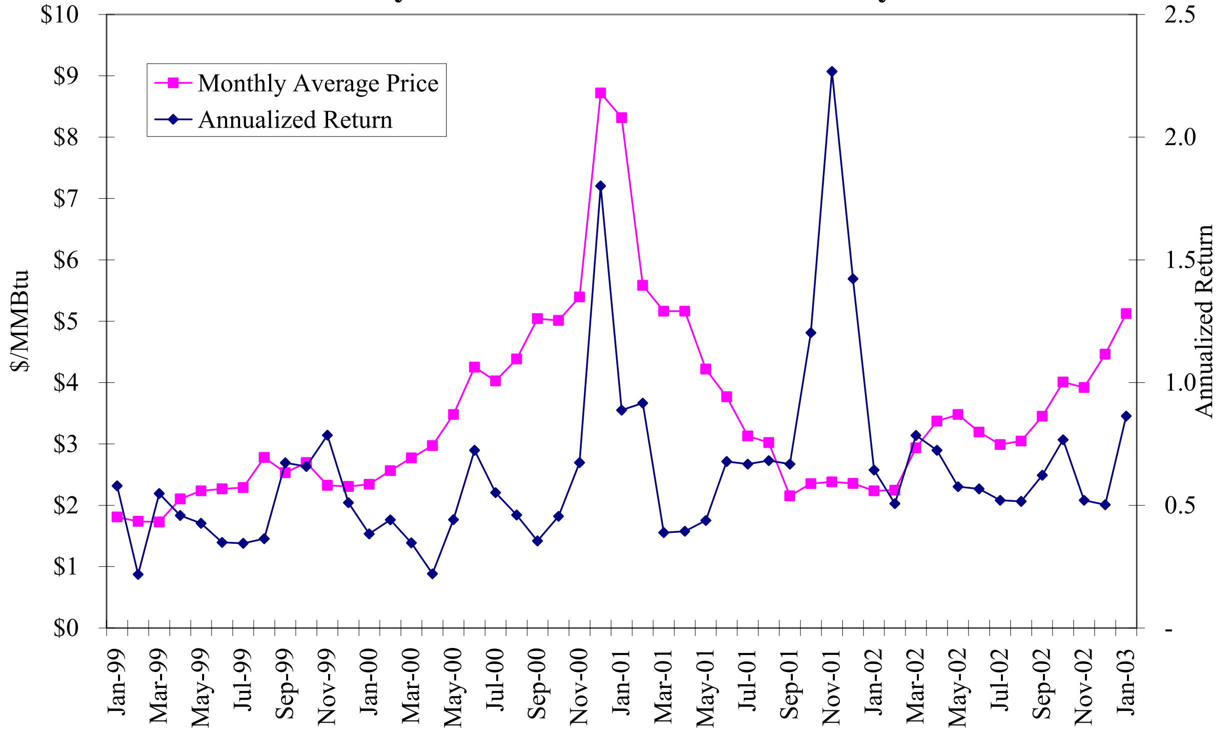



**Table A-6**
**Relationship Between Natural Gas Prices and Price Volatility at Katy Hub**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.787 |
| R Square | 0.620 |
| Adjusted R Square | 0.604 |
| Standard Error | 0.233 |
| Observations | 49 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 2 | 4.058 | 2.029 | 37.537 | 2.1537E-10 |
| Residual | 46 | 2.487 | 0.054 | | |
| Total | 48 | 6.545 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.244 | 0.087 | 2.786 | 0.008 | 0.068 | 0.420 | 0.068 | 0.420 |
| Monthly Average Price | 0.095 | 0.023 | 4.162 | 0.000 | 0.049 | 0.140 | 0.049 | 0.140 |
| Enron Collapse Dummy | 1.164 | 0.141 | 8.250 | 0.000 | 0.880 | 1.448 | 0.880 | 1.448 |

## Figure A-7
## Columbia Gas, Appalachia Price and Price Volatility

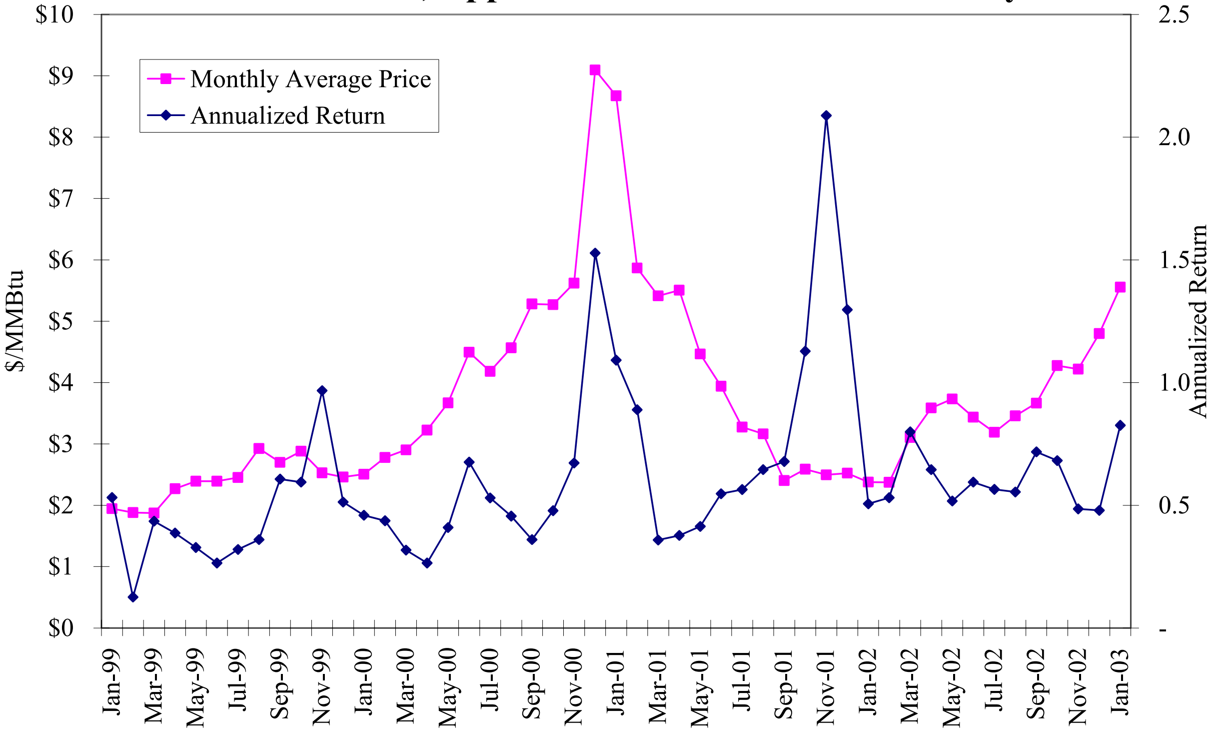



**Table A-7**
**Relationship Between Natural Gas Prices and Price Volatility**
**at Columbia, Appalachia**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.786 |
| R Square | 0.617 |
| Adjusted R Square | 0.601 |
| Standard Error | 0.216 |
| Observations | 49 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 2 | 3.475 | 1.737 | 37.123 | 2.5228E-10 |
| Residual | 46 | 2.153 | 0.047 | | |
| Total | 48 | 5.628 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.212 | 0.083 | 2.552 | 0.014 | 0.045 | 0.379 | 0.045 | 0.379 |
| Monthly Average Price | 0.091 | 0.020 | 4.460 | 0.000 | 0.050 | 0.132 | 0.050 | 0.132 |
| Enron Collapse Dummy | 1.062 | 0.131 | 8.085 | 0.000 | 0.797 | 1.326 | 0.797 | 1.326 |

# F

# APPENDIX F: USING FINANCIAL DERIVATIVE PRODUCTS TO HEDGE PRICES

Financial derivative products are contracts whose value are linked or "derived" from the value of an underlying commodity such as natural gas, oil, or electricity. The purpose of this appendix is to introduce a number of the products that are widely used in energy markets and to present some simple examples of how the products are used to hedge price risk and manage price volatility.

Financial derivatives can be sold either by an exchange, such as the New York Mercantile Exchange (NYMEX) or over the counter (OTC). In an exchange transaction, the exchange serves to balance the overall portfolio of contracts insuring that for every short position, there is a long position in exchange for a fee. In an OTC transaction, a "market maker" such as a large financial institution (e.g., Goldman Sachs, CityGroup, J P Morgan Chase, etc) manages their "business book." These entities can take a position themselves and are therefore subject to credit risk and can be subject to price risk to the extent that their "book" is not balanced. The large energy-marketing firms were important "market makers" prior to the Enron bankruptcy and the collapse of a number of other firms.

The objective of a hedge is to reduce the risk of price volatility. In a sense, when used as a hedge, a financial derivative is similar to an insurance policy. An insurance policy is a contract that provides for a cash payment if a specific (unfavorable) event occurs during the term of the policy. Financial derivatives can be used to reduce price risk by generating a cash payment in the event that the market price of the commodity moves in an unfavorable direction.

Every financial derivative specifies a "strike date." The strike date is the point in time when the contract must be settled and payment made. Every financial derivative also contains a price (or price formula) used to calculate the value of the contract at the time specified as the strike date. Finally, the derivative specifies the terms for the settlement of the contract that determines the relationship of the derivative to the commodity itself. For example, the NYMEX natural gas specifies the terms of settlement as 10,000 MMBtus of gas at Henry Hub in Louisiana delivered over a one-month period. The strike date for the contract is 3 business days ***prior*** to month of delivery. The commodity price is equal to the "market price" cleared by the exchange.

When "buying" a financial derivative, the party must pay a percentage of the "market" value of the derivative at the time of purchase. For energy and other non-currency derivatives, the percentage is generally between 10 and 20 percent. As a result, the party incurs the cost of the time value of the money committed. There is no interest paid on the "margin" payment required at the time that the party enters into the contract. Moreover, if the "market" price of the commodity changes, the party can be required to increase the "margin" or deposit on the contract.

Speculators to manage price risk also use these same products. A speculator's objective is to generate profits from the movement of prices in a commodity. The "leverage" provided by margin percentage to magnify the gains or losses of the speculator. The speculator must assume risk by taking an unbalanced position (short or long) in the hope that the commodity price moves in the direction that increases the value of the position.

**Futures Contract Example**

In March, the futures price for gas delivered in January $5.60. Party A expects to need gas in January and wants to make sure that they do not have to pay more than $5.60. Party A buys a contract for January gas at $5.60 to lock in the price.

As the strike date approaches in late January, the futures price should – and usually does – converge towards the bidweek prices. If in January, the bidweek price for gas at Henry Hub is $6.15, the purchaser buys physical gas for January for $6.15 and sells the future contract back at the prevailing future market price, around $6.15 per MMBtu. Party A has a gain of $.55 per MMBtu on the future transaction. The gain on the futures contract offsets the fact that Party A was forced to buy gas at $6.15 per MMBtu. When the cost of the gas is combined with the "gain" on the future contract, the "net" gas cost is $5.60 per MMBtu, which was the locked in price.

If, however, the bidweek price for January gas is $5.25 per MMBtu, the purchaser will buy their gas for $5.25 and take a $.35 loss on the futures contract. Nevertheless, the "net" cost January gas remains $5.60 per MMBtu because the loss is "offset" by the fact that Party A can buy the gas at the lower price.

**Commodity Swap Example**

A Swap contract between two parties in the market. Generally an OTC "market maker" offers swaps although any two parties could enter into such an agreement. A swap differs from a futures contract in that it specifies "marker" price that does not vary during the term of the contract. The contract obligates the parties to make payment equal to the difference between the cash price and the "trigger" price. If the cash price is above the "trigger" price, the seller of the swap pays the buyer, if the cash price is below the "trigger," buyer pays the seller.

Since the terms of settlement can be negotiated between the parties, a market maker can offer an almost infinite variety of swaps. For natural gas swaps, it is particularly valuable to commercial interests to be able to enter in swap at specific the location along the gas pipeline system, i.e., interconnects, citygates, and pipeline receipt and delivery points.

Assume that Party A wants to lock in a $4.00 price for gas at Transco station 65 over the next 3 months, so "A" signs a swap agreement with a market maker.

Over the three-month period, the index price averages $4.25 per MMBtu. The purchaser buys the physical gas at the index price of $4.25 and is paid $.25 under the swap for a "net" gas cost $4.00. If however the price averages $3.70 per MMBtu, the purchaser buys at index price but has to pay $.30 to the market maker under the terms of the swap. The net gas cost remains $4.00 per MMBtu.

**Collar Example**

A "collar" is similar to a swap but specifies a "dead band" of prices rather than a specific "market price." Under the terms of the collar, no payment is made when the index price falls within the dead band. A payment is made when the cash price falls outside the "dead band" based upon the difference in the index price and the limit of the dead band. The market maker charges an origination fee for the collar.

In this case, Party A wanting to insure against a large price increase, buys a three-month collar at $4.00 per MMBtu with a $.15 cent spread around the $4.00 price. If the cash price is between $3.85 and $4.15, no payment is made on the collar. Over the three-month period, the index price for physical gas averages $4.25 per MMBtu. The purchaser buys the gas at index, but is paid $.10 under the collar for a net cost of gas of $4.15. If the index price averages $3.70, the purchaser buys at index but has to pay $.15 under the collar for a net cost of gas of $3.85. If the average of index price over the three-month period falls between $3.85 and $4.15, no payment is made for the collar.

A common variant is a so-called "costless collar." Because the market maker recognizes that the prices tend to move by larger absolute values in an upward direction that they move in a downward direction, the market maker will offer a collar that has an dead band that is asymmetric around the price that the market expects. For example, if the NYMEX futures price for gas next December was $6.00, the market maker might sell a collar banded from $5.80 to $7.00 providing some insurance to the buyer against large price spikes.

The term "costless" collar is a misnomer because the buyer pays a fee to the market maker. The size of the fee can change depending upon the market conditions, but the cost of the example presented above would generally be below $0.50.

**Options**

An option provides "insurance" for price movements in one particular direction. The options give the holder the right, but not the obligation, to buy or sell at a "strike price." If a gas buyer wants to insure that the gas price does not rise beyond a certain limit, the buyer pays the market maker for a "Call." The Call gives the buyer the right to buy at the "strike price." Similarly, if a gas producer wants to establish a minimum price for its production, the producer pays the market maker for a "Put." The Put give the gas producer the right to sell gas at the "strike price."

Options are much more expensive than swaps or futures because the option does not obligate the buyer of the option to the strike price. Rather, the buyer can choose whether or not to exercise the right that is conveyed by the option. As a result, the buyer of the option does not forgo the benefit that occurs if the price of the commodity moves in a favorable direction, but does so at an increased cost.

In this case, Party A buys a May "call" with a $5.10 per MMBtu "strike price" for $0.26 to insure against a big price increase. If the May price is $5.50 per MMBtu, the value of the option is $.40. Party A can sell the option at the strike date for a net gain of $.14. Party A would then buy the physical gas at the market price of $5.50 for a net gas cost of $4.36.

If however, the May price is $6.00, the value of the option is $.90. When Part A sells the option, a net gain of $.64 is obtained. Party A would then buy the physical gas at the market price $6.00 for a net cost of $4.36.

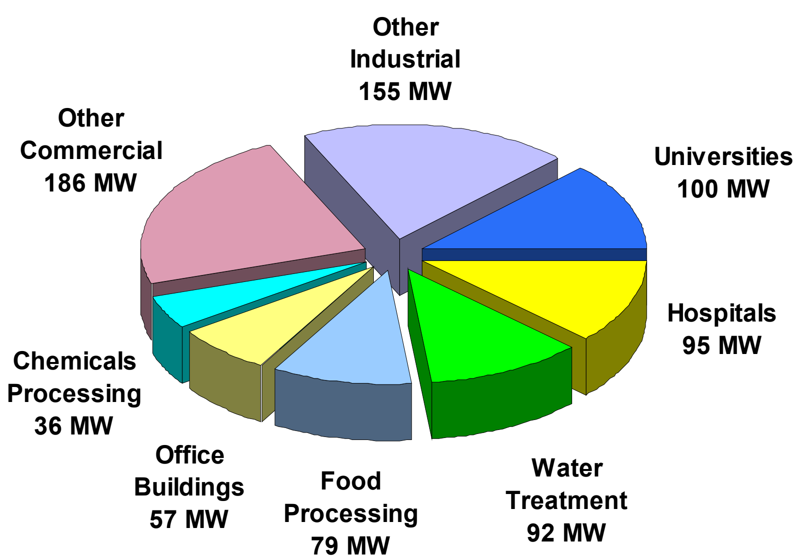
But if the May price drops to $4.00 per MMBtu, the value of the option is zero and Party A loses the entire initial cost of the option for a net loss of $.26. Party A would then buy the physical gas at the market price $4.00 for a net cost of $4.26 which is well below the strike price of the option.

# G
# APPENDIX G: INSTALLED CHP

## *Reciprocating Engine CHP*

There were an estimated 1,055 engine-based CHP systems operating in the United States in 2000 representing over 800 MW of electric capacity. Facility capacities range from 30 kW to 30 MW, with many larger facilities comprised of multiple units. Reciprocating engine CHP is installed in a variety of applications as shown in Figure 1. Spark ignited engines fueled by natural gas or other gaseous fuels represent 84% of the installed reciprocating engine CHP capacity.

**Figure 1**
**Existing Reciprocating Engine CHP - 801 MW at 1,055 sites**

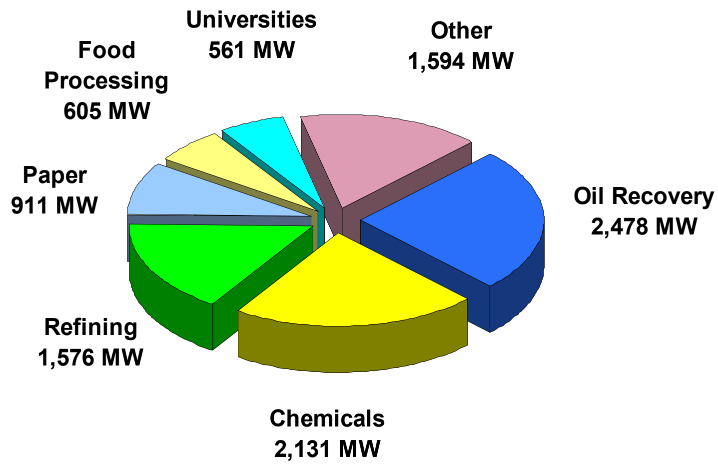



***Source:*** ***Energy and Environmental Analysis/Energy Nexus Group, Hagler Bailly Independent Power Database.***

## *Gas Turbine-Based CHP*

There were an estimated 40,000 MW of gas turbine-based CHP capacity operating in the United States in 2000 located at over 575 industrial and institutional facilities. Much of this capacity is concentrated in large combined cycle CHP systems that maximize power production for sale to the grid by generating additional power from steam turbines before sending the steam to internal process needs or to heat the facility. However, a significant number of simple cycle gas turbine-based CHP systems are in operation at a variety of applications as shown in Figure 2. Simple cycle CHP applications are most prevalent in smaller installations typically less than 40 MW.

**Figure 2**
**Existing Simple Cycle Gas Turbine CHP – 9,854 MW at 359 sites**

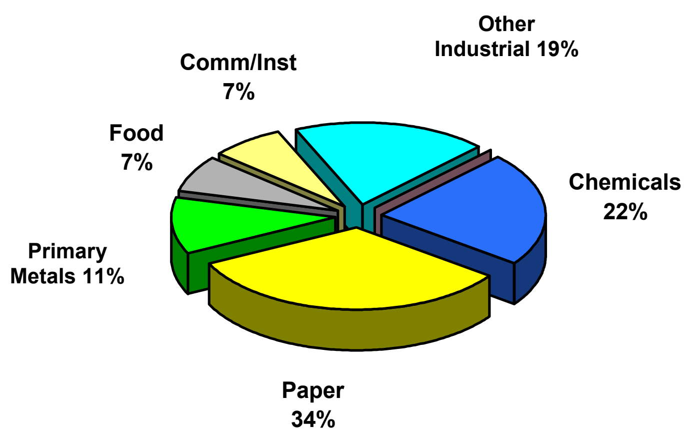



*Source: Energy and Environmental Analysis/Energy Nexus Group, Hagler Bailly Independent Power Database.*

### *Boiler/Steam Turbine CHP*

There were an estimated 19,062 MW of boiler/steam turbine CHP capacity operating in the United States in 2000 located at over 580 industrial and institutional facilities. As shown in Figure 3, the largest amounts of capacity are found in the chemicals, primary metals, and paper industries. Pulp and paper mills are often an ideal industrial/CHP application for steam turbines. Such facilities operate continuously, have a very high demand for steam, and have on-site fuel supply at low, or even negative costs (waste that would have to be otherwise disposed of).

**Figure 3 – Existing Boiler/Steam Turbine CHP Capacity by Industry**
**19,062 MW at 582 Sites**




Source: Energy and Environmental Analysis/Energy Nexus Group, Hagler Bailly Independent Power Database

# H
# APPENDIX H: DG/CHP TECHNOLOGY CHARACTERISTICS

## *Reciprocating Engines*

The features that have made reciprocating engines a leading prime mover for CHP and other distributed generation applications include:

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| Size range: | Reciprocating engines are available in sizes from 10 kW to over 5 MW, and can be matched to the electric demand of many end-users (institutional, commercial and industrial). |
| Thermal output: | Reciprocating engines can produce hot water and low pressure steam for a variety of combined heat and power applications. |
| Fast start-up: | In peaking or emergency power applications, reciprocating engines can quickly supply electricity on demand. The fast start-up capability of reciprocating engines allows timely resumption of the system following a maintenance procedure. |
| Black-start capability: | In the event of a electric utility outage, reciprocating engines can be started with minimal auxiliary power requirements. Generally only batteries are required. |
| Availability: | Reciprocating engines have typically demonstrated availability in excess of 95% in stationary power generation applications. |
| Part-load operation: | The high part-load efficiency of reciprocating engines ensures economical operation in electric load following applications. |
| Reliability and life: | Reciprocating engines have proven to be reliable power generators given proper maintenance. |
| Emissions: | Diesel engines have relatively high emissions levels of $NO_x$ and particulates. However, natural gas spark ignition engines have improved emissions profiles and can be sited in most non-attainment areas. |

### *Small Gas Turbines*

Gas turbine features may be summarized as follows:

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| Thermal output: | Gas turbines produce a high quality (high temperature) thermal output suitable for most combined heat and power applications. High-pressure steam can be generated or the exhaust can be used directly for process drying and heating. |
| Fuel flexibility: | Gas turbines operate on natural gas, synthetic gas, landfill gas and fuel oils. Plants are often designed to operate on gaseous fuel with a stored liquid fuel for backup to obtain the less expensive interruptible rate for natural gas. Dual-fuel combustion capability is a purchase option on many gas turbines. |
| Reliability and life: | Modern gas turbines have proven to be reliable power generators if maintained properly. Time to overhaul is typically 25,000 to 50,000 hours. |
| Size range: | Gas turbines are available in sizes from 500 kW to 250 MW, and can be selected to match nearly any end-user electric demand. |
| Part Load Operation: | Because gas turbines reduce power output by reducing combustion temperature, efficiency at part load can be substantially below that of full power efficiency (i.e., 20 % lower efficiency at 50 % load). |
| Emissions: | Many small gas turbines burning gaseous fuels (mainly natural gas) feature lean premixed burners (also called dry low-$NO_x$ combustors) that produce $NO_x$ emissions below 25 ppm, with laboratory data down to 9 ppm, and simultaneous low CO emissions acceptable to regulators and safety personnel in the 50 to 10 ppm range.[1] Further reductions in $NO_x$ and CO can be achieved by use of selective catalytic reduction (SCR) or catalytic combustion. Many gas turbines sited in locales with extremely stringent emission regulations use SCR after-treatment to achieve single-digit (below 9 ppm) $NO_x$ emissions. |

[1] Gas turbines have high oxygen content in their exhaust because they burn fuel with high excess air to limit combustion temperatures to levels that the turbine blades, combustion chamber and transition section can handle without compromising system life. Consequently, emissions from gas turbines are evaluated at a reference condition of 15% oxygen. For comparison, boilers use 3% oxygen as the reference condition for emissions, because they can minimize excess air and thus waste less heat in their stack exhaust. Note that due to the different amount of diluent gases in the combustion products, the mass of $NO_x$ measured as 9 ppm @ 15% oxygen is approximately 27 ppm @ 3% oxygen, the condition used for boiler $NO_x$ regulations.

### *Steam Turbines*

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| Custom design: | Steam turbines can be designed to match various design pressure and temperature requirements. The steam turbine can be designed to maximize electric efficiency while providing the desired thermal output. |
| Thermal output: | Steam turbines are capable of operating over a very broad range of steam pressures. Utility steam turbines operate with inlet steam pressures up to 3500 psig and exhaust vacuum conditions as low as one inch of Hg (absolute). Steam turbines can be custom designed to meet the thermal requirements of the CHP applications through use of backpressure or extraction steam at appropriate pressures and temperatures. |
| Fuel flexibility: | Steam turbines offer a wide range of fuel flexibility using a steam generated in a boiler by combustion of a variety of fuels, including coal, oil, natural gas, wood and waste products. |
| Reliability and life: | Steam turbine life is extremely long. There are steam turbines that have been in service for over 50 years. Overhaul intervals are measured in years. When properly operated and maintained (including proper control of boiler water chemistry), steam turbines are extremely reliable. They require controlled thermal transients as the massive casing heats up slowly and differential expansion of the parts must be minimized. |
| Size range: | Industrial steam turbines are available in sizes from under 100 kW to over 250 MW. In the multi-megawatt size range, industrial and utility steam turbine designations merge, with the same turbine (high pressure) section able to serve both industrial and small utility applications. |
| Emissions: | Emissions are dependent upon the fuel used by the boiler or other steam source, boiler furnace combustion section design and operation, and built-in and add-on boiler exhaust cleanup systems. |
| Efficiency: | The electrical generating cycle efficiency of steam turbine power plants varies from a high of over 36% HHV[2] for large, electric utility plants designed for the highest practical annual capacity factor, to under 10% HHV for small, simple plants that make electricity as a byproduct of delivering steam to industrial processes or district heating systems for colleges, industrial parks and building complexes. |

[2] Steam turbine power plants traditionally measure efficiency on a higher heating value (HHV) basis, while gas turbine and engine manufacturers quote heat rates in terms of the lower heating value (LHV) of the fuel. The usable energy content of fuels is typically measured on a HHV basis. Electric utilities measure power plant heat rates in terms of HHV. For natural gas, the average heat content of natural gas is 1,030 Btu/scf on an HHV basis and 930 Btu/scf on an LHV basis – or about a 10% difference. The difference between the HHV and LHV is the heat of condensation of the water vapor in the combustion products.

### *Microturbines*

Summary characteristics of microturbines are:

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| Thermal output: | Microturbines produce thermal output at temperatures in the 400 to 600° F range, suitable for supplying a variety of building thermal needs. |
| Fuel flexibility: | Microturbines can operate using a number of different fuels: natural gas, sour gases (high sulfur, low Btu content), and liquid fuels such as gasoline, kerosene, and diesel fuel/heating oil. |
| Reliability and life: | Design life is estimated to be in the 40,000 to 80,000 hour range. While units have demonstrated reliability, they have not been in commercial service long enough to provide definitive life data. |
| Size range: | Microturbines available and under development are sized from 30 to 350 kW. |
| Modularity: | Units may be connected in parallel to serve larger loads and provide power reliability. |
| Part-load operation: | Because microturbines reduce power output by reducing mass flow and combustion temperature, efficiency at part load can be below that of full-power efficiency. |
| Dimensions: | At about 12 cubic feet, microturbines are very compact. |
| Emissions: | Low inlet temperatures and high fuel-to-air ratios result in $NO_x$ emissions of less than 10 parts per million (ppm) when running on natural gas. |

### *Fuel Cells*

Fuel cell systems are composed of three primary subsystems: 1) a fuel cell stack that generates direct current electricity; 2) a fuel processor that converts the natural gas into a hydrogen-rich feed stream (this can be integrated into the fuel cell stack in certain fuel cell configurations); and 3) a power conditioner that processes the electric energy into alternating current or regulated direct current. All systems run on hydrogen, which is most commonly derived by reforming natural gas.

There are five types of fuel cells currently under development. These are: 1) phosphoric acid (PAFC), 2) proton exchange membrane (PEMFC) – often referred to as a polymer electrolyte membrane cell, 3) molten carbonate (MCFC), 4) solid oxide (SOFC), and 5) alkaline (AFC). Each type is distinguished by the electrolyte used and by operating temperatures. Operating temperatures range from near-ambient to 1,800° F.

The features that have the potential to make fuel cell systems a leading prime mover for CHP and other distributed generation applications include:

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| Size range: | Fuel cell systems are constructed from individual cells that generate 100 W to 2 kW per cell. This allows systems to be configured in a wide range of capacities. Systems under development for DG application range in sizes from 5 kW to 2 MW. Multiple systems can operate in parallel at a single site to provide higher capacities. |
| Thermal output: | Fuel cells can achieve overall efficiencies in the 65 to 85% range. Waste heat can be used primarily for domestic hot water applications and space heating. |
| Availability: | The commercially available 200 kW PC25 system fleet (200-plus units) has demonstrated greater than 90% availability during over four million operating hours. As fuel cell systems mature, their reliability is expected to improve. |
| Part-load operation: | Fuel cell stack efficiency improves at lower loads, which results in a system electric efficiency that is relatively steady down to one-third to one-quarter of rated capacity. This provides systems with excellent load following characteristics. |
| Cycling: | While part load efficiencies of fuel cells are generally high, MCFC and SOFC fuel cells require long heat-up and cool-down periods, restricting their ability to operate in many cyclic applications. |

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| High quality power: | Electrical output is computer grade power, meeting critical power requirements without interruption. This minimizes lost productivity, lost revenues, product loss or opportunity cost. |
| Reliability and life: | Since only auxiliary components have moving parts, the reliability of fuel cells is expected to be high. A few of the initial PC25 systems have achieved operational lives of 70,000 hours. |
| Efficiency: | Different types of fuel cells have varied efficiencies. Depending on the type and design of fuel cells, efficiency ranges from 30% to over 50% HHV. |
| Quiet Operation: | Conversational level (60dBA @ 30 ft.), acceptable for indoor installation. |
| Siting and Size: | Indoor or outdoor installation. |
| Fuel Use: | The primary fuel source for the fuel cell is hydrogen, which can be obtained from natural gas, coal gas, methanol, and other fuels, such as biomass, containing hydrocarbons. |
| Emissions: | The only combustion within a fuel cell system is the low energy content hydrogen stream exhausted from the stack. This stream is combusted within the reformer and can achieve emissions signatures of $< 2$ ppmv CO, $<1$ ppmv $NO_x$ and negligible $SO_x$ (on 15% $O_2$, dry basis). |