# 3. The Emergence of Natural Gas Market Centers

Several major commercial innovations have developed during the past 10 years in response to the restructuring of the U.S. natural gas industry. In the mid-1980's, the "marketer" segment of the industry emerged. Marketers exploited short-term, open spot markets and more open transportation markets, and they effected exchanges of gas between buyers and sellers who never before had been brought together. Market conditions and regulatory reform in the late 1980's and early 1990's continued to bring about a more open market, not only for transportation but also for storage capacity rights. This evolution resulted in the development of capacity release markets, which supported the exchange of rights to transportation and storage by buyers and sellers of gas. More frequent trading in gas and rights to transportation and storage services by a diverse group of industry participants resulted in greater price volatility. This in turn led to the institution of a futures market where transparent price information could be found and contracts for controlling some of the price risks could be purchased.

The development of market hubs and centers is a recent innovation in the natural gas marketplace. (See box, p. 64 for a description of differences between hubs, market hubs, and market centers.[45]) They have been key features in the evolution of competitive markets in other industries such as air transportation. In the natural gas industry, market hubs and centers were the logical outgrowth of open-access restructuring, providing the place where many buyers and sellers can transact business and receive services.

These centers, supported in Federal Energy Regulatory Commission (FERC) Order 636,[46] were formed by companies that saw opportunities to provide new services to increase trade in gas and capacity across pipeline and storage systems and to meet the need for short-term balancing services formerly provided by pipeline companies under bundled service. Market centers combine features of recent commercial innovations in that they: (1) provide the means to increase short-term exchanges between parties, (2) provide short-term/short-haul transportation services that improve a company's capability to move gas between systems, and (3) offer a means to reduce price risk exposure. In particular:

- Market centers have increased shippers' access to both long- and short-term gas supplies. Access to short-term supply is particularly important, especially for short-term adjustment of available supply with demand. At least 39 centers are operating in the United States and Canada, providing numerous interconnections and routes to move gas from production areas to markets.

- Market centers have access to 47 percent of working gas storage capacity in North America and are connected to practically all the high-deliverability storage facilities. Many physical services at market centers involve storage. The high-deliverability facilities are ideally suited for providing a variety of short-term services such as balancing, parking, and loaning.

- The availability of better price information and access to other buyers and sellers at market centers should provide a means of reducing price risk exposure. This is key because price risk for natural gas is greater than for any other major commodity. However, this capability is limited by the fact that public, real-time information on gas prices and the cost of nearby pipe and storage is available only for a few market centers.

- Active trade in the futures contract market has led to major development of the Henry Hub and Waha Hub market center areas. More than 25 pipeline systems have access to these market centers. In 1995, several hundred billion cubic feet of gas moved through the Henry Hub under a variety of hub services.

This chapter discusses the value of market centers in today's natural gas marketplace, highlighting their importance in capacity and financial transactions. The further development of an interconnected network of hubs seems likely as the industry increasingly looks for ways to make better use of existing pipe and storage capacity and to move gas from areas of ample supply and low prices to areas of greater demand and higher prices.

## Value of Market Centers

When it issued Order 636, FERC recognized that the type of expertise developed over the years by pipeline companies to manage gas purchases and balance ever-changing user demand with supply would somehow have to be retained. As one solution, FERC promoted the development of the market center concept as a means and location to provide the new

[45]For simplicity, the term "market center" is used throughout the rest of the chapter to represent market hubs and market centers.

[46]While FERC Order 636 did not require the creation of market centers, it disallowed any efforts that would hinder their development. Order 636-B defined a market center as an area where (a) pipelines interconnect and (b) there exists or is a reasonable potential for developing a market institution that facilitates the free interchange of gas.

## Distinguishing Between Hubs, Market Hubs, and Market Centers

Just what type of facility constitutes a natural gas market center, a market hub, or simply a hub operation? Applying the correct label to a specific site is often difficult. The answer often differs among operators themselves. The following definitions were developed to help categorize the distinct types of operations that usually are thought of as market centers and hubs. For convenience, the remainder of Chapter 3 will use the term "market center" for both market hubs and centers.

1. **Hubs** are operated as physical transfer points (often referred to as headers) where several pipelines are connected to a facility that permits the redirecting of gas volumes from one pipeline to another (Figure 26). Separate facilities for storage and gas plant processing may also be interconnected with the hub, but the hub operator usually does not handle a customer's relationship with these facilities. The operator merely routes a customer's gas volumes back and forth. Often such hubs are located in supply areas, receiving volumes and directing them forward to markets (Figure 26, E to F) with little or no bi-directional activity. A good example of a conventional hub is the Aqua Dulce Hub in southeastern Texas. This facility primarily offers pipeline interchange and transportation services.

2. **Market hubs** include the same types of activities as described above, except that the operator offers a number of expanded services that facilitate the buying, selling, and transportation of gas within the local facility. These services often include making arrangements for storage and plant processing services, peaking services, transfer of title for gas sales/purchases, anonymous gas trading (often handled via electronic gas-trading systems), in addition to wheeling (or transportation) of gas. As an adjunct to these services, the market hubs often include information services and electronic gas trading for their customers. Some market hubs have broadened their operations to become market centers. The Henry Hub in Louisiana and the several Katy hubs in eastern Texas are examples of market hubs. These facilities provide services such as parking and loaning of gas, balancing, and intra-hub transfers of gas, in addition to transportation and interchange services at a physical hub.

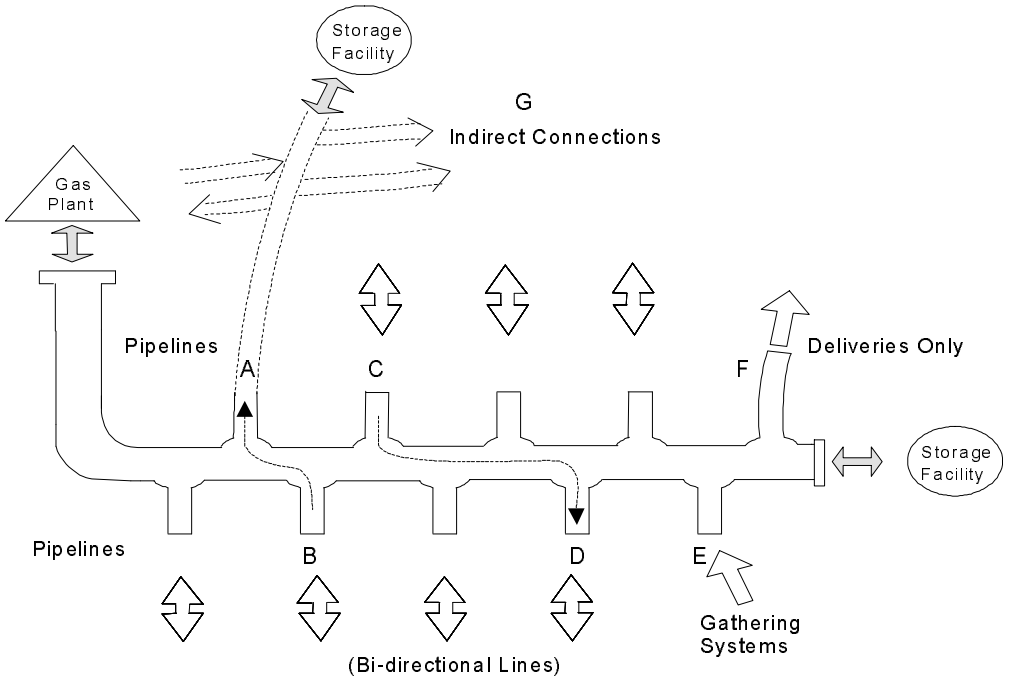
3. **Market centers** can operate almost independently of physical facilities. Often, however, they are associated with, and use, the physical infrastructure of one or more pipeline systems in the implementation of their operations and services (wherein the system(s) can function as one very large hub). Many centers are situated/structured so as to have broad access to other centers and to be easily accessed from many parts of the country. They can be used to access storage or arrange transportation from a supply area (receipt) to a customer's desired delivery point. At the same time, a center can provide the ancillary services a customer might need, such as short-term parking or gas borrowing/loaning, balancing services, etc. Two good examples of such operations are the Union Hub in Ontario, Canada, and the Columbia Market Center in the U.S. Northeast. Both centers support the interchange of gas for their customers via the many interconnections and delivery points on their associated pipeline systems, but neither center operates a physical hub.

Market centers also provide a location, or "market," where shippers and traders can buy and sell transportation, capacity, and natural gas itself. Some examples of how market centers may be used include:

**A shipper with firm capacity on Pipeline A wants to deliver gas to an end user located off Pipeline B.** The shipper can make arrangements to transfer the gas through the market center, with the center providing (de-)compression services if pipelines A and B operate at different pressures. Needed capacity on Pipeline B may be sought and acquired at the center if trading services (or traders) have such posted. Similarly, the shipper can use the center's services to revise its nominations (or temporarily release some capacity) on Pipeline A, with the center handling the administrative requirements, including confirmations, associated with the transactions. To cover any imbalances that might occur when the purchased production volume exceeds nominated capacity on Pipeline A, the shipper can execute an operational balancing agreement with the center.

**A large end user or local distribution company with firm capacity on Pipeline D buys gas in an area serviced by Pipeline C, which has only interruptible capacity available.** The shipper can arrange to have supplies moved on Pipeline C during nonpeak periods; any excess gas is injected into (high-deliverability) storage at the center. When the shipper experiences a sudden increase in demand, the center will provide the necessary incremental support from storage. If the shipper temporarily exceeds its storage inventory at the center, the center offers gas loaning, with the shipper responsible for replacement of the gas within a specified period. Similarly, storage withdrawal and loaning by the center can also be used to cover shortfalls when purchased production flowing into Pipeline C does not equal transportation nominations. Many centers also provide a real-time tracking service to notify shippers immediately when such imbalances are imminent.

**Figure 26. General Representation of a Hub Configuration**




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

services that customers (now shippers) needed to manage their portfolios of supply, transportation, and storage. In addition, these locations would increase the potential number of exchanges across pipeline systems and permit a "market" to develop for the trading of natural gas volumes, storage, and pipeline capacity. Because services were priced separately, it was presumed that additional efficiencies would develop.

The location and form of these centers was to be left up to the industry and the marketplace to decide. A possible location for a market center was, of course, where a large number of pipelines already were interconnected and nearby storage facilities already existed. Such locations could be readily developed into trading centers where supplies from a number of sources could be aggregated or traded and where a large number of buyers could access supplies from multiple pipelines. Moreover, these exchanges would promote efficiency by encouraging greater utilization of the associated pipeline and storage systems throughout the year. Such facilities located in major producing areas would also help smooth production by providing a place to put gas readily when there was no immediate market for the gas. This would also promote productive efficiency since production costs are minimized by producing at a relatively steady rate.

The Nation's vast interstate natural gas pipeline system includes numerous pipeline interconnections. Most of these connections were developed singly as individual pipeline companies expanded their markets and supply sources and hooked up to system storage. Hub sites, with multiple interconnections, developed mainly around major gathering systems and in supply areas. Before the 1980's, pipeline interconnections were put in place as additional insurance to maintain the reliability of the system, to receive supply via a major trunkline, or to fulfill exchange gas commitments with other pipeline companies.

Until open access (1987), little value was to be gained from regularly using these connections. Moreover, such use was restricted by long-term contractual relationships along particular pipeline systems. Flexibility was often further constrained by the companies' unwillingness to release gas because arrangements with lenders required them to maintain specific amounts of dedicated reserves. Many interconnections were used only for emergency situations or when a pipeline company had an unexpectedly large need for gas.

The value of moving gas between pipeline systems and between pipeline and storage systems increased significantly in the 1980's and 1990's with development of interruptible, discount markets for rights to transmission capacity. Overall, these market developments expanded possible opportunities and thus encouraged choice. The challenge was to extend

these choices to a large number of customers to enhance the competitiveness of the natural gas industry.

The market center provided a focal point and location where transparent and public spot markets could expand and further encourage improvements in the efficiency of exchange. This would take place by (1) enabling an increasing number of buyers to seek out the cheapest source of supply, (2) encouraging sellers to seek out the buyer who valued the gas commodity most, and (3) encouraging trading rights to transportation service.

In addition, access to storage interconnections increased the value of centers even further when customers of pipeline companies had to assume the responsibility for adjusting the amount of gas they received with the amount of gas they had reserved, or face imbalance penalties. The interconnections became even more valuable when they provided access to high-deliverability storage sites, which supported such needed services as short-term parking, loaning, swing supplies, and peaking.

The value of the location is also improved if it enables customers, or an administrator acting for customers, to reallocate gas and rights to transportation and storage services depending on the customers' current needs. Opportunities for reallocating these resources occur when customers' short-term needs vary in an unpredictable way. Situations can continually arise where one customer has an unexpected need for gas, and concurrently, another customer has an unexpected capability to release gas or rights to pipe and storage space.

However, the value of a location as a market center is reduced when customers' demands are influenced by the same forces in the same way. When customer demands on the system are very similar, the hub acts merely as a part of the pipeline system and not a trading center at which rights are exchanged to make fuller use of the system.

How well individual market centers, individually or collectively, have improved gas interchange and transportation flexibility is difficult to ascertain because of the lack of systematic and complete data on market center operations. Nonetheless, market centers have become a familiar and often a key feature in today's natural gas marketplace.

## Market Center Locations

The market center segment of the natural gas industry has grown rapidly since industry restructuring. As of September 1996, approximately 39 market centers were operating in the United States and Canada (Figure 27), with another 6 expected to be in operation by 1999. Most are located in the production areas of Texas and Louisiana, and 7 are in Canada. Of the 39 active sites, 27 began operating between 1994 and late 1996 (Table 7). A number of these market centers, however, have not yet attracted significant business.

Some market centers have extensive delivery capability. For example, many customers regularly conduct business at the Henry Hub in southern Louisiana through 12 interconnecting pipeline systems and 3 high-deliverability, directly accessible salt storage caverns (Table 8). The Henry Hub is accessible to major producers both onshore and offshore Louisiana where price and other relevant information is readily available via electronic and printed media. This hub and others in the producing areas help producers to smooth production.

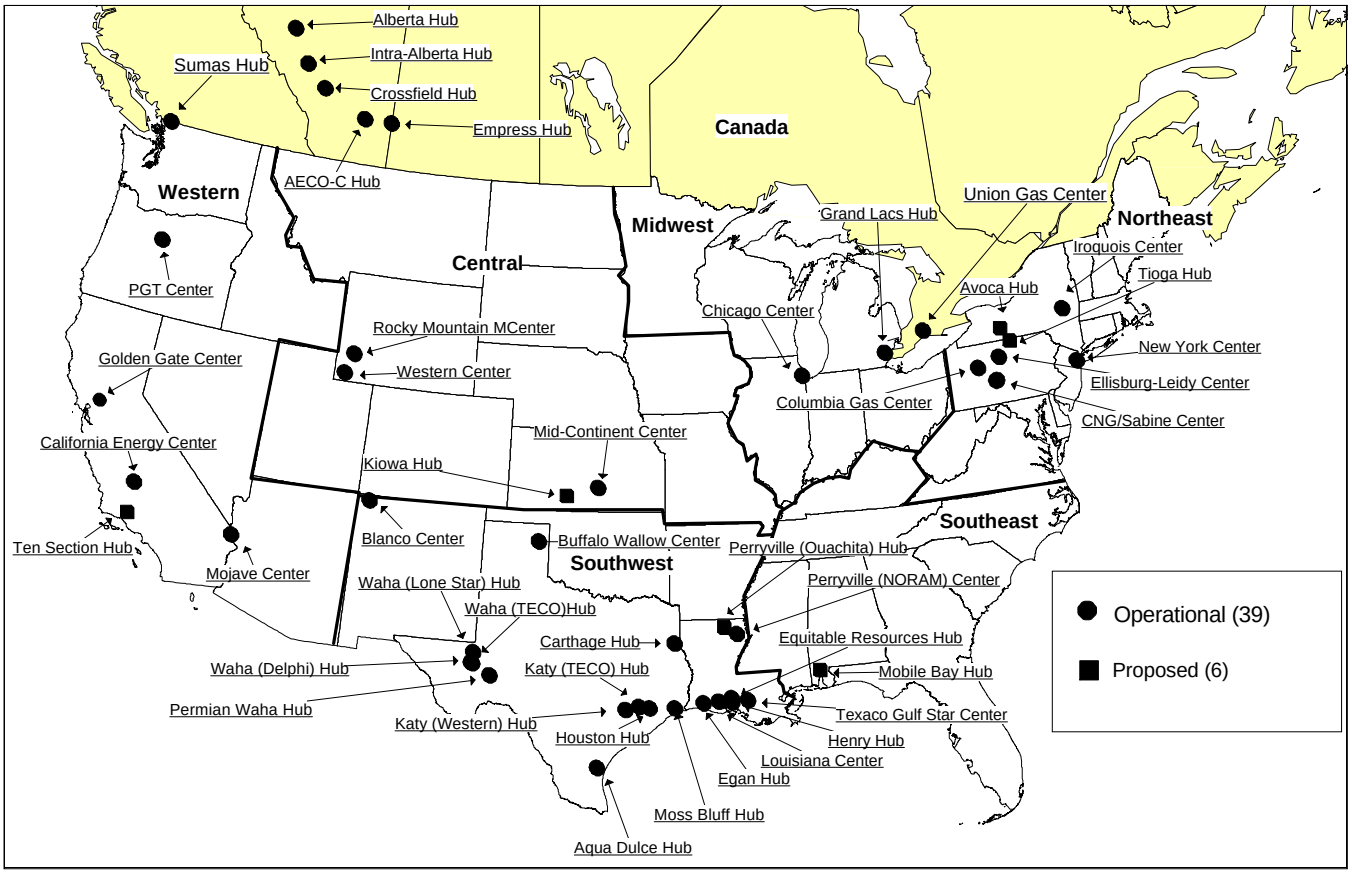
The Henry Hub is also the delivery point for a New York Mercantile Exchange futures contract, which improves the value of this location as a market center.[47] The ready availability of information on the price of gas and supporting services helps customers to become knowledgeable buyers and sellers. In addition, many different types of customers—producers, major industrial customers, and local distribution companies (LDCs)—use the Henry Hub. Because of this ready availability of information, the difference between the price that sellers are willing to take for their gas and the price that buyers are willing to pay is probably not great. Hence, it is relatively easy for these customers to agree on a price to complete a deal, which helps explain the large number of transactions.[48]

An important market center in the Northeast consuming region is the Ellisburg-Leidy Center in northern Pennsylvania, which has access to 32 storage reservoirs and also has electronic trading (Table 8). The continued success of this market center is, in part, based on the relative independence of customers' demands for gas, the variety of contract terms, and the ease of transferring the contract rights. If demands are relatively independent, then the exchange of gas and supporting services between customers could result in a reduction in the amount of pipeline service required to bring gas from major production areas to major consuming markets.

[47]The three other natural gas futures contracts also have delivery points in major producing areas. Two contracts have delivery points in West Texas: the Kansas City Board of Trade contract is through the Waha Hub and a NYMEX contract is through the Permian Basin Pool. A new NYMEX contract for delivery in Alberta, Canada, began trading in September 1996.

[48]Such a market frequently is referred to as a liquid market. Liquidity is often defined in terms of the smallness of the spread between bid and offer price and the number of trades.

**Figure 27. Locations of the Major Natural Gas Market Centers in the United States and Canada**




Source: Energy Information Administration, EIAGIS-NG Geographic Information System, Natural Gas Market Center/Hub Database, as of September 1996.

## Trade Between Market Centers

The emergence of the natural gas market center within the North American natural gas pipeline network has facilitated the movement of natural gas from production and storage sites to customers needing gas. But as customers demand greater access to diverse supply sources, market center operators are having to develop improved interconnections and better ways to transact business. Creating closer business and physical relationships with other market centers is one way to improve service and attract customers. By examining the locations of a number of today's market centers, one can see how this trade occurs.

- **The Waha area of West Texas has four market centers.** These sites represent a total of 26 interconnections with a number of inter- and intrastate pipelines, many serving several of the sites. In addition to these four, the Buffalo Wallow Center, located to the north of Waha in the Texas Panhandle, also interconnects with many of the same pipelines that interchange in the Waha area. These ties permit the operator of the center to redirect its customer's needs either northward toward the Midwest or eastward depending upon market demands (Figure 28).

- **The Katy area, in East Texas, also has several hubs that provide a direct link via several pipelines (Oasis, TECO, and Valero), with Waha area centers** (Figure 28). In addition, the Valero pipeline system provides a link between the Waha area and the Carthage hub located northeast of the Katy area. The five Katy area hubs interconnect with at least 33 pipelines, including a number of the major interstate pipelines. For example, Texas Eastern Transmission and Tennessee Gas Pipeline companies, which are major transporters of gas to the Midwest and Northeast, have links with the Carthage Hub and several of the Katy area hubs. The large majority of interconnections, however, are between

**Table 7. Summary of U.S. and Canadian Market Center Operations**

| Item | Number of Operations | Number Reaching Maximum Capability in Jan-Feb 1996[1] | Storage Availability | | | | |
|---|---|---|---|---|---|---|---|
| | | | Number of Sites | Total Working Gas (Bcf) | Total Daily Deliverability (MMcf/d) | Salt/High-Deliverability Storage (MMcf/d) | Linepack Used for Parking and Loaning (number of centers) |
| Market Centers | | | | | | | |
| Pre-1994 | 12 | 4 | 56 | 568 | 10,928 | 1,840 | 0 |
| 1994-1996[2] | 27 | 2 | 94 | 1,438 | 29,221 | 4,785 | 3[3] |
| Total Operational | 39 | 6 | 150 | 2,006 | 30,149 | 6,625 | 3 |
| Proposed | 6 | -- | 6 | 104 | 3,010 | 1,860 | -- |
| Total U.S./Canada Storage (January 1, 1996) | -- | -- | 414 | 4,306 | 77,697 | 10,004 | -- |

[1]Includes market centers that operated at their maximum (pipeline transfers or storage withdrawals) throughput capability sometime during the 2-month period.
[2]Does not include sites slated to be in operation after April 1, 1996.
[3]Approximately 560 million cubic feet of linepack, on average, is available for parking and gas loaning services at these market centers.
Bcf = Billion cubic feet. MMcf/d = Million cubic feet per day. -- = Not applicable.
Sources: Energy Information Administration, EIAGIS-NG Geographic Information System, Natural Gas Underground Storage Database and Natural Gas Market Center/Hub Database (as of August 1996), compiled from industry trade press and filings with the Federal Energy Regulatory Commission.

pipeline systems, which play a major role in allowing shippers a large degree of flexibility in routing their gas.

- **The two market centers in the Perryville area of northeast Louisiana (NORAM Transmission Company (operational) and Ouachita River Gas Storage Company (proposed))** have, or will have, arrangements in place to support trading with several of the Katy/Waha interconnections, as well as the Carthage Market Hub (Figure 28). The NORAM market center is not a hub, but it has a large number of receipt and delivery points on its system in the area that provide access to nine of the major interstate systems transporting gas north and east to major market areas. The NORAM center also provides shippers access to supplies located in the Anadarko and Acoma basins of Oklahoma. The Ouachita Hub will have many of the same interconnections with the interstate system, including the NORAM system, but will also provide storage and a number of other hub services.

- **The Henry Hub, given its strategic location and its association with the NYMEX futures trading market, is directly linked with the Carthage hub as well as most of the Katy hubs.** Shippers using the Henry Hub have access to major production areas for gas as distant as eastern Texas and as local as south Louisiana onshore and offshore gas production. The Henry Hub, via the many interstate and intrastate systems, handled several hundred billion cubic feet of gas in 1995. The center also serves as the operational arm for the Texaco Market Center, which itself provides direct and indirect transportation ties with 26 inter- and intrastate systems.

- **The Katy and Carthage area hubs also may soon be linked to pipeline(s) serving the Oklahoma Anadarko Basin production area.** These market centers located in eastern Texas could benefit from increased access to the relatively lower priced production in the Anardarko area (Figure 28). Current area pipeline systems, with some improvements in interconnections, could direct some of their flows eastward: for instance, via the Transok Pipeline system onto the Ozark and NORAM Pipeline systems for routing to the Perryville centers in northern Louisiana. They could also route their flows through the Carthage hub located in southeast Texas, via the intrastate Texoma Pipeline system which runs from northeast Texas southward. Tejas Gas recently acquired the Transok system, perhaps in part with the intention of rerouting some of the Anadarko production to higher priced markets via current and future market center interconnections.[49]

The trading of gas between market centers occurs especially at those centers in the Texas and Louisiana producing areas.

[49]See "Tejas Gas Buys Transok," *Gas Processors Report* (Houston, TX, June 3, 1996).

## Table 8. Operational Market Centers in the United States and Canada, September 1996

| Region / Market Center Name | State | Year Began | Type of Operation[1] | Direct Pipeline Inter-connects | Maximum Handling Capability (MMcf/d)[2] | Number of Storage Sites[3] | Type of Storage Sites[4] | Electronic Trading Available[5] |
|---|---|---|---|---|---|---|---|---|
| **Southwest** | | | | | | | | |
| Aqua Dulce Hub | TX | 1990 | Hub | 12 | 1,200 | 0 | None | No |
| Blanco Market Center | NM | 1993 | System | 6 | 755 | 0 | None | EBB |
| Buffalo Wallow Market Center | TX | 1994 | System | 23 | 700 | 1 | Cavern | EBB |
| Carthage Hub | TX | 1990 | Hub | 15 | 1,865 | 0 | Indirect | Yes |
| Egan Hub | LA | 1995 | Hub | 6 | 1,100 | 1 | Cavern | EBB |
| Equitable Resources Hub | LA | 1996 | Hub | 13 | 360 | 1 | Cavern | EBB |
| Henry Hub | LA | 1988 | Hub | 12 | 2,015 | 3 | Cavern | Yes |
| Houston Hub | TX | 1992 | Hub | 5 | 425 | 2 | Reservoir | Yes |
| Katy (TECO) Hub | TX | 1995 | Hub | 9 | 500 | 0 | None | No |
| Katy (Western) Hub | TX | 1993 | Hub | 12 | 800 | 2 | Reservoir | EBB |
| Louisiana Market Center | LA | 1994 | System | 20 | 850 | 1 | Cavern | EBB |
| Moss Bluff Hub | TX | 1994 | Hub | 6 | 900 | 1 | Cavern | EBB |
| Permian Waha Hub | TX | 1995 | Hub | 10 | 800 | 1 | Cavern | Yes |
| Perryville (NORAM) Center | LA | 1994 | System | 10 | 1,300 | 4 | Reservoir | Yes |
| Texaco Star Market Center | LA | 1993 | System | 26 | 400 | 1 | Cavern | Yes |
| Waha (Delphi) Hub | TX | 1995 | Hub | 4 | NA | NA | NA | EBB |
| Waha (Lone Star) Hub | TX | 1995 | Hub | 5 | NA | NA | NA | EBB |
| Waha (TECO) Hub | TX | 1995 | Hub | 7 | 500 | 0 | None | EBB |
| **Northeast** | | | | | | | | |
| CNG/Sabine Market Center | PA | 1994 | System | 14 | 3,081 | 11 | Reservoir | EBB |
| Columbia Gas Market Center | PA | 1995 | System | 12 | 7,074 | 43 | Reservoir | Yes |
| Ellisburg-Leidy Market Center | PA | 1993 | System | 6 | 1,691 | 32 | Reservoir | Yes |
| Iroquois Market Center | NY | 1996 | System | 5 | 1,100 | 0 | Linepack | EBB |
| New York Market Center | NJ | 1993 | System | 4 | 451 | 6 | Mixed | EBB |
| **Midwest** | | | | | | | | |
| Chicago Market Center | IL | 1993 | System | 5 | 3,435 | 8 | Mixed | Yes |
| Grand Lacs Hub | MI | 1995 | System | 7 | 200 | 3 | Reservoir | EBB |
| **Central** | | | | | | | | |
| Mid-Continent Market Center | KS | 1995 | System | 9 | 480 | 3 | Mixed | EBB |
| Rocky Mountain Center | WY | 1995 | System | 3 | 740 | 8 | Reservoir | Yes |
| Western Market Center | WY | 1995 | System | 6 | 1,800 | 10 | Reservoir | Yes |
| **Western** | | | | | | | | |
| California Energy Market Center | CA | 1994 | System | 6 | NA | 5 | Reservoir | EBB |
| Mojave Market Center | CA | 1996 | System | 4 | 400 | 0 | Linepack | No |
| PGT Market Center | OR | 1994 | System | 4 | NA | 0 | Linepack | EBB |
| **Canada** | | | | | | | | |
| AECO-C Hub | AB | 1990 | System | 6 | 2,000 | 1 | Reservoir | Yes |
| Alberta Center | AB | 1996 | Hub | 1 | 500 | 1 | Reservoir | Yes |
| Crossfield Hub | AB | 1995 | Hub | 1 | 500 | 1 | Reservoir | Yes |
| Empress Hub | AB | 1986 | System | 3 | 6,200 | 1 | Reservoir | Yes |
| Intra-Alberta Hub | AB | 1994 | Hub | 3 | 12,000 | 4 | Reservoir | Yes |
| Sumas Hub | BC | 1994 | Hub | 3 | 1,800 | 1 | Reservoir | Yes |
| Union Gas Market Center | ON | 1985 | System | 5 | 4,000 | 1 | Aquifer | No |

[1]A market center utilizing the interconnections of one or more pipeline systems for gas interchange purposes is categorized as a "system" operation, while one that uses a central (localized) interchange point is categorized as a "hub."

[2]Maximum volume that may be moved through the system or hub on a daily basis.

[3]Sites directly or readily accessible to operator.

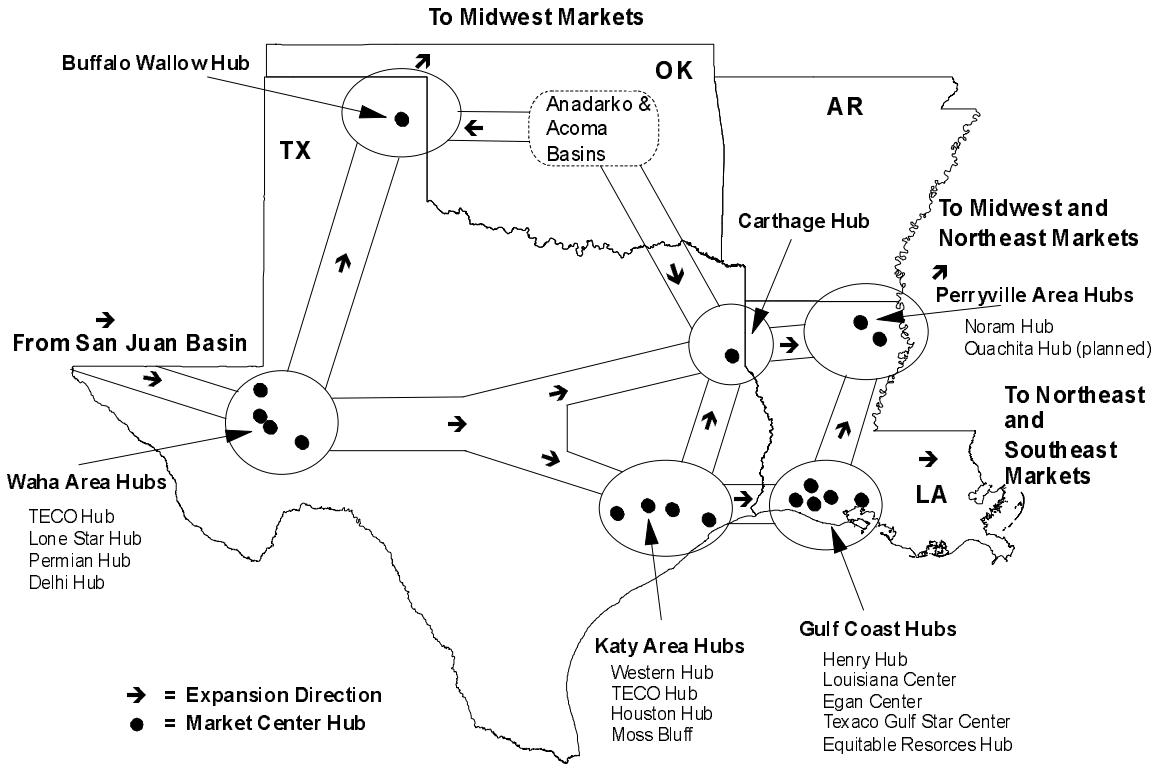
[4]Reservoir represents depleted production field or reef storage site.

[5]An electronic trading system is either available at the center itself or the center is a trading point on one or more commercially available electronic trading systems. EBB indicates that the center at least has one electronic bulletin board service available.

MMcf/d = Million cubic feet per day. EBB = Electronic bulletin board. NA = Not available.

Source: Energy Information Administration, EIAGIS-NG Geographic Information System, Natural Gas Market Center/Hub Database as of September 1996, compiled from various industry news sources, discussions with the industry, and filings with the Federal Energy Regulatory Commission.

**Figure 28. West Texas Market Centers Interplay with North and East Texas and Louisiana Market Centers**




Note: Not all area pipelines are represented.

Sources: Energy Information Administration, EIAGIS-NG Geographic Information System, Natural Gas Market Center/Hub Database, Natural Gas Proposed Pipeline Construction Database, compiled from Federal Energy Regulatory Commission filings and various industry news sources, as of September 1996.

This trade is facilitated by the fact that several key market centers have ready access to incremental gas supplies from a wide variety of sources. This trade is well motivated by market centers with readily available price information. If this information indicates that the difference in the price of gas between market centers exceeds the cost of transporting the gas between these locations, then trading will occur if pipeline capacity is available to move this gas.

It is not surprising that market centers in Texas and Louisiana are continuing to improve their physical and business interconnections and to increase the number of exchanges. Increased trade and interconnections between centers could help to reduce the great price uncertainty currently associated with moving gas between major markets in the United States.

# Market Center Operations

## Types of Services

A number of market centers offer an extensive portfolio of services (see box, p. 71). Currently, however, many customers are choosing only a few of these services. Some of the more frequently used services are wheeling (transportation), parking, loaning, and storage (Table 9). Originally, the Henry Hub offered only transportation service, but recently it began to offer additional services that include parking (short-term storage service) and loaning of gas.

Wheeling, or transportation, is the main service currently provided by the majority of market centers. Two parties that exchange gas at a market center or move gas among pipeline systems via a market center generally require only transportation service. Salt dome storage type hubs are used to transport gas to and from hub interconnections and from one pipeline system to another. In many cases, they also are

## Market Center and Hub Services

The types of services offered by market centers and hubs vary significantly. No two operations are identical in the services offered, and in fact the features of similarly named services often differ in meaning and inclusions. The list below provides only some of the general types of services offered. Refer to Table 9 for the number of facilities that have offered the service (although the center may not currently be performing the transaction or the service named). The definitions were obtained from the Federal Energy Regulatory Commission's Office of Economic Policy.

**Wheeling**—Essentially transportation service. Transfer of gas from one interconnected pipeline to another through a header (hub), by displacement (including exchanges), or by physical transfer over the transmission of a market center pipeline.

**Parking**—A short-term transaction in which the market center holds the shipper's gas for redelivery at a later date. Often uses storage facilities, but may also use displacement or variations in line pack.

**Loaning**—A short-term advance of gas to a shipper by a market center that is repaid in kind by the shipper a short time later. Also referred to as advancing, drafting, reverse parking, and imbalance resolution.

**Storage**—Storage that is longer than parking, such as seasonal storage. Injection and withdrawal operations may be separately charged.

**Peaking**—Short-term (usually less than a day and perhaps hourly) sales of gas to meet unanticipated increases in demand or shortages of gas experienced by the buyer.

**Balancing**—A short-term interruptible arrangement to cover a temporary imbalance situation. The service is often provided in conjunction with parking and loaning.

**Gas Sales**—Sales of gas that are used mainly to satisfy the customer's anticipated load requirements or sales obligations to others. Gas sales are also listed as a service for any market center that is a transaction point for electronic gas trading.

**Title Transfer**—A service in which changes in ownership of a specific gas package are recorded by the market center. Title may transfer several times for some gas before it leaves the center. The service is merely an accounting or documentation of title transfers that may be done electronically, by hard copy, or both.

**Electronic Trading**—Trading systems that either electronically match buyers with sellers or facilitate direct negotiation for legally binding transactions. A market center or other transaction point serves as the location where gas is transferred from buyer to seller. Customers may connect with the hub electronically to enter gas nominations, examine their account position, and access E-mail and bulletin board services.

**Administration**—Assistance to shippers with the administrative aspects of gas transfers, such as nominations and confirmations.

**Compression**—Provision of compression as a separate service. If compression is bundled with transportation, it is not a separate service.

**Risk Management**—Services that relate to reducing the risk of price changes to gas buyers and sellers, for example, exchange of futures for physicals.

**Hub-to-Hub Transfers**—Arranging simultaneous receipt of a customer's gas into a connection associated with one center and an instantaneous delivery at a distant connection associated with another center. A form of "exchange" transaction.

**Table 9. Service Profile of Operational U.S. and Canadian Market Centers**

| Types of Service | Active Centers and Hubs Where Service Is: | | | |
|---|---|---|---|---|
| | Offered | Most Highly Used[1, 2] | Second Most Highly Used | Third Most Highly Used |
| Wheeling/Transportation | 34 | 13 | 6 | 3 |
| Parking | 26 | 5 | 12 | 5 |
| Loaning | 23 | 1 | 5 | 8 |
| Title Transfer/Tracking | 22 | 0 | 1 | 1 |
| Electronic and OtherTrading | 17 | 5 | 1 | 1 |
| Buyer/Seller Matching | 15 | 4 | 1 | 1 |
| Storage (Separate Service) | 12 | 6 | 2 | 3 |
| Peaking | 8 | 1 | 0 | 2 |
| Compression | 8 | 0 | 2 | 1 |
| Balancing | 16 | 0 | 0 | 1 |
| Risk Management | 5 | 0 | 0 | 0 |
| Exchanges | 6 | 0 | 2 | 0 |
| Hub-to-Hub | 2 | 0 | 0 | 1 |
| Administration | 4 | 0 | 0 | 0 |

[1]Based on volumes, number of transactions, or revenues generated, depending on the individual market center methodology for estimating overall business activity.

[2]Level of service information unavailable from 4 of the 39 market centers.

Sources: Energy Information Administration, EIAGIS-NG Geographic Information System, Natural Gas Market Center/Hub Database, as of September 1996, compiled from industry trade press, discussions with the industry, and filings with the Federal Energy Regulatory Commission.

used to arrange for the movement of volumes to the eventual delivery point. Thus, these hubs support exchanges simply through normal storage services.

Many of the recently opened market centers are gradually increasing their business, concentrating their major marketing efforts on the services that are reflected in the physical capabilities of their supporting systems. For instance, many centers with associated storage provide significant short-term parking, gas loans, and storage capacity brokering, while doing little business in the area of gas buying and selling.

Several operations specialize in arranging the movement of gas over an area. These centers may be considered to be market areas with several delivery points, pipeline interconnections, and/or storage sites. Their customers' needs change in ways that are difficult to predict. Thus, planned deliveries do not always equate well with actual requirements for these customers. These requirements need frequent adjustment and are well served by such systems.

A customer's use of a particular service is influenced greatly by the contract terms made available at the center. For example, if a customer needs gas and other service for only 4 days in the week, it would not release the rights for the other 3 days if the shortest term for wheeling service is one week. The shorter the term of the contract for the exchange of gas and rights to service, the greater the number of trades. Long-term, nonreleasable contracts for gas and related gas services, under which customers have highly variable demands for gas, imply underutilization of the service over an extended time period and full utilization for relatively short time periods. This is the opposite of the expected utilization of pipeline systems near market centers that serve as trading centers.

## Costs of Services

The cost of doing business at a market center depends on the types of services used. Many of the services provided are essentially market based, that is, the charges are whatever the local market dictates. The prices of some services, such as transportation or storage-related services, however, are often governed by the Federal Energy Regulatory Commission or State utility commissions.[50] Usually these rates are cost-of-service based, that is, they are set at a level that is expected to generate enough revenues to allow the company to recover its expenses plus an allowed rate of return on assets used in producing the service.

[50]Most of the 32 operational market centers in the United States operate under FERC jurisdiction and are governed by Natural Gas Policy Act (NGPA) Section 311 rates. Five operate under FERC Natural Gas Act (NGA) Section 7 authority. The remaining centers operate under their respective State jurisdictional agencies, all subject to cost-of-service tariffs.

In other cases, the market center has been granted the authority to operate under a market-based rate structure entirely.[51] Such exceptions have been granted when it has been proven to the satisfaction of FERC that the center (operator) does not, or will not, have excessive market power in the region. Currently, seven market centers are offering market-based rates for "hub services" although several are operating on a subject-to-refund basis pending final FERC approval.

Those market centers operating under cost-of-service rate structures, while they may not charge above the maximum set rate, are permitted to discount below the maximum charge. In today's market, competition has often forced center operators to discount the ceiling rate, except perhaps during peak demand periods for some short-term contracted services.

In some instances market centers can make up the lost revenues that result from discounting of regulated tariffs by selling interruptible service and by selling unregulated services. In general, the expenses incurred from providing transportation services are relatively less than those from operating the rest of the system. Furthermore, many market centers expect or hope to increase returns in the future if they gain approval for market-based pricing of their hub services. They also anticipate continued growth as the majority of the market centers have experienced growth rates of 30 percent or more per year since they began operating. Since they are not near capacity limits, the expectation of continued growth seems reasonable.[52]

Nevertheless, revenues generated by the large volumes flowing through the major market centers, even at highly discounted rates, can be significant. For instance, the Henry Hub moved several hundred billion cubic feet of gas through its facilities during 1995. Since the Henry Hub charges about 3 cents per million cubic feet to move gas through the hub, the revenues from this service alone were significant.

Another major cost issue is whether some market centers are underutilized because they are not using market-based rates. This makes it easier for companies to rationalize charging a lower summer rate than would otherwise be possible, because market-based rates allow companies to charge a higher rate in the winter when daily demand for gas is large and volatile.

## Ease of Contracting Supports Trade

An important characteristic of many successful markets is the ease and speed at which contracts can be finalized. For example, standardized contracts and preapproved credit or creditworthiness support the ease of trading and finalization of contracts.[53]

Market centers, to operate successfully, depend upon transaction volume, a relatively small spread between bid and offer prices (or liquidity), and minimization of transaction costs. One driving force for similarity of bid and offer prices is well-informed market participants. This highlights the importance of having contracts that can be easily understood with a limited number of key provisions.

Many market center providers have standardized contracts on hand for candidate customers. The advantage of a standardized contract is well understood and includes the minimization of transaction costs and a clear understanding of legal responsibilities.

## Key Role of Information

### *Electronic Trading*

Access to electronic gas trading (EGT) and electronic bulletin boards (EBBs) tends to be thought of synonymously with market center activity. Electronic trading provides the means by which centers can attract customers to broker their own gas trades, frequently in an anonymous environment.

Yet, not all operations currently make such services directly available to customers. According to available data, 17 of the 39 U.S. and Canadian centers can be accessed via one or more electronic trading systems (Table 9). The lack of such services reflects several business considerations. First, the amount of actual or potential trading may not support the investment needed to install an EGT system. Second, some market centers, without an EGT system, rely upon their own operations staff to carry out trades for their customers. Staff also provides many of the other administrative services such as title transfers and price discovery.

[51]All seven market centers located in Canada are permitted to charge market-based or negotiated rates. Canada has had market-based pricing since 1984. However, many contract rates are negotiated by a wholesaler, e.g., a distribution company, and individual customers, and the rates do not represent the price paid by customers over time for gas and other services because the needs of customers change in unexpected ways.

[52]In fact, a number of market center administrators have reported much higher growth rates, ranging from 50 to 300 percent annually in their second year of operation and beyond.

[53]Lines of credit, which are not generally used at market centers, are commonly used in related markets to expedite the completion of trades and, hence, the liquidity of the market. For example, the London Metals Exchange (LME) uses lines of credit. It is important to note that LME is largely made up of companies in the metals industry, much as one might expect market center participants to be made up of members of the gas industry, rather than members of the financial industry. Every day contracts for future and current delivery are traded on the LME as companies alter their competitive strategies in the metals market as economic conditions and their current situations change.

### *Price Information*

Price information is generally available to market center customers through electronic bulletin boards, electronic trading systems, or directly from center staff. Usually, however, this information is not publicly available. This lack of public information reflects the still low level of integration and interaction between centers.

Another reason for the lack of extensive electronic trading is the fixed cost associated with providing this information. For example, the technology required to support electronic trading requires new investment in equipment and people. Thus, the average cost of such information may be prohibitive unless the volume of trading is much greater than it is currently at many market centers.

Gas prices are also available through electronic services such as Bloomberg's and Reuter's data services and from the trade press at a fixed subscription cost. The drawback is that they may not be timely enough and may not be reliable. Some of these prices are not representative of completed deals. Instead they may represent an attempt by a company to influence market behavior. Moreover, the volumes of gas sold at different prices on spot markets on a particular day are often not known and may be small.

Price transparency, or the ability to identify quickly and accurately the cost of gas and other gas-related services at and near market centers, is crucial. At the Henry Hub, where price transparency is high, buyers appear willing to pay more, on average, than at nearby places with equal access to the same end-use markets but with less price transparency.[54]

The key with price transparency is to make public the price, quantity, and type of services received per transaction without revealing the parties involved in the transaction. Most successful markets with high trading volumes, such as the financial and commodity markets in the United States, provide full disclosure of price and other trading information.

Access to publicly available price data for the commodity and for available pipeline and storage space would encourage a variety of buyers and sellers with different needs to exchange gas and rights to ancillary services via market centers. All too often, however, the primary service provided by some market centers amounts only to conventional balancing services. In these instances, companies do not seek short-term gains by trading the gas commodity via a market center service. Indeed, activity at the market center is engaged in to sustain the operational and contractual integrity of gas delivery system not much different from the delivery system prior to Order 636.

## How Storage Supports Trade at Market Centers

Access to storage is vital to many market centers, although it may not always be underground storage. Three centers support their parking and loaning services through linepacking on their supporting pipelines, and a few provide supplemental liquefied natural gas supplies to support their peaking service.

While a number of market centers have but one or two storage sites linked directly to their operations, many have access to multiple storage sites. Some market centers also have indirect access to storage because of contracts they have, or can readily acquire, for transportation service between storage sites and market centers.

An indicator of the importance of storage is that more than two-thirds of market centers have some form of access to storage. The total working gas capacity of accessible storage exceeds 2,006 billion cubic feet, or about 47 percent of all the working gas capacity in the United States and Canada. Expressed in terms of daily deliverability, this represents 30 billion cubic feet, or 39 percent of North American underground storage capability (Table 7). Practically all the salt storage sites are accessible to market centers.

Of course, not all of this capacity is accessible to the centers, because some of it is dedicated to selected high-priority customers such as distribution companies. The portion that is available to service new customers is often interruptible or releasable capacity within the storage site.

At least two salt storage sites, Egan and Moss Bluff, are specifically tied into hub operations. Two planned market centers, Tioga (PA) and Avoca (NY), have their market center operations developed around salt storage.

Regionally, underground storage availability to market centers depends upon the type of storage. Most of the underground storage in the production areas of the Southwest and Central regions is owned by independents or producers and is often open-access high-deliverability salt storage, most adaptable to the needs of market center operations.

Many of the proposed new underground storage sites over the next several years will be located in major production areas or in proximity to major market centers. Of the 45 storage sites

[54]Of course, other factors may enter into this difference such as the liquidity of the market at the center and overall quality of hub service at the Henry Hub.

planned for development or expansion,[55] 11 are located in the Southwest Region, and represent an additional 91 billion cubic feet of working gas capacity and 4.3 billion cubic feet per day of withdrawal capability.[56] Of this total, seven are high-deliverability sites with a total of 3.2 billion cubic feet per day of withdrawal capability (see Appendix F). Existing oil and gas and even aquifer storage is being refurbished to increase flexibility and deliverability because customers are increasingly demanding flexibility and higher deliverability from their storage service contracts. However, such storage is still ideally obtained from salt dome storage tied to a market center.

In summary, many hubs are connected to seasonal storage and also to high-deliverability salt storage caverns or other flexible, high-deliverability reservoir sites. This is not surprising since salt storage caverns can serve as market centers if they are connected to a diverse group of suppliers and gas customers. Salt storage is ideally suited for satisfying both balancing needs and short-term strategic marketing objectives (to include arbitrage) by gas companies, and thus provides new choices for many gas customers.

### *Value of High-Deliverability, Flexible Storage*

The value of having ready supplies of gas near a market center can be estimated by examining the difference in the current cash price of gas at the Henry Hub and the price of the most current natural gas futures contract being traded at the Henry Hub (Figure 29). This calculation is most relevant for market centers connected with high-deliverability, flexible storage near the Henry Hub. This calculation is convenient both because the futures price implicitly includes the cost of storage and the lost interest payments associated with having stored gas, and because it is difficult to obtain estimates of the cost of storing gas on a daily basis. The difference could be readily calculated for other market centers if reliable estimates of the daily cost of storage and gas were readily available. When the Henry Hub futures price is used, the difference represents the value that current supplies have relative to supplies a few weeks hence. This difference or premium is related to what economists refer to as a convenience yield.[57]

The current trade press cash price is an estimate of the price that a company could receive for stored gas today. The futures price is an estimate of the cost to replace the released gas in a few weeks. Thus, the difference in the two prices could be viewed as an indicator of the premium value of the stored gas near a market center when, for example, aggregate demand increases significantly.

When the difference between the spot and the futures price or the premium[58] at the Henry Hub for the 1995–96 heating season is computed, it is found that it was positive throughout much of the heating season. At times, it was large and exceeded $1.00. In fact, the average daily value of the premium at the Henry Hub was about $0.70 per million Btu between November 1, 1995, and April 1, 1996.[59] Even when the 13 largest differences were deleted from the data set and the average difference was recomputed, the average was still large at about $0.30 per million Btu. Similar results were obtained for December-through-February price differences for the past several years.[60]

## Role of Market Centers in Managing Price and Volume Volatility

### *Volume Volatility*

As previously stated, exchanges of gas and pipe and storage space at market centers frequently can be viewed as satisfying unexpected changes in customer supply and demand volumes, especially demand. The average variability of these changes in volume is referred to as volume volatility. These unpredictable changes, especially when they accrue over time, are designated imbalances within the gas industry. Imbalances occur because the companies' needs for gas, storage, and pipe space differ from the amounts they have reserved. Thus, companies are often in a position where either they need to acquire such rights or they have unused rights to release for sale. Most companies can be viewed as alternating between a buyer and a seller of rights over time. For example, an LDC, which is ordinarily thought of as a buyer of gas at a market center or a buyer of center services such as parking, can be a

[55] As of September 1996, 58 projects are actually planned but 19 of these projects represent phased development of single sites.

[56] It is important to note that working gas capacity statistics, as ordinarily reported, assume one cycle per year, which is possibly deceiving because they are capable of being cycled many times during the year. Effective capacity is the number of times cycled times the working gas capacity.

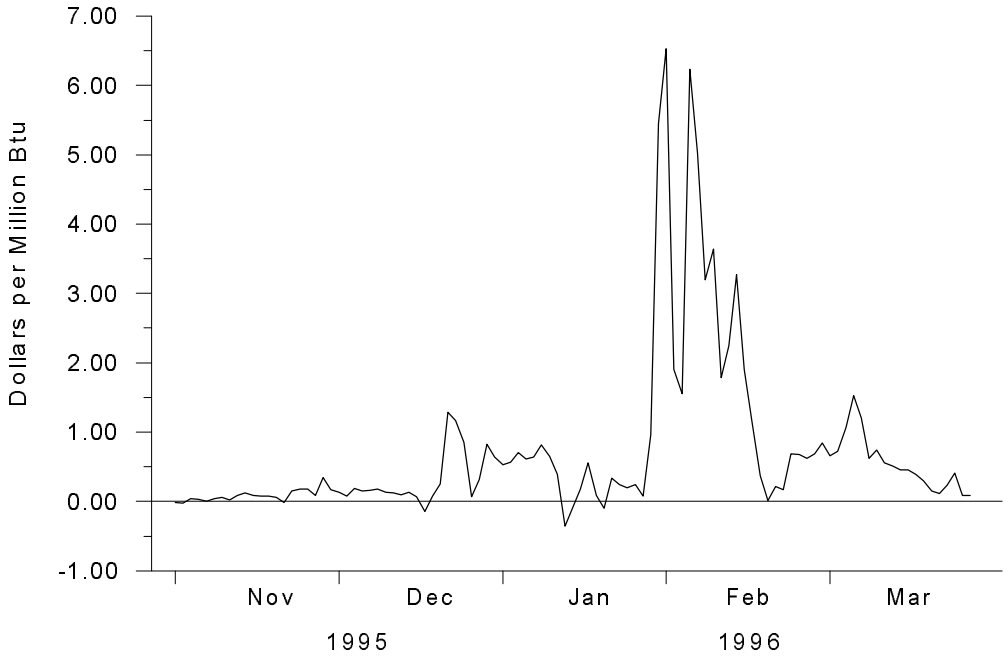
[57] The convenience yield or premium is the value after subtracting the influence of storage cost and the cost of money from the difference.

[58] For a further discussion of premiums, see Energy Information Administration, *The Value of Underground Storage in Today's Natural Gas Industry*, DOE/EIA-0591 (Washington, DC, March 1995. Also see John H. Herbert, "Improving Competitive Position with Natural Gas Storage," *Public Utilities Fortnightly* (Washington, DC, October 15, 1995).

[59] The distribution of the values for the premium was also skewed towards high values. Thus, the relative frequency of high values was much greater than the relative frequency of low values. The high values were associated with large and persistent drops in the temperature below normal levels. Similar results were obtained for the heating seasons in the past several years. Although the average value of the premium was not nearly as large, large values were observed and the distribution of the premium appeared to be skewed towards high values.

[60] See Energy Information Administration, *Natural Gas 1994: Issues and Trends*, DOE/EIA-0560(94) (Washington, DC, July 1994).

**Figure 29. Premium Return for Quick and Flexible Delivery Capability, November 1995 - March 1996**




Sources: **Cash:** Pasha Publications, Inc., *Gas Daily*. **Futures:** Commodity Trading Commission, Division of Economic Analysis.

seller of gas if its needs for gas are less than its rights to gas.[61] The LDC could release short-term gas to others via the short-term transportation services offered by market centers when demand for gas declines from expected levels.

In principle, companies constantly have the capability to enter short-term exchanges at market centers. During any one week, a particular company could be a net seller of rights to gas, pipe, and storage space, and then in the next week be a net buyer. Interestingly enough, this type of constant buying and selling results in a smoothing out of natural gas costs for a company over time and may result in a reduction in price risk exposure.

For example, suppose an LDC has a contract to purchase 100 million cubic feet (MMcf) of gas in each of the next 3 months at $2.00 per thousand cubic feet. During the period, however, the LDC sometimes needs less and sometimes more than 100 MMcf. For the sake of discussion it is assumed that this amount, on average, equals 20 MMcf. If prices rise above $2.00 during the next 3 months, the LDC receives a return every time it sells gas into the market and it pays an additional cost every time it buys gas from this market. If the LDC's demand varies at an average of about 3.3 MMcf per day (the daily average of 100 MMcf per month) during the time period, then the sum of the returns is likely to be similar to the sum of the incremental costs. If the LDC assumed only its traditional role as a buyer, it would incur additional costs each time its demands increased unexpectedly, without receiving any compensating revenues when its demands fell below reserved levels. By being both a buyer and a seller of gas, the LDC effectively fixes its cost near $2.00 per thousand cubic feet.

Currently many companies try to control price risk exposure through a combination of a futures contract and a location basis swap. The futures contract is used to reduce the price risk associated with buying and selling the commodity. The swap contract is used to reduce the location price risk associated with taking the gas at a location other than the Henry Hub.[62]

There is a cost associated with using both of these financial instruments. Additionally, location basis risk or the price risk associated with taking gas at a location other than the Henry

[61]There are reports that several LDCs did in fact sell gas onto the market this past winter.

[62]The price risk is due not just to variations in transportation cost between locations but to a myriad of factors such as physical and contractual constraints in moving gas between locations and in obtaining gas from different supply sources.

Hub is difficult to control.[63] Price risk control at the Henry Hub may also be difficult to obtain for some companies because of their timing of gas sales and purchases.

As market centers develop liquid markets with transparent prices for gas and for nearby pipe and storage capacity, a larger proportion of a company's exchanges could be accomplished at market centers. This could also attract additional customers. Hence, there would be less price risk exposure because the company would obtain more of its gas locally and avoid location basis risk. For example, buyers in local markets escape price risk caused by pipeline bottlenecks. Thus, some of a company's price risk exposure could be controlled through active participation at a market center, which would reduce the need for financial instruments. Moreover those companies that wish to hedge their price risk completely could enter into a swap arrangement written in terms of a market center price; or if an actively traded and liquid forward market develops at a market center, then they could buy and sell these contracts to hedge their price risk.[64]

Another direct way of receiving some price risk protection via a market center is through the active use of high- deliverability, flexible storage such as salt cavern storage and, in particular, through the joint use of conventional oil/gas storage with such salt storage. The company obtains this risk protection by moving gas from conventional storage to salt storage when space is available in a salt storage site during the winter time. Then, if gas prices or customers demands for gas increase, gas is released quickly from storage either for own use or for the use of another company.

When the customer uses the gas for its own use, it avoids the high cost of spot gas at the time. When the company provides gas to another company, it obtains a return as discussed previously. This type of behavior provides price protection to buyers only when prices rise.[65] They also incur a cost equal to the cost of gas and the cost of money. However, it would seem prudent to consider such strategies because current spot prices have tended to move unexpectedly sharply upwards at different times during the past several heating seasons.[66]

### *Reducing Price Risk Exposure - Market Center Versus Futures Market?*

As previously mentioned, the ready access to and release of gas via regular market center activity can provide price risk protection in markets near the centers. However, a view held by some in the gas industry is that the NYMEX Henry Hub futures contract market can also be used for price risk protection at a variety of locations scattered throughout the United States. Thus, why would a company incur the expense of attempting to control price risk exposure through market center activity when a market is already available that specializes in price risk protection? The reason for taking this additional measure is that price risk can be effectively hedged through a futures contract only if prices behave in a similar way at the location and at the Henry Hub and if spot prices and futures prices at the Henry Hub converge.[67]

One indication that futures contracts can be used to hedge price risk effectively at other locations is if futures prices change by, for example, $0.10 per million Btu and then cash prices change, on average, by $0.10 or by some other relatively constant amount. On average, changes in cash prices need to be highly correlated with changes in futures prices in order to hedge the price risk effectively with the futures contract.[68]

For many commodities, the difference in the cost of gas at different locations is explained by a relatively constant charge for transporting the commodity from a primary producing or storage area to a primary consuming area. If such conditions do not hold or if the relationship between futures and cash prices is complicated, then it is difficult to hedge price risk using a futures contract.[69]

It is possible to evaluate how difficult it might be to hedge price risk using a futures contract by examining the relationship between the futures market price at the close of trading of the futures contract and the bid week price at several major gas-consuming locations. Three locations were chosen for the analysis because of their importance as major consuming areas and because of their ready access to the Henry Hub: (1) the Appalachia region (near the Kentucky,

[63]For examples and discussion, see John H. Herbert, "Gas Price Behavior: Gauging Links Between Hubs and Markets," *Public Utilities Fortnightly* (April 1, 1996), pp. 27-30.

[64]The shorter the term and the smaller the size of the contract, the greater chance that a liquid forward market will develop as long as transaction costs are kept low.

[65]In fact, there is a cost that can be calculated by examining the distribution of the relevant premium. This sort of calculation would be relatively straightforward for salt storage properties readily accessible to the Henry Hub.

[66]See Energy Information Administration, *Natural Gas 1994: Issues and Trends*, DOE/EIA-0560(94) (Washington, DC, July 1994).

[67]For additional discussion, see J.H. Herbert and E. Kriel, "U.S. Natural Gas Markets - How Efficient Are They?" *Energy Policy* (January 1996). If the spot and futures prices do not converge, the calculation discussed previously becomes more difficult to justify because the magnitude of the nonconvergence (another type of basis risk) needs to be considered in the estimation.

[68]Another indication that futures contracts can be used to hedge price risk effectively is the occurrence of a relatively constant proportionate relationship between cash price and the futures price plus a constant difference.

[69]It may also be difficult or expensive to use options or swaps to hedge location basis risk completely.

Ohio, West Virginia, and western Pennsylvania area) along the Columbia Gas System, (2) the New York citygate, and (3) the Chicago citygate. These three locations have good access via long-distance trunk pipelines to South Louisiana near the Henry Hub where deliveries through a futures contract take place. Hubs are also currently operating at these locations.

When the difference between the spot price at these three key locations and the Henry Hub futures price (at the close of trading for the futures contract) is examined (Figure 30), it is observed that the difference is not always positive or relatively constant. In fact, the difference in the price between Chicago and the Henry Hub can be positive as well as negative. The difference between the price for the Appalachian region and the Henry Hub has a winter/summer seasonality, yet the character of the seasonality varies between years. The magnitude of the difference in the New York price and the Henry Hub price also varies greatly, and high values can be seven times as great as low values. High or low values also tend to persist at times but not in a predictable way between years. Thus, it might be difficult to hedge price risk at these locations using a futures contract.

As previously stated, the futures contract market can provide an effective hedge if changes in the futures price are highly correlated with changes in the cash price. However, statistical analysis reveals that a large proportion of the variability in cash prices is left unexplained by changes in futures price at all locations. The most striking result is for Chicago where only 56 percent of the variability of changes in cash prices is explained by changes in futures prices. In Appalachia and New York, the variability is equal to 74 percent and 79 percent, respectively. Thus, the amount of price variability hedged through a futures contract may be poor for Chicago and limited for the other locations.[70]

## Future Challenges

In just a few years, market centers have become a key component in the North American natural gas transmission and distribution network. The number of market centers has grown rapidly during the past 5 years, with 27 added since 1993. Today's market centers are structured and positioned to handle full-service marketing operations. They have made it easier for buyers to access the least expensive source of supply and helped sellers to allocate gas to the highest bidding buyer. Market centers also enable shippers to keep their receipt/delivery flows in balance and avoid paying penalties.

Market centers have led to the enhancement and expansion of a number of pipeline systems (see Appendix G) and the development of additional interconnections to expedite service. Such interconnections help level the flow of gas along pipeline systems throughout the year and thus reduce costs and encourage the redirection of flows when price disparities arise between various supply locations.

Nevertheless, most market centers are not operating near their full potential, even though they have expanded the number of services they offer and are doing increasing business. For instance, salt cavern storage sites associated with market centers are frequently less than 40 percent full, and the amount of withdrawals at these sites is rarely near upper limits from one week to the next.[71] If these facilities were constantly being recycled (inventory turnover), they would be much closer to being full and the percentage amount full would usually change from one week to the next. In addition, the sum of injections and withdrawals for a week would be a significant percentage of total working gas capacity. High-deliverability storage facilities offer the capability of taking advantage of trading opportunities provided by the great daily volatility in gas prices and in gas demand and by the daily and weekly imbalances experienced by many companies.

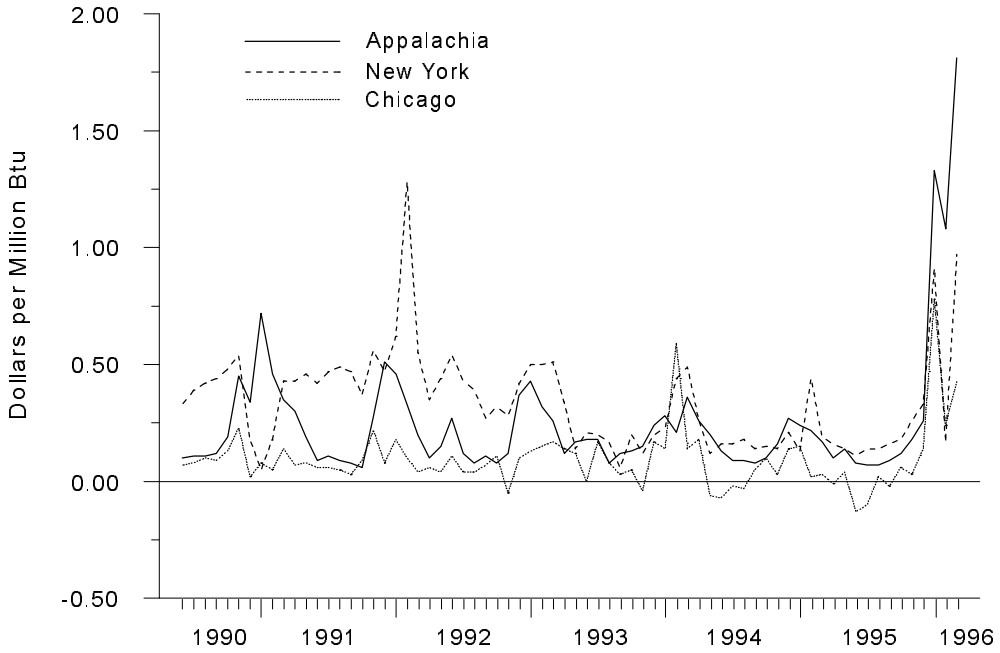
Other evidence that market centers are not being fully utilized is the size of the daily price spikes experienced this past winter. One of the primary functions of market centers should be to release additional gas to market when prices start to rise. This releasing of gas to market should tend to shave peak prices and thus eliminate extreme price peaks unless there is extreme stress on the system.

A major challenge facing the natural gas industry is to improve or create new services that will minimize or mitigate imbalance situations and their associated costs. These costs can be high in major consuming areas during peak usage periods. The expansion of market centers and trading services designed specifically to address the problem may be part of the solution. However, such services may not be able to address the problem fully, in part because of the special circumstances surrounding most imbalance situations, that is,

[70]The estimates are obtained using ordinary least squares. The change in gas price by location is regressed on changes in futures price at the Henry Hub. The data are for the period June 1990 through March 1996. Monthly data are from McGraw-Hill, Inc., *Inside FERC's Gas Market Report* (Washington, DC); and Oil Daily Company, *Natural Gas Week* (Washington, DC, June 1990-March 1996), various issues. The methodology is similar to that used in E.J. Brinkman and R. Rabinovitch, "Regional Limitations of the Hedging Effectiveness of Natural Gas Futures," *Energy Journal*, Vol. 16, 3 (1995), pp. 113-124.

[71]Oil Daily Company, *Natural Gas Week*, "Salt Cavern Storage," (Washington, DC), various issues.

**Figure 30. Difference Between Futures Final Settlement Prices at the Henry Hub and Bid-Week Spot Prices at Selected Locations, June 1990 - March 1996**




Note: Spot prices are the first of the month for the Appalachia region (Kentucky, Ohio, West Virginia, and western Pennsylvania) along the Columbia Gas Transmission system and the New York and Chicago citygates.

Sources: **Spot Price:** McGraw-Hill, Inc., *Inside FERC's Gas Market Report*. **Futures Price:** Commodity Futures Trading Commission, Division of Economic Analysis.

the restrictive delivery or receipt point conditions set forth in pipeline company "Operational Flow Orders."[72]

Pipeline companies may impose penalties during a severe imbalance situation. However, the penalties are arbitrary and do not reflect precise market conditions. Moreover, the imposition of penalties frequently follows the period of greatest demand, which provides no motivation to reduce demand during the period of greatest demand. Furthermore, after the time of greatest demand, the dollar cost of the penalty will determine the natural gas price. A customer with a severe imbalance situation will be willing to pay a price for incremental supplies up to the cost of the imbalance penalty.

A possible solution could be the development of regional networks, electronic or otherwise, which would provide real-time information access to all affected parties. This would allow operational conditions and price information to direct the resolution of a potential imbalance before it becomes a problem. Regional networks would provide access to real-time pricing over a wider area. This should improve the trading and allocation of gas and rights to pipe and other services when demand has increased significantly. Thus, the market-determined price of these items could determine use of the pipeline system. Pipeline usage would have a greater chance of being reduced when demand was greatest, because prices would most likely be at their highest level at these times.

If regional markets were developed in major consuming areas, the opportunities to exchange gas should expand and improve the competitiveness of the market and thus support the use of market-based rates. Instead of a single provider allocating loaning services at a fee, gas would be allocated between end users exchanging rights to gas through market-determined prices (a center operator might receive a transportation fee that was indexed to a percentage of the cost of the gas). This would shift the proof of a competitive market from the number of alternative providers of hub-like services to the

[72]Operational flow orders are put into effect by pipeline companies during periods of extreme demand or duress on the physical facilities of the system. These orders include specific limitations and conditions that a customer must adhere to during the period of enforcement, or face penalties.

number of customers able to enter into free exchange at market centers.[73]

A significant shortcoming of many market centers is the unavailability of transparent, reliable, real-time price information. An improvement in price discovery could further the value and use of market centers by providing many other natural gas users with the type of information heretofore available only to the largest marketing companies and traders. This development could draw in more companies to engage actively in the gas marketplace and thus improve the overall efficiency of the gas industry.

Continued growth in market center use and operations depends to a great degree upon how these centers react to ever-changing market conditions. Further development of business interrelationships among market centers will most certainly support increased growth. Trade between centers can be expected to grow during the next several years as the interconnected network expands. There are several ways in which this trade might improve.

- Joint administration of hubs or joint ventures between companies that administer the center's business or operate the hubs. These endeavors would help consolidate operations and facilitate interhub trading and transfers.
- The use of the same electronic trading systems with expanded capabilities to accommodate intercenter tradingand services. Common trading software, combined with interhub business agreements, would attract customers, particularly those wishing to engage in risk management and price arbitrage.
- The creation of new market centers in strategic locations. As market demand and supply sources shift, new centers could be linked with existing centers that have complementary services.

Natural gas market centers have already demonstrated their value and importance to the smooth running of the Nation's transmission and distribution system. Doubtless, in the future, they will have to change further as the market continues to integrate and expand. Nonetheless, the reliability and transparency of price and other information will determine their value in allocating scarce supplies and in avoiding system bottlenecks.

[73]Most importantly, many customers would become sellers during one period and buyers during another, depending on their current imbalance situation.