Underground Storage of Natural Gas

Underground Natural Gas Storage

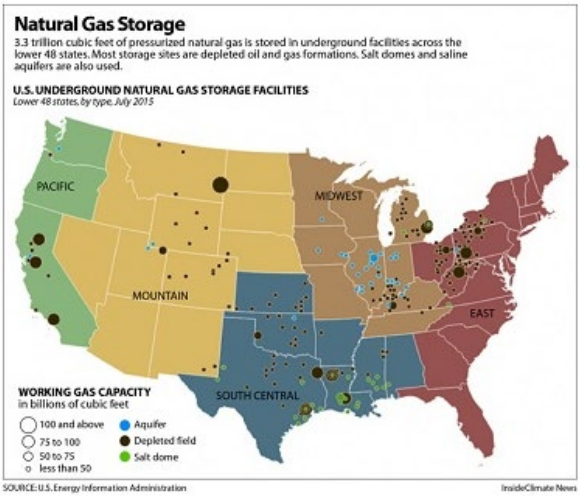
Overview

Following production and processing, natural gas is an energy product that is frequently stored for later use. The exploration, production, and transportation of natural gas take time, and the natural gas that reaches its destination is not always needed immediately, so it is injected into underground storage facilities. These storage facilities can be located near market centers that do not have a ready supply of locally produced natural gas.

Traditionally, natural gas has been a seasonal fuel. That is, demand for natural gas is usually higher during the winter, partly because it is used for heat in residential and commercial settings. Stored natural gas plays a vital role in ensuring that any excess supply delivered during the summer months is available to meet the increased demand for the winter months. However, with the recent trend towards natural gas-fired electric generation, demand for natural gas during the summer months is now increasing (due to the demand for electricity to power air conditioners and the like). Natural gas in storage also serves as insurance against any unforeseen accidents, natural disasters, or other occurrences that may affect the production or delivery of natural gas.

There are 400 other storage sites holding billions of cubic feet of natural gas and man,y thousands of storage wells make up part of the US interstate natural gas pipeline network (both transmission and distribution) and fall under the jurisdiction of the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA). The agency inspects and regulates these storage units, often by deferring to state regulators.

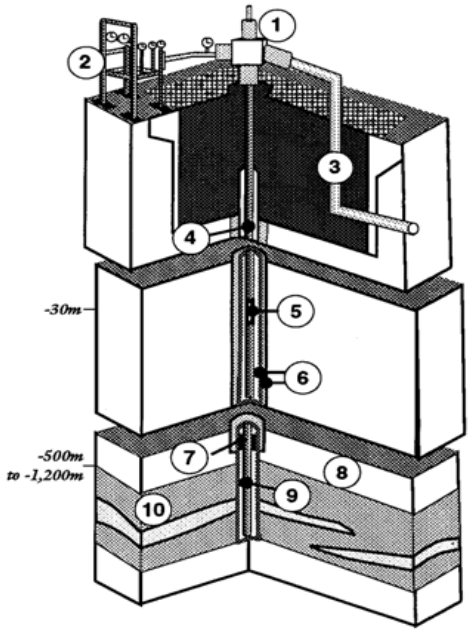
Underground natural gas storage provides pipelines, local distribution companies, producers, and pipeline shippers with an inventory management tool, seasonal supply backup, and access to natural gas needed to avoid imbalances between receipts and deliveries on a pipeline network.



There are three principal types of underground storage sites used in the United States today. They are:

- depleted natural gas or oil fields (326),
- aquifers (43), or
- salt caverns (31).

Production Reservoir Underground Natural Gas Storage Configuration

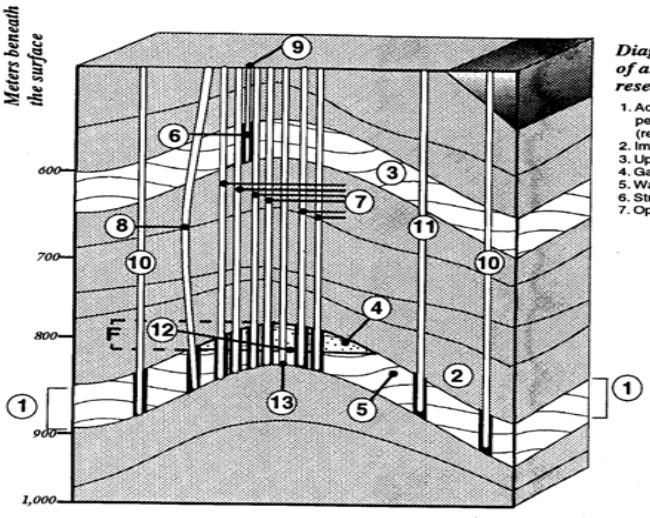


Cross Section of a Storage Well:

1. Wellhead.
2. Safety Valve Control.
3. Connection Pipe.
4. Flow Tubing String.
5. Automatic Safety Valve.
6. Cemented Casing.
7. Packer.
8. Caprock.
9. Strainers(-500 to -1,200m).
10. Reservoir.

Source: Gaz de France, "Underground Storages Facilities" (June 1992): Recreated by Energy Information Administration, Office of Planning Management, and Information Services.

Aquifer Underground Natural Gas Storage Reservoir Configuration



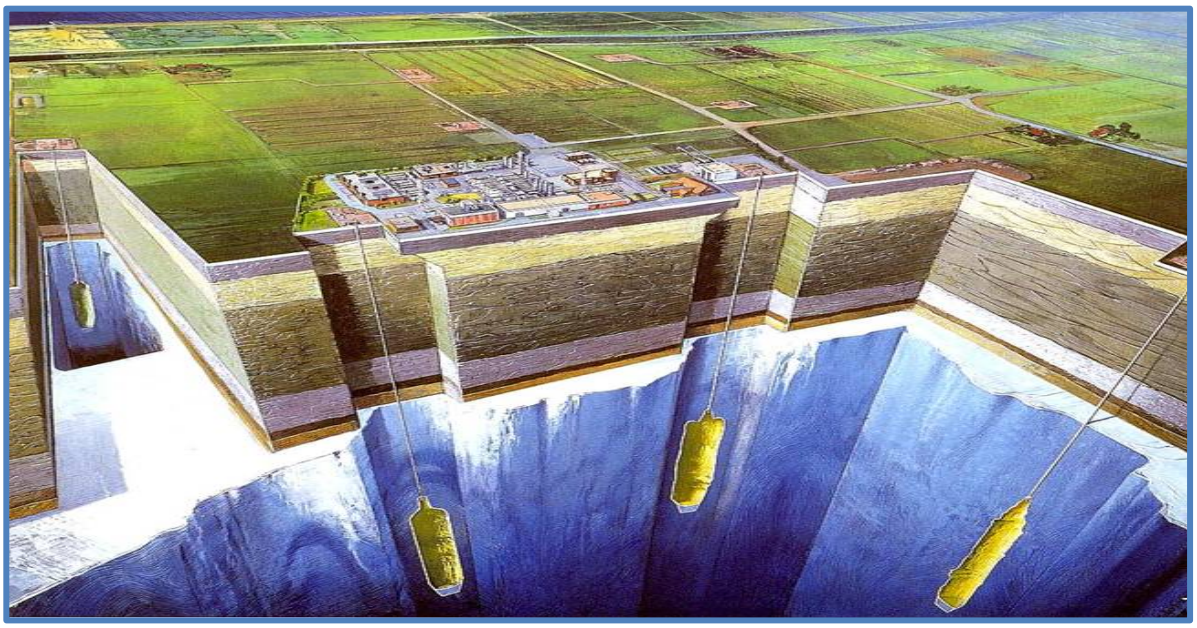
Diagrammatic cross section of an aquifer storage reservoir:

1. Aquifer. Porous, permeable layer (reservoir).
2. Impermeable cap rock.
3. Upper control aquifer.
4. Gas.
5. Water.
6. Strainers.
7. Operating well.
8. Deviated well.
9. Upper aquifer observation well.
10. Peripheral observation well.
11. Water level monitoring well.
12. Water level gas/water interface.
13. Neutron logging well.

F. Closure.

Source: Gaz de France, "Underground Storages Facilities" (June 1992): Recreated by Energy Information Administration, Office of Planning, Management, and Information Services.

Salt Cavern Underground Natural Gas Storage Reservoir Configuration



In a few cases, mine caverns have been used. Most underground storage facilities, 82 percent, were created from reservoirs located in depleted natural gas production fields that were relatively easy to convert to storage service, and that was often close to consumption centers and existing natural gas pipeline systems.

In some regions, such as the Midwestern United States, suitable natural aquifers have also been converted for use as natural gas storage facilities. An aquifer is used for natural gas storage if the water-bearing sedimentary rock formation is overlaid with an impermeable cap rock. While the geology of aquifers is similar to that of depleted production fields, their use in gas storage usually requires more base (cushion) gas and greater monitoring of withdrawal and injection performance.

Since the 1980s, the number of salt cavern storage sites developed in the United States has grown steadily, principally because of its unique capabilities and high cycling rate (inventory turnover).

The large majority of salt cavern storage facilities have been developed in salt dome formations located in the Gulf Coast States. Salt caverns leached from bedded salt formations in Northeastern, Midwestern, and Western States have also been developed, but the number has been limited due to a lack of suitable geology.

Cavern construction is more costly than depleted field conversion when measured on the basis of dollars per thousand cubic feet of working gas capacity, but the ability to perform withdrawal and injection cycles each year reduces the per-unit cost of each thousand cubic feet of gas injected and withdrawn.

Salt Domes

Salt Dome Formation

Salt Domes were created by an upwelling of evaporite (salt) deposits that exist beneath the ancient inland and coastal seas. These upwellings are known as “salt domes.”

A dome is a feature that has symmetrical anticlines and the outline on a map are usually circular or oval. The strata of rocks are up warped toward the center. A salt dome is a geologic formation formed when a thick bed of evaporite minerals (normally salt, or halite) from far below the Earth’s surface intrudes vertically into surrounding rock strata.

There are hundreds of known subsurface salt domes. However, just a handful breaches the surface.

Damon Salt Mound

The Damon Mound (Damon, Texas near Houston) is an example of an aboveground salt dome.

The Damon Mound salt dome has pushed its way up from the Jurassic Louann salt layer thousands of feet beneath the surface to create the mound, which is mostly made of ancient sea reef. It rises 80 feet above the surrounding the Texas coastal plain.

Avery Island, Louisiana - Profile

Avery Island, Louisiana is another aboveground salt dome. It is a forested hill, surrounded by salt marsh.

The caprock of the Avery Island site contains Pleistocene-age sediments where the remains of prehistoric mammals including mammals, mastodons, Harlan’s ground sloth, Jefferson’s ground sloth, horse, and bison have been excavated.

Avery Island is a huge dome of rock salt, three miles long and two and one-half miles wide. Avery Island is one of five salt domes islands that rise above the flat Louisiana Gulf Coast.

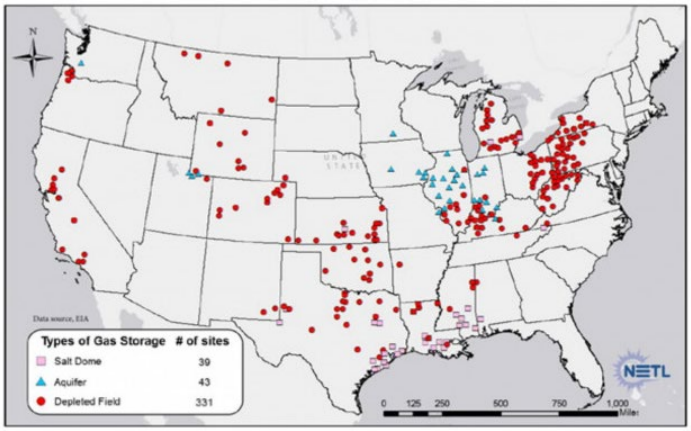
The five islands from the northwest to the southeast are Jefferson Island, Avery Island, Weeks Island, Cote Blanche Island, and Belle Isle.

Avery Island is a huge dome of rock salt, three miles long and two and one-half miles wide.

Satellite image- Avery Island, ca. 2010 (Source: Google Maps)

There are more than 400 underground storage sites in 27 states across the United States and Canada. Together, these sites can hold approximately 3 billion cubic feet of natural gas.

Storage acts as a buffer between the pipeline transporter and the distribution system, allowing distribution companies to serve their customers by withdrawing more gas from storage to meet demand during peak use periods.



US & Canada Storage Locations

Additionally, specific quantities of natural gas are sold on the spot market during off-peak periods. Access to underground gas storage reduces the time necessary for a delivery system to respond to increased gas demand. Storage allows continuous service, even when production or pipeline transportation services are interrupted.

Gas Storage Meter Tubes - Connected to Storage wells

Gas may also be super-chilled until it converts to a liquid (LNG – liquefied natural gas) for storage (in aboveground tanks) or transport, but this is very expensive.

Gas stored for physical and financial reasons:

Underground Storage by U.S. Region

At the close of 2007, 400 underground natural gas storage sites were operational in the United States. During the year, four new storage sites were added, one in Michigan, Mississippi, Pennsylvania, and West Virginia, while 18 existing storage fields underwent expansions, and two storage fields were abandoned (ceased operations).

Consequently, working gas capacity in the U.S. increased by 32 Bcf, to 4,091 Bcf (4,059 Bcf in 2006) while deliverability rates rose to 88.2 Bcf/d (85.1 Bcf/d in 2006). The largest expansion of working gas capacity (9.3Bcf) occurred at the Midland natural gas storage site in Kentucky, a depleted-reservoir facility. Depleted-reservoir storage accounted for about 89 percent of the 41 Bcf of new working gas capacity added in 2007.

The number, type, and profile of underground natural gas storage vary by region. Below is a brief overview of each of the six regions in the lower-48 States.

Central (49)
Midwest (121)
Northeast (110)
Southeast (34)
Southwest (66)
Western (20)
Overall (400)

Central Region

Underground natural gas storage in the Central Region is notable for several reasons. First, many of the 49 storage facilities located in the region are used to store excess production rather than to serve as a supply source for local markets. Production is stored to allow a stable flow rate despite temporary demand fluctuations.

Second, the region has the Nation's largest storage site, the Baker/Cedar Creek Field in Montana, with a total capacity of 287 billion cubic feet (Bcf) and a working gas capacity of 164 Bcf. The total regional working gas storage capacity (approximately 557 billion cubic feet) is 14 percent of the U.S. total, while daily deliverability from storage is only 6.2 billion cubic feet per day or 7 percent of the U.S. total.

Central Region -- Underground Natural Gas Storage, by State and Reservoir Type, Close of 2007

Region/ State	Depleted Gas/Oil Fields			Aquifer Storage			Salt Cavern Storage			Total		
	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)
Central Region												
Colorado	8	42	1,088	0	0	0	0	0	0	8	42	1,088
Iowa	0	0	0	4	77	1,060	0	0	0	4	77	1,060
Kansas	18	116	2,418	0	0	0	1	1	0	19	117	2,418
Missouri	0	0	0	1	11	350	0	0	0	1	11	350
Montana	5	196	310	0	0	0	0	0	0	5	196	310
Nebraska	1	16	169	0	0	0	0	0	0	1	16	169
North Dakota	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
South Dakota	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Utah	1	51	427	2	1	100	0	0	0	3	52	527
Wyoming	7	45	227	1	1	75	0	0	0	8	46	302
Total Sites	40	466	4,639	8	90	1,585	1	1	0	49	557	6,224
(Marginal Sites)[1]	(5)	(2)	(186)	(0)	(0)	(0)	(1)	(1)	(0)	(6)	(3)	(186)
Percent of U.S.	12	13	7	19	23	19	3	1	0	12	14	7

[1] **Marginal sites: very little or no activity reported during the 2007 calandar year. Marginal sites included in State/Regional total.**

Note: Bcf = Billion cubic feet. MMcf = Million cubic feet. States with no underground storage facilities are shown in *Italics*.

Source: Energy Information Administration, Gas Transportation Information System, December 2008.

The Baker/Cedar Creek Field, owned and operated by the Williston Basin Interstate Pipeline Company, serves as support infrastructure for the natural gas that is produced in association with oil production in the area. With an estimated peak-day withdrawal rate of about 134 million cubic feet per day, the flow from this storage field is directed primarily to interconnections with the Northern Border Pipeline Company system between North and South Dakota. In recent years, however, the Baker field has not been heavily utilized due to a decrease in production from nearby associated-gas fields.

Storage facilities in Kansas, specifically in the southeastern portion of the region, provide service to the interstate pipeline systems that move natural gas to the Midwest Region, but they are also integral to regional requirements. For instance, about 35 percent of the State's working gas storage capacity of approximately 118 billion cubic feet is owned and operated by Southern Star Central Gas Pipeline Company, which is primarily a regional interstate pipeline.

About 96 percent of the storage capacity in Kansas is available to customers and shippers on other interstate trunklines, while the remaining 4 percent is devoted to local distribution and production field service. About 40 percent of the daily peak-day storage deliverability in the State, or 967 million cubic feet per day, is available to the two interstate pipeline companies traversing the region, Northern Natural Gas Company and Panhandle Eastern Pipe Line Company.

Storage facilities in the rest of the region serve primarily as seasonal supply sources for

local markets. Storage fields in Utah provide service to shippers on the Questar Pipeline Company system as well as to customers within the Salt Lake City area. The storage fields in Colorado and portions of Wyoming service the Denver area through the Colorado Interstate Gas Company system. The local distribution companies serving these markets account for about 16 percent of the total storage deliverability in the region.

Midwest Region

Many of the pipelines serving the region also provide their shipper/customers with access to a large amount of underground storage capacity located in Illinois, Indiana, Michigan, and Ohio. The Midwest Region has 121 sites, the largest number in the country.

Midwest Region -- Underground Natural Gas Storage, by State and Reservoir Type, Close of 2007

	Depleted Gas/Oil Fields			Aquifer Storage			Salt Cavern Storage			Total		
Region/ State	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)
Midwest Region												
Illinois	11	52	832	18	249	5,304	0	0	0	29	301	6,136
Indiana	10	14	261	12	20	526	0	0	0	22	34	787
Michigan	43	641	16,786	0	0	0	2	2	85	45	643	16,871
Minnesota	0	0	0	1	2	60	0	0	0	1	2	60
Ohio	24	220	4,670	0	0	0	0	0	0	24	220	4,670
Wisconsin	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total Sites	88	927	22,549	31	271	5,890	2	2	85	121	1,200	28,524
(Marginal Sites)[1]	(10)	(8)	(258)	(2)	(4)	(108)	(0)	(0)	(0)	(12)	(12)	(366)
Percent of U.S.	27	26	34	72	69	70	6	1	1	30	29	32

[1] **Marginal sites: very little or no activity reported during the 2007 calendar year. Marginal sites included in State/Regional total.**

Note: Bcf = Billion cubic feet. MMcf = Million cubic feet. States with no underground storage facilities are shown in *Italics*.

Source: Energy Information Administration, Gas Transportation Information System, December 2008.

Of all six regions, this region has the largest volume of underground (working gas) storage capacity (almost 1.2 trillion cubic feet (Tcf)) and daily deliverability (28.5Bcf/d) from storage. These levels account for about 30 percent of the U.S. total in each category. Regional intrastate pipelines and/or local distribution companies, such as Northern Illinois Gas Company (NICOR), control about 61 percent of daily deliverability from storage in this region.

In Illinois, 50 percent of the daily deliverability from storage is integrated into three pipeline or distribution systems: Northern Illinois Gas Company, Illinois Power Company, and Central Illinois Public Service Company. Northern Illinois Gas Company also provides access to part of its working gas storage to support shippers using the regional Chicago natural gas market center.

The Great Lakes Gas Transmission Company and the ANR Pipeline Company systems both use Michigan storage facilities extensively to support their shippers' needs. In the first case, the Great Lakes Transmission Company system transports most of its volume eventually to markets in Ontario, Canada, but it uses storage sites located in Michigan to store supplies shipped for Canadian customers during the summer, providing withdrawal and delivery services during winter peak periods. ANR Pipeline Company and its affiliate ANR Storage Company together operates 15 sites in the State, while other storage operators in the State include the MichCon Gas Company (four sites), the Michigan Gas Storage Company (three sites), and its parent Consumers Energy Company (14 sites).

Elsewhere in the Midwest Region, Consumers Energy Company, with 14 sites in Michigan, is the single largest LDC operator of underground storage fields in the lower 48 States. Its sites have overall deliverability of more than 4.0 Bcf/d and a working capacity of 140 Bcf. Trailing closely is the Northern Illinois Gas Company, which operates eight natural gas storage facilities in Illinois with a total daily deliverability level of 3.1 Bcf/d but with a total working gas capacity level of more than 152 Bcf.

Northeast Region

The States of Pennsylvania and New York are the key transit areas for gas deliveries within the region and include the major service territories of Dominion Transmission Company and Columbia Gas Transmission Company systems. These States, along with West Virginia, also have the largest underground storage capacity in the region. Storage is essential as a supply backup and for balancing gas supplies on the pipelines operating in the region. More pipeline capacity exits these States than enters, reflecting their storage capacity as a seasonal supply source for the States to the north and east.

Northeast Region -- Underground Natural Gas Storage, by State and Reservoir Type, Close of 2007

	Depleted Gas/Oil Fields			Aquifer Storage			Salt Cavern Storage			Total		
Region/ State	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)
Northeast Region												
Connecticut	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Delaware	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Maine	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Maryland	1	17	400	0	0	0	0	0	0	1	17	400
Massachusetts	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
New Hampshire	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
New Jersey	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
New York	23	116	1,696	0	0	0	1	1	145	24	117	1,841
Pennsylvania	50	406	8,615	0	0	0	0	0	0	50	406	8,615
Rhode Island	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Vermont	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Virginia	1	1	20	0	0	0	2	4	325	3	5	345
West Virginia	32	251	4,002	0	0	0	0	0	0	32	251	4,002
Total Sites	107	791	14,733	0	0	0	3	5	470	110	796	15,203
(Marginal Sites)[1]	(7)	(31)	(43)	(0)	(0)	(0)	(0)	(0)	(0)	(7)	(31)	(43)
Percent of U.S.	33	22	22	0	0	0	10	3	3	28	19	17

[1] Marginal sites: very little or no activity reported during the 2007 calandar year. Marginal sites included in State/Regional total.

Note: Bcf = Billion cubic feet. MMcf = Million cubic feet. States with no underground storage facilities are shown in *Italics*.

Source: Energy Information Administration, Gas Transportation Information System, December 2008.

The largest storage operators in the Northeast are also three of the largest pipeline companies in the region. Columbia Gas Transmission Company operates 22 storage facilities (out of 110 within the region), with a working gas storage capacity of 138 Bcf (out of a total 796 Bcf). Although Dominion Transmission Company operates only 15, its facilities have the largest amount of working gas capacity in the region, 413Bcf. National Fuel Gas Supply Company operates the largest number of storage facilities in the region, 31, but its storage fields are only capable of storing up to 106 Bcf of working gas.

(Note: The peak-day deliverability from LNG in the region, 5.1 Bcf per day, is 33 percent as large as the total daily deliverability from underground storage facilities. This backup capability is incorporated into the operations of the regional network and is used to meet the rapid increases in demand that can occur because of sudden temperature changes in the region. Three of the eight currently active LNG importing facilities in the U.S. are located in the Northeast Region, the Cove Point LNG Company facility, located on the eastern shore of Maryland, the Northeast Gateway LNG Terminal located 16 miles offshore of Massachusetts and the DistriGas Company's Everett LNG facility located outside of Boston, Massachusetts.)

Southeast Region

The Texas Gas Transmission Company is the only long-haul natural gas pipeline system that retains a large portion of its deliverability for regional service, primarily in Kentucky. Slightly over 50 percent of its deliverability is within the region. This pipeline company also provides its shippers access to five company-owned underground storage facilities with a working gas capacity of more than 80 Bcf, or about 66 percent of the total working gas capacity in the State of Kentucky (and 45 percent of the regional total).

Southeast Region -- Underground Natural Gas Storage, by State and Reservoir Type, Close of 2007

	Depleted Gas/Oil Fields			Aquifer Storage			Salt Cavern Storage			Total		
Region/ State	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)
Southeast Region												
Alabama	1	8	300	0	0	0	1	7	600	2	15	900
Florida	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	0	0
Georgia	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	0	0
Kentucky	20	89	1,792	3	7	68	0	0	0	23	96	1,860
Mississippi	5	51	1,048	0	0	0	3	32	3,022	8	83	4,070
North Carolina	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	0	0
South Carolina	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0	0	0
Tennessee	1	1	20	0	0	0	0	0	0	1	1	20
Total Sites	27	149	3,160	3	7	68	4	39	3,622	34	195	6,850
(Marginal Sites)[1]	(4)	(2)	(24)	(0)	(0)	(0)	(0)	(0)	(0)	(4)	(2)	(24)
Percent of U.S.	8	4	5	7	2	1	13	23	26	9	5	8

[1] Marginal sites: very little or no activity reported during the 2007 calendar year. Marginal sites included in State/Regional total.

Note: Bcf = Billion cubic feet. MMcf = Million cubic feet. States with no underground storage facilities are shown in *Italics*.

Source: Energy Information Administration, Gas Transportation Information System, December 2008.

That level of storage service is equivalent to about 80 percent of the total daily capacity of Texas Gas Transmission Company's lines moving north into Indiana. These storage facilities are also in close proximity to the ANR Pipeline Company system, which traverses the State of Kentucky to Indiana and Michigan. Combined, Texas Gas Transmission Company and ANR Pipeline Company have the capacity to move 3.0 Bcf per day north into Indiana.

In addition to the conventional underground storage facilities located in the northern portion of the region, a number of high-deliverability (salt cavern) storage sites have been built during the past decade in the southern portion to better serve a restructured U.S. natural gas pipeline industry. Four such sites are now located in Mississippi (three) and Alabama (one), with several more planned. The availability of these sites has made these two States a prime market for the type of storage services needed by shippers with high upstream demand swings and local load balancing requirements. These sites are used by customers and shippers doing business on Florida Gas Transmission Company, Gulf South Pipeline Company, Tennessee Gas Pipeline Company, Transcontinental Gas Pipeline Company, and Southern Natural Pipeline Company systems.

Southwest

Underground natural gas storage plays a vital role in the efficient export and transmission of natural gas from the Southwest to other regions, as well as in supplementing regional needs. Its 66 underground storage facilities represent 1,030 Bcf of working gas capacity and an estimated daily deliverability level of 23.2 million cubic feet.

Only the Midwest Region has more working gas capacity and daily deliverability from storage. A large portion of regional storage is near production fields and is used to balance production flows with fluctuating market demand. In recent years, however, an increasing amount of the area's storage capacity is being developed and used to support regional natural gas market center/hub operations. It is also being used as high-deliverability storage (from salt-caverns) to serve the growing number of variable-load customers, such as gas-fired power plants, that are emerging in the region and which have a need for rapid access to stored natural gas working gas.

Southwest Region -- Underground Natural Gas Storage, by State and Reservoir Type, Close of 2007

Region/ State	Depleted Gas/Oil Fields			Aquifer Storage			Salt Cavern Storage			Total		
	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)
Southwest Region												
Arkansas	2	15	231	0	0	0	0	0	0	2	15	231
Louisiana	8	286	3,965	0	0	0	7	48	3,165	15	334	7,130
New Mexico	2	54	375	0	0	0	0	0	0	2	54	375
Oklahoma	13	194	3,772	0	0	0	0	0	0	13	194	3,772
Texas	20	365	5,334	0	0	0	14	78	6,361	34	443	11,695
Total Sites	45	914	13,677	0	0	0	21	126	9,526	66	1,040	23,203
(Marginal Sites)[1]	(8)	(30)	(184)	(0)	(0)	(0)	(1)	(4)	(0)	(9)	(34)	(184)
Percent of U.S.	14	26	21	0	0	0	68	73	70	17	25	26

[1] Marginal sites: very little or no activity reported during the 2007 calandar year. Marginal sites included in State/Regional total.
Note: Bcf = Billion cubic feet. MMcf = Million cubic feet.
Source: Energy Information Administration, Gas Transportation Information System, December 2008.

The States of Louisiana and Texas have more salt-cavern natural gas storage facilities (21) than anywhere else in the United States, of which almost half are owned/operated by independent storage operators. In fact, one-fifth of the working gas capacity and one-third of the daily deliverability available in the region is operated by independents.

About 35 percent of the region's daily storage deliverability remains with interstate pipeline companies, while the rest is operated by LDCs (33 percent) or intrastate pipeline companies (32 percent). All of the interstate pipeline-owned storage and most of the independently-owned storage is open access, that is, working gas storage capacity that is available to shippers/customers on a first-come, first-served basis at nondiscriminatory rates. The remainder is reserved for system or pipeline use, such as load balancing operations.

While only about a third of the region's storage capacity is owned by LDCs and used exclusively for local service, regional distributors also have access to and use interstate and independent storage facilities. Most of the LDC-owned storage is near major industrial and population centers and has little impact upon the interstate pipeline network in the area. In Texas and Oklahoma, approximately 40 percent of underground storage capacity is at facilities operated by LDCs or intrastate pipeline companies, whereas in Arkansas, all of the storage capacity is controlled by local operators.

Western Region

Underground natural gas storage facilities are found in only half of the states in the region, California, Oregon, and Washington. Moreover, approximately 88 percent of the region's working gas capacity is located in California's 12 underground natural gas storage sites, seven of which are owned by the two principal gas distributors in the State, Southern California Gas Company (SoCal) and Pacific Gas and Electric Company (PG&E). Most of their storage capacity is used for system balancing and as a way of maintaining a steady and high-utilization of pipeline capacity directed from Canada and the Southwest.

The five independent storage facilities in California are used primarily as depositories for gas produced within the State that is not immediately marketable. In addition, these sites are connected to and deliver their withdrawals to the Southern California Gas Company and/or Pacific Gas and Electric.

Western Region -- Underground Natural Gas Storage, by State and Reservoir Type, Close of 2007

Region/ State	Depleted Gas/Oil Fields			Aquifer Storage			Salt Cavern Storage			Total		
	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)
Western Region												
Arizona	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
California	12	266	6,875	0	0	0	0	0	0	12	266	6,875
Idaho	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Nevada	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Oregon	7	15	497	0	0	0	0	0	0	7	15	497
Washington	0	0	0	1	22	850	0	0	0	1	22	850
Total Sites	19	281	7372	1	22	850	0	0	0	20	303	8,222
(Marginal Sites)[1]	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Percent of U.S.	6	8	11	2	6	10	0	0	0	5	7	9

[1] Marginal sites: very little or no activity reported during the 2007 calandar year. Marginal sites included in State/Regional total.
Note: Bcf = Billion cubic feet. MMcf = Million cubic feet.
Source: Energy Information Administration, Gas Transportation Information System, December 2008.

Storage facilities in Washington and Oregon are used primarily to provide seasonal backup to several LDCs located in the northwest and are crucial in maintaining their operational flexibility and system integrity. These storage facilities are also used by some Canadian shipper/customers to support their marketing and operational needs. The import/export facilities of the Northwest Pipeline Company at Sumas, Washington, are used to move natural gas in either direction to the storage, depending on marketing conditions.

Overall

Total U.S. working gas capacity and daily deliverability at the beginning of 2008 reached 4.1 Tcf and 88.2 Bcf per day, respectively. Four hundred underground natural gas storage facilities were operational in the lower 48 States, although 38 were marginal operations that reported little or no activity during 2007. The number of operational underground natural gas storage facilities peaked in 2001 at 418.

In almost all operational aspects, the underground natural gas storage profile of the Midwest Region is larger than that of any of the other five regions. The prevailing cold winters, large population centers, large natural gas pipeline systems, and available geology, have all contributed to major storage development in the region over the past century. The Southwest Region, on the other hand, with its large natural gas production levels and the presence of many large salt-formations, is the second-largest source of working gas capacity and daily deliverability in the lower 48 States.

Summary of Underground Natural Gas Storage, by Region and Reservoir Type, Close of 2007

	Depleted Gas/Oil Fields			Aquifer Storage			Salt Cavern Storage			Total		
Region	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)	Sites	Working Gas Capacity (Bcf)	Daily Withdrawal Capability (MMcf)
Central	40	466	4,639	8	90	1,585	1	1	0	49	557	6,224
Midwest	88	927	22,549	31	271	5,890	2	2	85	121	1,200	28,524
Northeast	107	791	14,733	0	0	0	3	5	470	110	796	15,203
Southeast	27	149	3,160	3	7	68	4	39	3,622	34	195	6,850
Southwest	45	914	13,677	0	0	0	21	126	9,526	66	1,040	23,203
Western	19	281	7372	1	22	850	0	0	0	20	303	8,222
Total U.S.	326	3,528	66,130	43	390	8,393	31	173	13,703	400	4,091	88,226
(Marginal Sites)[1]	(34)	(73)	(695)	(2)	(4)	(108)	(2)	(5)	(0)	(38)	(82)	(803)

[1]Marginal sites: very little or no activity reported during the 2007 calandar year. Marginal sites included in State/Regional total.

Note: Bcf = Billion cubic feet. MMcf = Million cubic feet.

Source: Energy Information Administration, Gas Transportation Information System, December 2008.

Natural Gas Markets

Historically, pipelines were the main merchants who bought gas from producers, transported and stored the gas and resold the gas to LDCs at the city-gate.

In 1993 the market was deregulated, and the marketplace changed significantly (FERC Order 636). Pipelines no longer buy and sell but only provide transportation and storage services.

Customers (and this may be an LDC on behalf of their customers) are responsible for finding a gas supply for purchase and then arrange for transportation and storage as needed.

There are two basic markets in the natural gas industry – Physical and Financial:

Physical: The commodity is produced, transported, and sold. Physical gas is exchanged for money.

Compressor Station Pipe Yard

Physical Gas is transported primarily in large diameter pipelines – sometimes over very long distances (for example, offshore Gulf Coast gas moves to East Coast markets). The owner of the gas is responsible for arranging transportation services from an intrastate or interstate pipeline.

There are two basic transport services:

Firm: premium service, more expensive, “guaranteed” availability

Interruptible: available on first-come, first-served basis, like flying "standby."

Points of Sale/Exchange include:

Wellhead: production is sold “as is” or after processing to purify the gas stream

Pipeline Interconnects: locations where two pipelines physically connect

Pipeline Pooling Points: aggregation location (could be physical or “paper”)

Pipeline Rate Zone Boundary: many pipelines have rate boundaries whereby crossing a boundary incurs additional transportation cost

Local Distribution Company (LDC) City-Gate: location where LDC and Pipeline interconnect

Financial: Natural gas is a commodity and futures, and derivatives contracts are traded on financial exchanges such as NYMEX (New York Mercantile Exchange).

Market Trading Floor

New York Mercantile Exchange

NYMEX Futures

Most futures transactions do not result in the physical exchange of gas. Futures contracts are used for speculation (betting the price will move in a direction) and to hedge (lock in a price) for a future buy or sell Options, Swaps; Derivatives are like another type of publicly traded commodities.

Basic Futures contracts are in quantities of 10,000 MMBtu (Dth), and are the price is per MMBtu (Dth). The official physical location to clear contracts (exchange the contract for physical gas) is pricing at the Henry Hub in South Louisiana (Erath, Louisiana).

Physical: since natural gas is used primarily for home heating and cooling, there are times during the year where physical supply is insufficient to meet demand. Gas is stored in off-peak seasons for future delivery.

Financial: Gas may be stored because the owner believes that it will be worth more at a future time. For this to occur, the current price plus the cost of storage would need to be less than the expected future price.