



Everything You Wanted to Know about Natural Gas Storage but Were Afraid to Ask

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David A. Pursell
dpursell@pickeringenergy.com
713-333-2962

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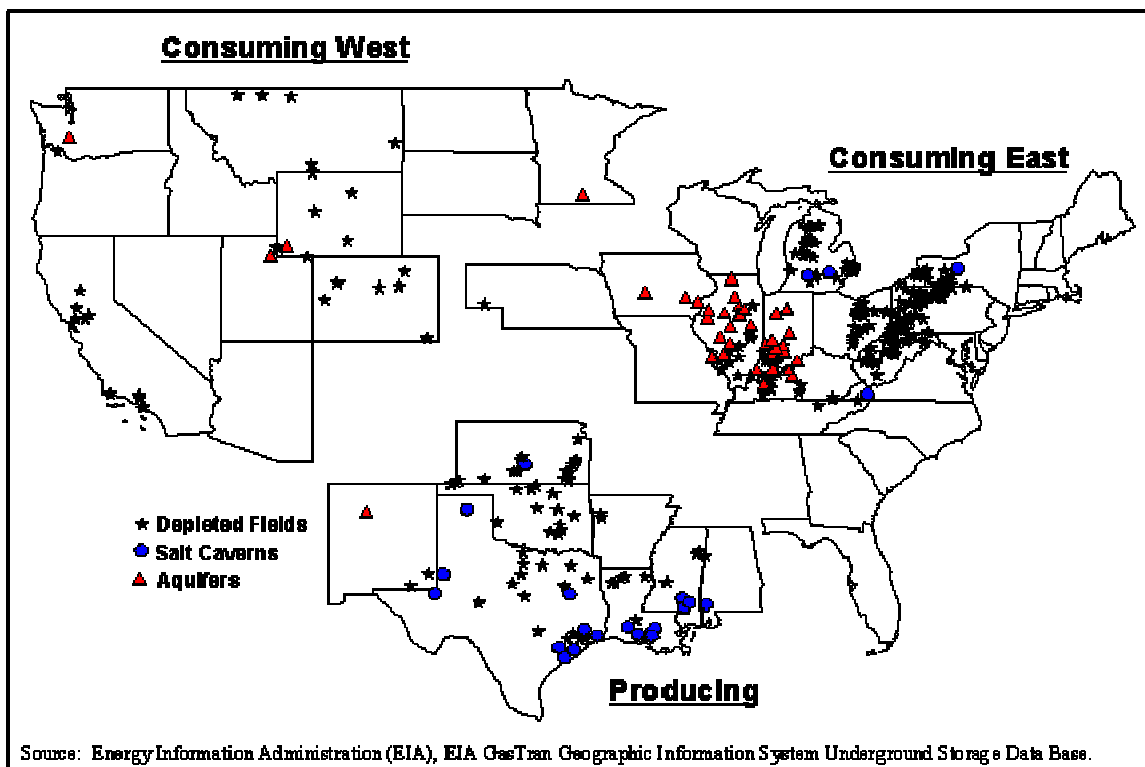
Summary

With gas storage at record levels, investors are asking questions about storage operations. This report is our attempt to address the most commonly asked questions and to provide some background information on the U.S. storage system.

Total gas storage capacity has increased ~150bcf in the past several years. **We believe useable storage capacity is between 3,400 and 3,500bcf**, well below nameplate capacity of 4,050bcf.

The U.S. does not currently need more storage capacity to meet demand. Total U.S. demand has been essentially flat over the past five years while working gas capacity and peak deliverability have increased.

Forced withdrawals from storage in March/April will not result in gas-on-gas competition in the near term (if we lost you with “forced withdrawals” and “gas-on-gas competition”, further explanation on pages 10 and 13). With ample capacity and an efficient market, any forced storage withdrawals will be re-injected elsewhere. Gas-on-gas competition is a risk later in the injection season when storage levels approach “full”.



Key Points

This report is written as a series of questions and answers, which are summarized below. *The body of the report contains more thorough “answers” and background information.*

1. What is “useable” storage capacity?

3,400 to 3,500bcf...well below name plate capacity of 4,050bcf.

2. Has total storage capacity increased?

Yes, about 150bcf in the past several years.

3. Who injects gas into storage?

Pipelines, LDC’s, independent providers and gas marketers.

4. Are there different types of gas storage?

Depleted oil/gas fields are the most common and typically located in the Northeast. Salt caverns are the most operationally flexible and located in the Gulf Coast.

5. What is the difference between these types of storage?

Salt caverns are more operationally flexible and have high deliverability. Depleted reservoirs and aquifers are generally less flexible and have lower deliverability.

6. What happens when storage capacity fills?

Storage injection is more difficult, pipes pressure up and producers are forced to shut in some production. Although not common, this can occur late in the injection season (October).

7. With current record storage levels, do forced winter withdrawals mean there will be gas-on-gas competition in March/April?

No – Forced withdrawals in March/April will not crater the gas market, but *will* maintain the steep contango in the futures market.

8. Does the degree of contango in the natural gas forward curve determine the amount of gas injection?

Not necessarily...but it does influence the end-of-season storage levels.

9. With gas demand increasing, don’t we need more storage capacity?

No, natural gas demand has been flat for five years. Meaningful increases in storage are not required.

Confused with the terminology? See Appendix A for Glossary.

1. What is “useable” storage capacity?

With increases in total rated storage capacity in recent years, we believe useable working gas capacity is between **3,400bcf and 3,500bcf**, an increase of ~150bcf in the past three years. “Useable” working gas capacity is well below “nameplate” capacity of 4,050bcf.

For example, in the fall of 2001, storage levels exceeded **3,250bcf** and some pipelines curtailed E&P companies’ production due to increased pipeline pressure as storage fields approached full (see Question #6). This occurred well below nameplate working gas capacity of ~4,000bcf.

As we discuss in Question #8, in recent years there has been a large economic incentive to store gas during the summer via contango in the forward curve (i.e., summer gas prices well below winter gas prices). *Maximum working gas of 3,326bcf was seen in 2004...suggesting useable capacity is well below 4,000bcf.* The market simply could not inject more gas to take advantage of the significant economic incentive.

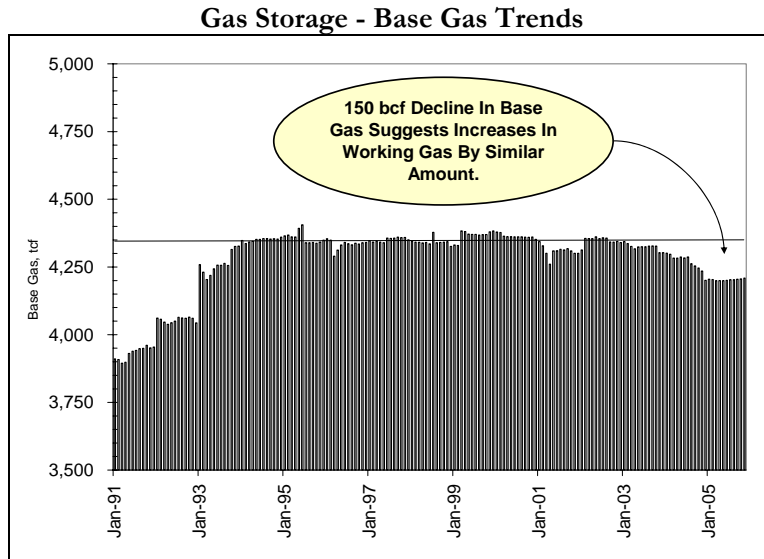
System injectivity is greatly decreased as storage fills. Imagine putting air in a flat tire. As the tire fills, each extra amount of air takes much more effort to inject. The same is true in gas storage reservoirs. Examples:

- *Fall 2001:* Storage levels exceeded 3,250bcf and there were widespread occurrences where pipelines curtailed E&P company deliveries/production, because line pressures in storage fields were too high (could not push gas into the tire...to use our prior analogy).
- *2004 Storage Injection:* A dramatic economic incentive to inject gas was present as the forward curve had significant contango (~\$1/mcf spread between summer and winter). Storage finished the year at ~3,325bcf, well below nameplate capacity – the market simply could not inject more gas.

2. *Has total storage capacity increased?*

Yes – we think storage capacity has increased ~150bcf in the past few years through improving the effectiveness of existing storage facilities and addition of new storage facilities (based on DOE data). Increased working gas has been achieved through improved efficiency of existing storage fields and the addition of new salt cavern storage sites.

Base gas decline in recent years supports this thesis. Some of the base gas declines occurred as a few marginal storage fields were taken out of service...but the majority is reclassification to working gas. This reclassification is achieved as storage operators improve the efficiency of wells and surface facilities of existing storage fields.



Source: DOE and Pickering Energy Partners, Inc.

3. *Who injects gas into storage?*

Owners and operators of gas storage are:

Interstate pipeline companies - use gas storage to facilitate load balancing on their interstate transmission systems as well as supply energy demand of end use customers.

Local distribution companies (“LDC’s”) - utilize gas storage to meet customer needs directly. The LDC controlled storage fields will typically be located near the end-user consumption.

Independent providers - own or operate ~10% of current working gas capacity. Many high deliverability storage facilities (salt caverns) have been developed by independent storage operators.

Gas marketers - may not own or operate the physical storage facility, but may have access to storage capacity per FERC open access regulations.

It is important to point out that few (if any) entities in the gas storage market are speculating on the price of natural gas. Interstate pipelines and LDC’s are **price insensitive**. They can pass on the cost of gas in storage to their customer base. Independent providers and marketers are also **price insensitive**...they only inject and withdraw gas based on the economic incentive of the futures prices (see Question #8).

Data on working gas in storage is provided regionally by the DOE. LDC-controlled storage is often leased to gas marketers under open access provisions, which makes it impossible to assess who exactly own/controls gas in storage at any point in time.

Generally, we think producing region (Gulf Coast) storage is typically controlled by independents/marketers due to high deliverability nature of the reservoirs (salt caverns). We believe storage in the East (east coast and mid-west) is generally controlled by LDCs/pipelines. The west is a more even mix of storage ownership.

Appendix B contains regional storage graphs.

4. Are there different types of gas storage?

Yes, there are three main types of storage (see question 5 for a detailed explanation).

- *Depleted oil/gas fields* – the most common storage, consisting of depleted oil/gas fields which have been converted to storage.
- *Salt Caverns* - provide the most operationally flexible storage reservoirs located mainly on the Gulf Coast.
- *Aquifer storage* – concentrated in the Midwest due to the absence of depleted oil/gas fields and salt cavern storage.

Regional Storage Breakdown

	Nameplate		
	Number of Sites	Working Gas Capacity, bcf	Peak Deliverability, bcf/day
East	284	2,174	40
West	39	659	10
Producing	96	1,209	32
Total	419	4,042	82

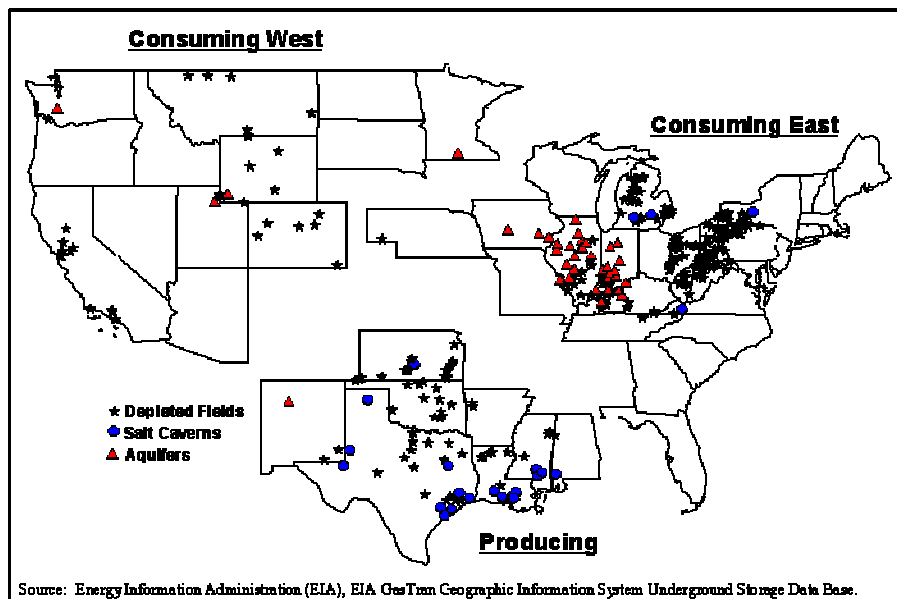
Sources: DOE and Pickering Energy Partners, Inc

Storage Breakdown by Reservoir Type

	Nameplate		
	Number of Sites	Working Gas Capacity, bcf	Peak Deliverability, bcf/day
Depleted Oil/Gas Reservoirs	351	3,510	58
Aquifers	42	400	9
Salt Caverns	26	132	15
Total	419	4,042	82

Sources: DOE and Pickering Energy Partners, Inc

- *Working gas capacity has increased ~150bcf in the past few years.*
- *Peak deliverability has also increased at least 4bcf/day during the past few years.*



5. *What is the difference between these types of storage?*

There are significant differences between the three types of storage:

Depleted natural gas/oil fields – the most common type of storage reservoir. 87% of nameplate capacity, 71% of peak deliverability

Advantages

- Widely available near demand centers.
- Low geologic risk as formations have previously trapped oil or gas and the potential for reservoir “leaks” is low.
- Storage fields can utilize existing wells, gathering systems, and pipelines.

Disadvantages:

- Typically have lower deliverability than salt caverns and aquifers.
- High base gas requirements....usually 1:1 ratio of base gas to working gas. Very expensive with ~\$8/mcf gas prices.

Salt Caverns – usually located in Gulf Coast salt dome formations; some salt bedded formations in the Northeast. 3% of nameplate capacity, 18% of peak deliverability

Advantages

- Highest deliverability storage reservoir (the most gas, the fastest gas).
- Flexible - can cycle gas more than once per season.
- Low base gas requirements.
- Reservoir integrity – salt caverns have excellent seals, which makes leaks unlikely.

Disadvantages:

- Higher capital cost per unit of working gas.
- Regionally located near supply centers in the Gulf Coast and far from winter demand in the Northeast and Midwest.

Aquifers – least desirable form of storage. Typically located in the Midwest due to lack of depleted reservoirs and salt caverns. 10% of nameplate capacity, 11% of peak deliverability

Advantages

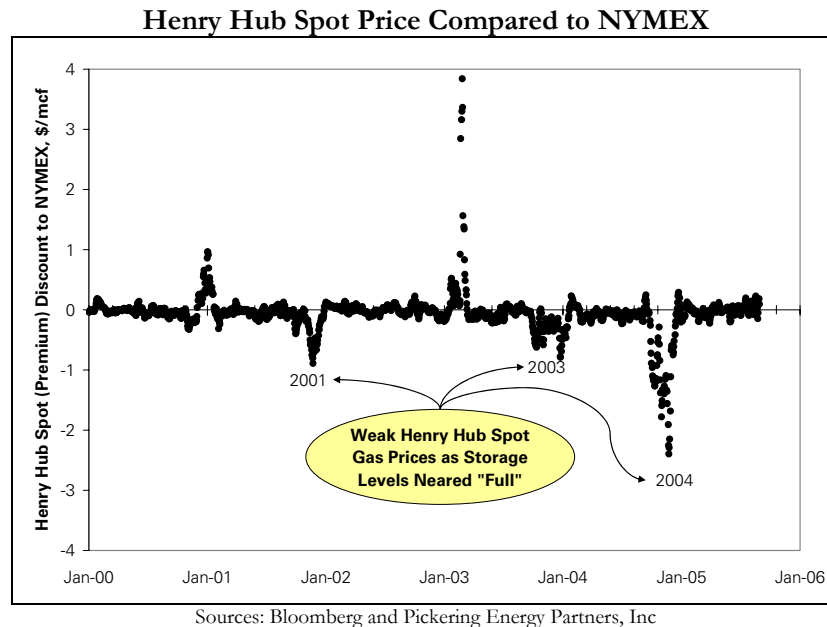
- High deliverability.
- Can be located near demand centers.

Disadvantages:

- Usually have water production associated with gas withdrawal, which increases operating costs.
- Reservoir “leaks” more common as formation seal less certain (aquifers have not trapped oil or gas in the past).
- High base gas requirements.
- Lower overall recovery of the base gas once field is ultimately depleted.

6. What happens when storage capacity fills?

As working gas in storage increases, the ability to inject natural gas into storage is diminished due to higher reservoir pressures. Towards the end of the injection season, as working gas volumes approach operationally full, some gas physically can not be injected. We previously used a flat tire analogy as a simple way to think about this situation. Pressure in interstate pipelines increases above acceptable levels and pipelines force E&P companies to curtail production. *Spot gas prices fall precipitously as there is temporarily nowhere for incremental gas to go.*



Bad news is good news. This situation of “full” storage causes weak natural gas prices when E&P companies experience physical curtailment. The good news...there is a maximum amount of gas that can be injected into storage (3,400 to 3,500bcf). With winter right around the corner, natural gas futures prices are usually not significantly impacted by weak fall shoulder period prices.

7. *With current record storage levels, do forced winter withdrawals mean there will be gas-on-gas competition in March/April?*

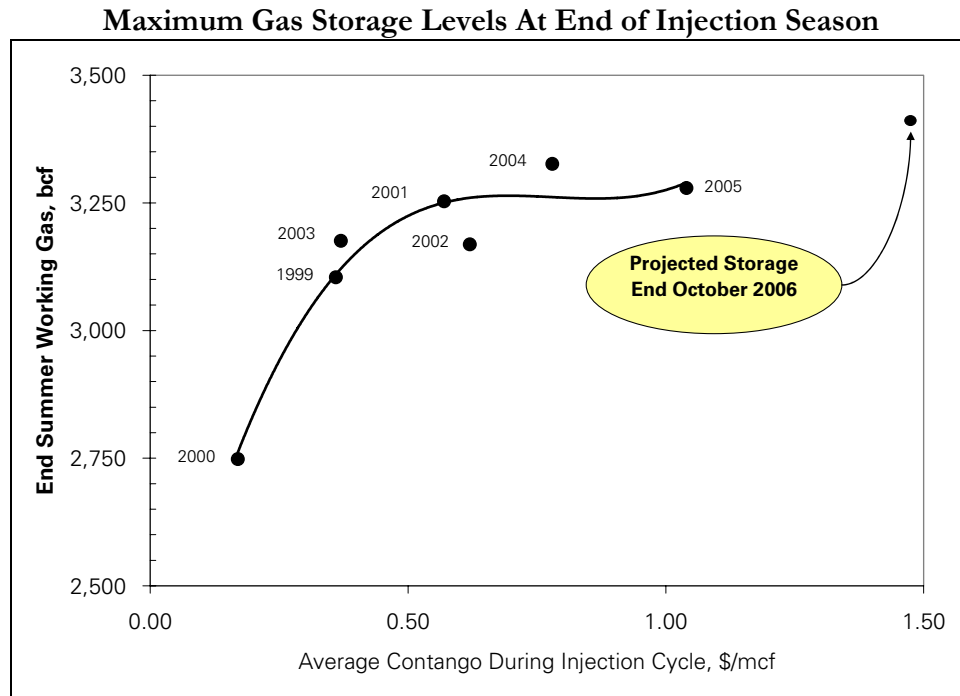
Not necessarily. Some storage reservoirs have scheduled gas withdrawal cycles 1) to maintain optimal reservoir performance in future injection/withdrawal cycles (mainly aquifers) and 2) to comply with regulatory issues. Some storage reservoir capacity is controlled by independent providers and gas marketers.

Any “forced turn” gas that enters the market creates injection opportunities for gas marketers. This opportunistic buyer purchases the “forced turn” gas, puts it back into the storage they control and captures the arbitrage presented by the contango between spot (cash) gas price and the higher NYMEX futures price in the winter months. This has already occurred this winter, as there have already been contra-seasonal net injections in the producing region (high % of marketer controlled storage).

Bottom Line: Forced withdrawals in March/April will not crater the gas market but will maintain the steep contango in the futures market.

8. Does the degree of contango in the natural gas forward curve determine the amount of gas injection?

The degree of contango drives the end-of-season storage levels. Large contango creates economic incentive to fill storage and results in a high end of season storage levels. Small contango does not provide economic incentives to store gas and results in low end-of-season storage levels.

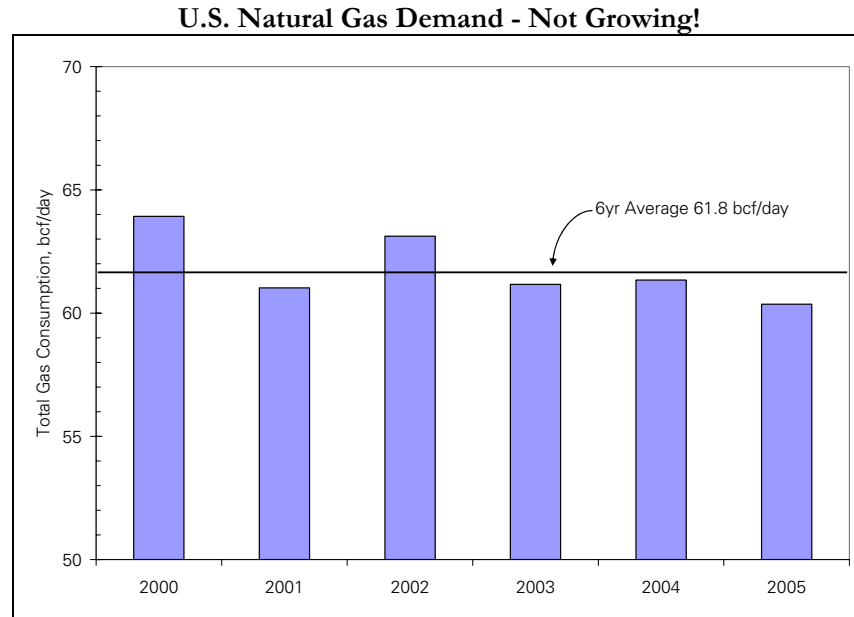


Sources: DOE, Bloomberg and Pickering Energy Partners, Inc

Maximum working gas in storage tends to peak once the storage arbitrage (winter vs. summer pricing) exceeds \$0.5/mcf. Even with increasing economic incentive to store in the 2004/2005 season, maximum storage levels did not significantly change. This analysis confirms that useable storage capacity is significantly below nameplate storage capacity (4,050bcf).

9. With gas demand increasing, don't we need more storage capacity?

The 1999 National Petroleum Council report “Meeting the Challenges of the Nation's Growing Natural Gas Demand” suggested U.S. gas consumption would grow from ~60bcf/day to 82bcf/day in 2010. This did not happen. Instead, demand has not grown materially over the past six years because 1) supply could not grow, forcing price to ration demand and 2) overly aggressive assumptions regarding the amount of future gas-fired power demand. *With demand growth stagnated by supply limitations, the system probably does not need a significant amount of new storage.*



However, the mix of demand has shifted slightly. Industrial demand has been impacted by high gas prices and residential/commercial demand (air conditioning in the summer and space heating in the winter) is less price sensitive. **The demand base is more weather sensitive** as some industrial demand has been “replaced” with weather sensitive demand.

The storage system has taken this into account with an increase in peak deliverability over the past few years (through new salt cavern storage fields). In 2001, the DOE estimated peak storage deliverability was 78bcf/day...we think the number today is **at least** 82bcf/day.

High capital costs are another reason gas storage capacity has not expanded at a faster pace. It is simply too expensive to develop depleted fields and/or aquifers. For example – to convert a 60bcf depleted gas field to storage, approximately 30bcf would be required for base gas and 30bcf for working gas. To fill the 60 bcf of gas at \$7/mcf would cost \$420mm and take ~3 years...with half the investment (\$210mm) that is not recovered until the storage field is abandoned (30+years). It takes a lot of contango and a lot of years to make this math work.

Appendix A - Storage Basics:

Backwardation – Future gas prices are lower than current prices, which usually occurs in the winter...providing economic incentive to empty storage to meet peak winter demand.

Base Gas - Permanent gas inventory in a storage reservoir that is required to maintain reservoir pressure and adequate deliverability throughout the withdrawal season. In a depleted gas field/acquifer, base gas can equal or exceed the amount of working gas. Base gas is sometimes referred to as cushion gas.

Contango – Future gas prices are higher than current prices which usually occurs in the summer...providing economic incentive to fill storage.

Deliverability – The rate at which natural gas can be drawn from storage. For a given storage reservoir, the deliverability depends on the reservoir pressure (or amount of base + working gas) and surface facility configuration. Typically, peak deliverability occurs when storage is full.

Deliverability Part II – Peak deliverability for a storage reservoir is usually not a critical design parameter. Deliverability during peak demand (January) and deliverability during March (when a late season cold spell when storage fields have low inventory and pressure) are more important design parameters.

LDC – Your local gas company.

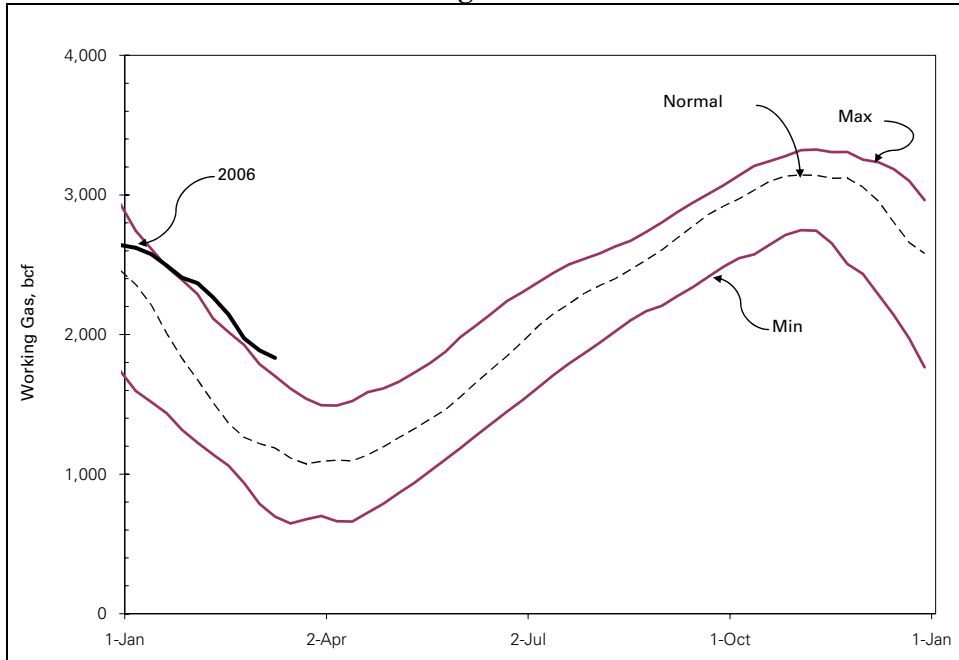
Total Capacity – is the maximum volume of gas that can be injected into a storage reservoir...determined by the physical characteristics of the reservoir. Total capacity is the sum of base gas and working gas.

“Useable” Working Gas – Working gas capacity is a “nameplate” value which is often not achievable because storage fields are often operated under non-optimal conditions. This explains why total “useable working gas” of ~3,400 bcf is well below nameplate capacity of 4,050bcf. The U.S. refining system is an example of this phenomena...nameplate capacity is >17mmopd but the system (on average) operates well below this level.

Working Gas – gas in the storage reservoir which is available for withdrawal...or the reservoir gas which is not base gas.

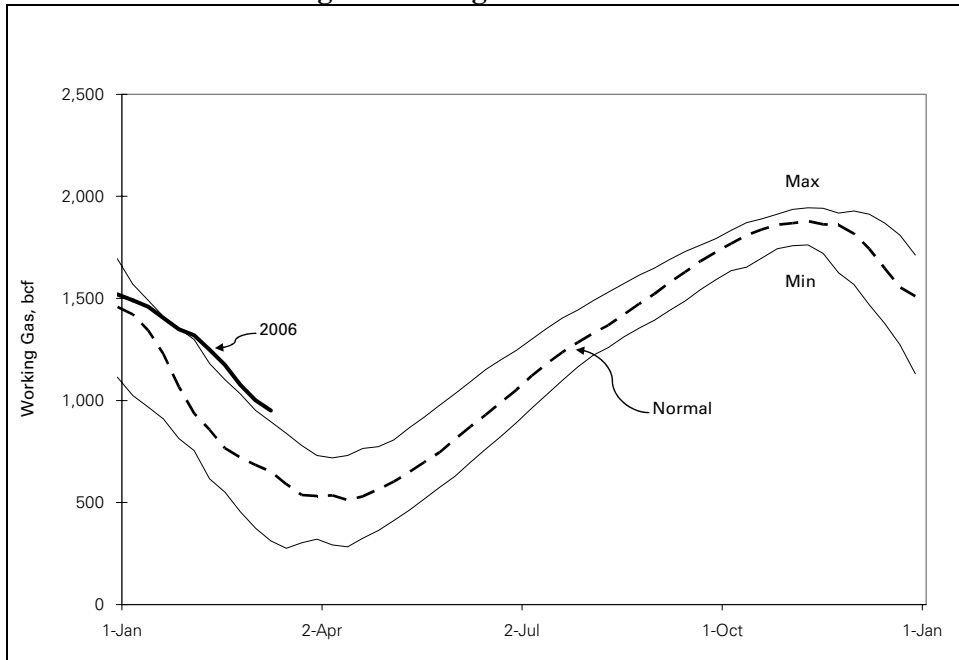
Appendix B - Working Gas Graphs By Region

U.S. Total Working Gas Seasonal Trends



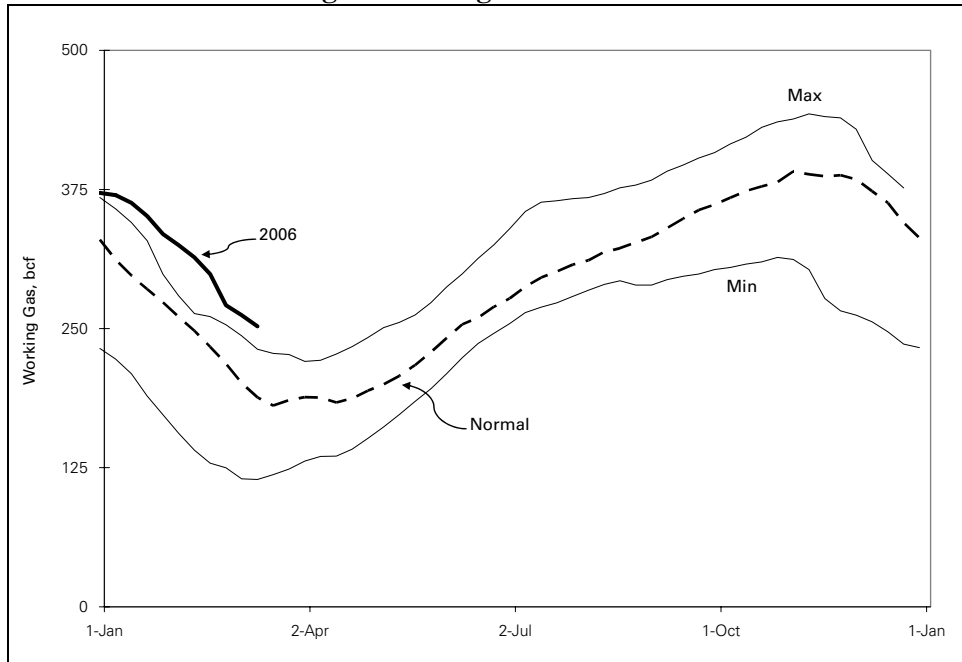
Sources: DOE and Pickering Energy Partners, Inc

East Region Working Gas Seasonal Trends



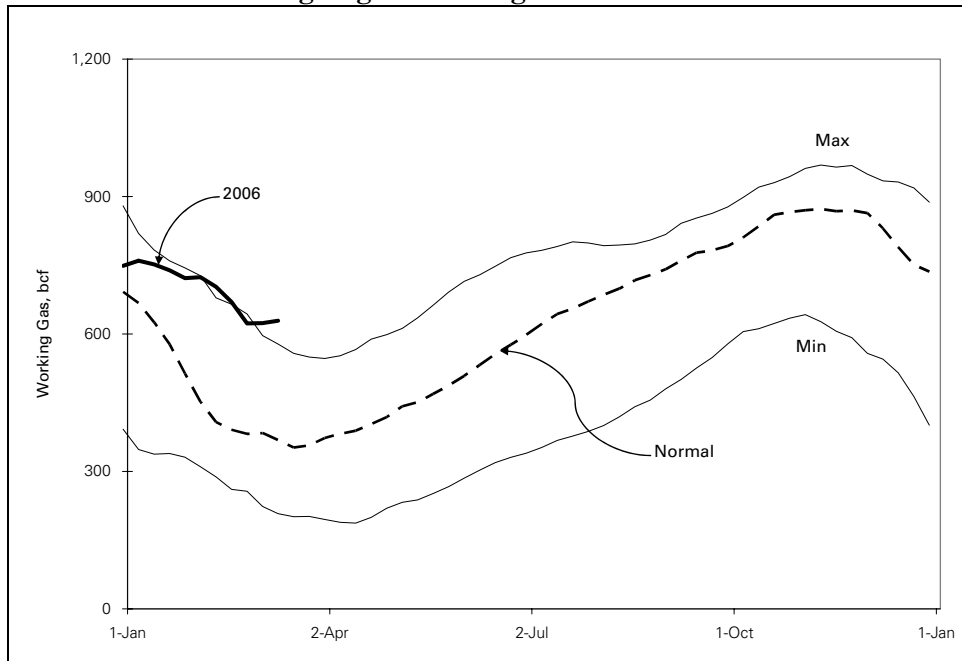
Sources: DOE and Pickering Energy Partners, Inc

West Region Working Gas Seasonal Trends



Sources: DOE and Pickering Energy Partners, Inc

Producing Region Working Gas Seasonal Trends



Sources: DOE and Pickering Energy Partners, Inc

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www.pickeringenergy.com

Institutional Research

Houston, TX
713 333-2960

New Orleans, LA
504-371-5563

Institutional Sales

Houston

Hance Myers
hmyers@pickeringenergy.com
713-333-2987

C. Paige DiMaggio
pdimaggio@pickeringenergy.com
713-333-2969

Mike Bradley
mbradley@pickeringenergy.com
713-333-2968

Lori Yentzen
lyentzen@pickeringenergy.com
713-333-2974

Denver

Chuck Howell
chowell@pickeringenergy.com
303-300-1902

Jon Mellberg
jmellberg@pickeringenergy.com
303-300-1995

Jason Foxen
jfoxen@pickeringenergy.com
303-300-1960

Trading Desk
800-507-2400

Michael du Vigneaud
mduvigneaud@pickeringenergy.com
713-333-2976

Matthew Pham
mpham@pickeringenergy.com
713-333-2977

Josh Martin
jmartin@pickeringenergy.com
713-333-2982

Email: info@pickeringenergy.com

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