

The Role of Natural Gas Storage in Maintaining Reliability of the Electric Power System

As natural gas provides an increasing percentage of the nation's electric power, growing from 18 percent in 2002 to 30 percent in 2012¹, the electric power system may become more vulnerable to certain types of reliability risks. Unlike other power generation sources such as coal, which typically stores 50–80 days' worth of fuel onsite, or nuclear, which refuels every 18–24 months, gas-fired power plants rely on just-in-time delivery of natural gas². Congestion and outages along natural gas pipelines and/or compressor stations that supply gas-fired electric generating units can cause service interruptions to those units. While it is different from on-site fuel storage, bulk natural gas storage facilities are vital to the reliability of the electric power system by providing a backup supply of natural gas near major pipelines and electric load centers, thereby partially alleviating gas-fired electric power generators' vulnerability to service interruptions.

Background

In the United States, geologic formations provide the primary means of bulk natural gas storage. Three types are used:

Depleted Natural Gas Field: This is typically the least expensive and most desirable type of storage to develop, because the storage viability of a depleted field is already proven. It is capable of holding large amounts of gas, the pipeline infrastructure is already in place, and it already contains the unrecoverable base gas needed in every storage facility.

Saline Aquifer: This formation can provide good storage capabilities. It is also the most expensive form of storage, requiring significant upfront investment to determine its storage suitability. To prepare a saline aquifer for use, surface infrastructure such as well drilling, piping, and compression facilities must be developed. Gas must also be injected initially to displace water in the formation. The initial gas injection is unrecoverable base gas and can account for up to 90 percent of the aquifer's total volume.

Salt Dome: This formation is developed by injecting fresh water into the cavern to dissolve the salt and then constructing the necessary surface infrastructure. It is typically much smaller than both a depleted field and a saline aquifer, but it provides greater flexibility in gas injection and withdrawal rates³.

These facilities are owned and operated by interstate and intrastate pipeline companies, local distribution companies, and independent storage operators. The gas held in storage may also be owned by the operator, but most of it is held in the storage facility under lease with shippers, local distribution companies, or end users⁴.



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Issues in Focus: Natural Gas and Electric Interdependencies

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Storage Capacity

The total gas storage capacity in domestic reservoirs is the sum of the “base gas” and “working gas.” The working gas is the volume of gas that is available to the market while the base gas is the minimum amount of gas that must remain in the reservoir for it to function.

The base gas storage requirement, reported in Table 1 as a percentage of a reservoir's total gas storage capacity, varies by storage type. This gas is not recoverable and constitutes the minimum amount of gas that must remain in the reservoir to maintain working pressures, permeability, and other critical storage parameters.

Table 1. Base Gas Requirements⁵

| Storage Type | Base Gas Requirement |
|----------------|----------------------|
| Depleted Field | 50% |
| Aquifer | 50%-90% |
| Salt Dome | 30% |

Over the last decade, total U.S. natural gas storage capacity has increased by 17 percent from just over 8 trillion cubic feet (TCF) to 9.35 TCF in 2014, as shown in Figure 1. It is projected to continue increasing during the short term, reaching nearly 9.6 TCF by 2016.

Figure 1. Total U.S. Natural Storage Capacity⁶

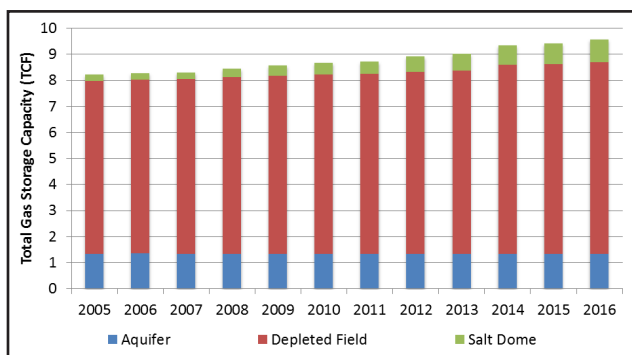
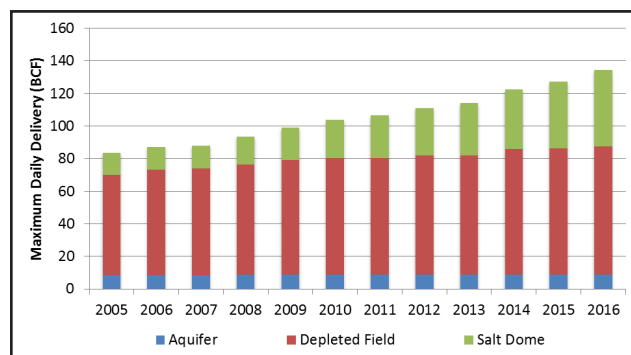


Figure 2. Maximum U.S. Daily Delivery from Storage⁸



Injection & Withdrawal Rates

The rate at which natural gas can be injected into, and withdrawn from, any type of storage varies by individual reservoir. As shown in Table 2, depleted fields and aquifers typically cycle once per year, whereas salt domes are much more flexible and can respond relatively quickly to meet changes in demand. Injections into aquifers and depleted fields occur during the warm months, when demand for gas is lowest, and withdrawals occur during the cold months, when demand for gas reaches its peak.

Table 2. Gas Injection/Withdrawal Periods⁷

| Storage Type | Injection Period (Days) | Withdrawal Period (Days) |
|-----------------------|-------------------------|--------------------------|
| Aquifer | 200 to 250 | 100 to 150 |
| Depleted Field | 200 to 250 | 100 to 150 |
| Salt Dome | 20 to 40 | 10 to 20 |

Salt domes are typically much smaller, on the order of 1/100th the size of a typical depleted field. Because of their small size and flexibility, salt domes operate as peaking facilities, as opposed to serving base load. Salt domes are able to deliver 8 percent of their working gas volumes in a day. Daily delivery rates for salt domes and aquifers are lower, at about 3 percent for both.

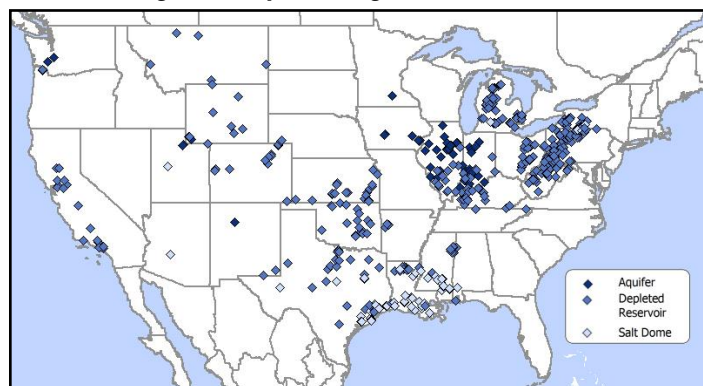
Total working gas volume daily delivery rates have increased by nearly 50 percent from 2005 to 2014, as shown in Figure 2, and are expected to increase another 8 percent through 2016. Although daily delivery volume has increased and is expected to continue increasing, the average percentage of working gas withdrawn on a daily basis for all types of storage has remained relatively consistent.

Potential Impact of Storage

The steady increase in the amount of natural storage capacity is a positive development for both the natural gas and electric power industries. Gas held in storage has the potential to improve the reliability of natural gas delivery to customers, which in turn improves the reliability of an electric power system that is increasingly dependent on natural gas.

However, continued growth is limited by the fact that, except in the form of liquefied natural gas (LNG), natural gas is primarily stored in geologic formations. For the most part, storage can only be added in areas where these formations naturally occur, which is not necessarily near the load centers where they are needed. Thus, while natural gas storage can play an important role in maintaining reliability of the electric power system, that role remains somewhat limited.

Figure 3. Map of Storage Facilities in U.S.



¹Energy Information Administration (EIA). Energy Power Annual. [Online] December 12, 2013. [Cited: September 3, 2014]. <http://www.eia.gov/electricity/annual/?src=Electricity-f5>

²Energy Information Administration (EIA). Coal stockpiles above five-year range in first quarter of 2012. [Online] May 31, 2012. [Cited: August 28, 2014]. <http://www.eia.gov/todayinenergy/detail.cfm?id=6490>.

³Niska Gas Storage Partners. Gas Storage Industry Primer. [Online] April 2010. [Cited: August 27, 2014.] <http://www.niskapartners.com/wp-content/uploads/2010/04/GasStorageIndustryPrimer.pdf>.

⁴Ibid.

⁵Ibid.

⁶The storage data presented in Figure 1 was mined from EIA's Natural Gas Annual Respondent Query System (EIA-191) and natural gas storage filings at FERC, and does not include LNG storage.

⁷Federal Energy Regulatory Commission. Staff Report: Current State of and Issues Concerning Underground Natural Gas Storage. AD04-11-000, 2004.

⁸The storage data presented in Figure 2 was mined from EIA's Natural Gas Annual Respondent Query System (EIA-191) and natural gas storage filings at FERC, and does not include LNG storage.