UNDERGROUND GAS STORAGE IN THE WORLD - 2013

EXECUTIVE SUMMARY

Global storage trends: a sustained growth by 2030 driven by Asia and the Middle East

Global gas storage capacity is expected to increase from 377 billion cubic meters (bcm) at the beginning of 2013 to 557-631 bcm by 2030. The incremental growth, 180-254 bcm by 2030, requires sustained investment all over the period: around €120 billion will need to be invested by 2030. In 2030, storage represents 11.6% to 13.1% of global gas demand, compared with 11.3% in 2013.

New storage markets (Asia, Middle East) account for around 60% of the incremental capacity through 2030. In mature markets (USA, most of Europe and the CIS), the growth in working capacity is limited. The focus is on increasing peak deliverability rather than storage volumes. In the fast emerging gas markets (China, in particular), a strong growth in storage is expected. Storage infrastructure has to be built almost from scratch. Investment focuses on creating large volumes of storage capacity as well as peak deliverability to cope with rising imports and growing city and power demand.

Underground natural gas storage is a vital component of the natural gas chain. It is initially developed to balance gas supply and demand, optimize the transmission network size and management, and provide security of supply in case of interruption in gas supplies. As markets developed and liberalized, market hubs emerge, and spot markets evolve along with these trading hubs. Storage acquires an additional commercial role as a supporting tool to trading. With the development of renewable energy sources in the power sector, storage is called to play a supplementary function to cover variability in gas demand when gas is used as a back-up to intermittent power supply

The large differences experienced in the development of the natural gas industry worldwide reflect on the current evolution of the regional underground gas storage markets:

In countries where the gas industry is still in its early days, storage projects are like in the past, chiefly linked to seasonal and peak balancing needs, optimization of the main long distance gas transmission pipelines and security of supply (China, Iran, India). Large volumes are needed but also peak deliverability to cope with increasing demand.

Conversely, in mature natural gas countries, the gas industry has undergone massive changes, largely impacting the storage activity which performs new functions in addition to the operational ones. New storage needs are linked to the development of trading activity and to the use of natural gas as back-up of intermittent renewable energy sources in electricity generation. These two trends favor flexible storage (salt caverns). Security of supply is also a major driver of additional storage needs in Europe where domestic production is decreasing and import dependence increases. Face with competition from other sources of flexibility, the storage industry has, constantly, to develop techniques to answer new requests of the market in terms of performance, flexibility and economic efficiency. In recent years, the trends are towards expansion of existing capacities, improvement of efficiency and performance, and development of larger flexible storage (mega size caverns).

CEDIGAZ
Centre International d'Information sur le Gaz Naturel et tous Hydrocarbures Gazeux
1 et 4, avenue de Bois-Préau, 92852 Rueil-Malmaison Cedex, France
Tel +33 1 47 52 67 20 – Fax +33 1 47 52 70 82
www.cedigaz.org – Contact : info@cedigaz.org

In producing regions, the limited flexibility of unconventional gas (shale gas and coal-bed-methane) drives the development of storage that allows a better management of production profile. In North America, peak storage at a market hub enables producers to maintain higher outputs throughout the year. In Australia, storage is used to support coal seam gas (CSG) production in East Australia. It brings the flexibility required by the CSG-to-LNG chain. This also applies to conventional gas in several producing/exporting countries (Russia, Azerbaijan for instance).

The gas industry is willing to continue investing in this key asset to support the expansion of global gas markets and accompany the trend towards more intermittent energy sources. **At worldwide level, there are 95 projects under construction adding 68 bcm of working capacity**. Most of them will be completed by 2020/25. In addition, there are **141 identified projects at different stages of planning**. These planned projects would add 85 bcm of working capacity if all realized. Europe ranks first for all categories: number of projects, additions to working gas capacity, projects under construction and planned projects.

China: The birth of a giant market

China is expected to increase its gas consumption to about 500 bcm by 2030. A large share of the increase comes from imported gas. Alternatively, it could come from coal-bed-methane, currently under development in the country, or shale gas, if the shale gas revolution succeeds in China – China is the world's largest holder of shale gas resources. In all cases, underground gas storage will need to be developed significantly. China still lags behind developed gas markets in terms of storage infrastructure. For example, the ratio of working gas volume to gas consumption is 19% in the three main storage markets, whereas it is less than 5% in China. Current storage capacity is very low: the working gas capacity totaled 4.7 bcm at the beginning of 2012 and an estimated 7.3 bcm at the beginning of 2013.

CEDIGAZ expects a growth in working gas capacity to 60-75 bcm by 2030 to meet seasonal and peak gas demand, to secure gas supply, and allow efficient management of long-distance gas pipelines. Storage would represent 12 to 15% of gas consumption in 2030, i.e. 44 to 55 days of gas consumption. China becomes one of the largest storage markets in the world, representing 11-12% of world capacity by 2030.

This development, however, encounters several geological, technological and economic/pricing issues. To solve these issues, the government is speeding up the building of new storage facilities to ensure the development of the natural gas industry, one pillar of its new energy policy to curb CO_2 emissions. It is investing US$13 billion between 2011 and 2015 to develop 24 storage sites. The ongoing gas pricing reform will enable storage companies to recover their costs and will encourage investment in the sector.

Europe: Challenging times for storage operators and developers

Market liberalization and increased trading in Europe are changing the way European storage facilities are used. New tailored-made services are offered to satisfy customers' needs. A secondary market for bundled and unbundled services has developed. **European storage capacity has increased by 16% since 2010.** Flexible storage (salt caverns) and sites located close to developed market hubs are the most valuable ones. While salt cavern facilities account for only 14% of total European working gas capacity, they can be rapidly cycled and deliver up to 31% of total European deliverability. **These dynamic trends, however, occur at a time of shrinking European gas demand, tough competition between storage and other sources of flexibility** – such as LNG and spot gas, and

falling summer/winter gas price spreads. These unfavorable market conditions create a tricky situation for European storage system operators and storage developers. Storage usage and prices have fallen. The current market conditions eliminate the financial motive to keep gas in store and develop new storage capacity, but the security aspect should not be overlooked. **Storage has proven to be the most powerful tool in covering interruptions or reductions in gas supply.** For instance, during the 14-day cold spell of February 2012, storage provided 30% of European gas supplies. While the expected storage price remains below that needed to invest in new gas storage, **Europe will require more storage capacity in the future.** This is due to a strong **structural shift in European supply and demand** that drives additional requirements for both short-term gas flexibility across Europe and seasonal flexibility in some European countries. The use of gas as a back-up fuel for renewable energy sources in the power sector is foreseen to expand dramatically. The variability and volatility of gas demand will therefore expand and requires flexible gas infrastructure with adequate storage capacity and flexibility. This trend reinforces the need for highly flexible storage capable of cycling very quickly (salt caverns). In addition, **trading is spreading all over Europe**. Market hubs need flexible supply to function efficiently. Storage at hubs is a key tool for market players: they provide a sink (market) or a source (supply) at the discretion of the storage operator/customers.

However ongoing capital constraints and lack of clear market price signals are hampering investment in new seasonal storage. Europe definitely needs to put in place a framework allowing the recognition of the full value of storage, including its strategic role for security of supply.

Gazprom's storage strategy in Europe

Gazprom has embarked in an ambitious development of storage capacity in Europe, close to its markets and main export routes. The company projects to expand its working gas capacity in Europe from 3 bcm in 2011 (4.5 bcm at the beginning of 2013) to 5 bcm by 2015. The long-term objective is to hold at least 5% of its annual European sales in storage with the emphasis on outright ownership of assets. Gazprom has invested in storage facilities in Austria, Germany and Serbia. It also leases capacity in Germany and the United Kingdom. In addition, Gazprom with partners are building a facility in the Netherlands and new facilities in Germany. The company has recently announced new storage investment in the Czech Republic and plans to construct storage sites in UK, Turkey and several other countries. With the recently announced 100% takeover of BASF´s Wingas, WIEN and WIEE – joint gas trading ventures – as well as the group's storage facilities in Austria and Germany, Gazprom emerges as a major actor in European storage (and trading). In 2011, Gazprom became the fourth largest storage company in Europe, overtaken RWE's position. **By 2015, the capacity Gazprom holds in Europe, either directly or indirectly, could increase to 10 bcm** taking into account new facilities built in Germany and the Netherlands and Gazprom acquisition of 100% stake in Wingas and subsidiary companies.

The main stated objective of Gazprom is to increase the security of its gas exports both via the existing transmission corridors, Nord Stream inclusive, and via new gas pipelines such as South Stream. **Its storage expansion in Europe will bring additional benefits and revenues to the company:** reliability of supplies and renown of the company; optimization of its transportation system operation; efficient and lower cost delivery of daily flexibility in gas contracts; sales of extra gas from storage facilities; access to hub and pricing. While Gazprom sticks to oil indexation for its long-term contracts, its move in storage facilities with high deliverability rates, close to major emerging hubs, as well as its growing trading activities, will allow the company to grasp the

opportunities of a fully competitive market with some 600 bcm of annual demand when it emerges in Europe. It is then that the real value of storage – and pipe infrastructure – will be felt.

USA: Shale gas spurs a new wave of salt cavern storage development

The shale gas revolution and the consecutive massive pipeline expansion capacity have spurred the development of high-deliverability storage facilities. While the number of U.S. storage facilities and their total capacity was quite stable from 2000 to 2007, the increase in gas trading and growth in natural gas demand by the power sector have triggered a fast development of salt cavern storage. While non-salt storage (mainly depleted natural gas fields) provides by far the largest share of U.S. natural gas storage capacity, **most of the increase in working gas capacity observed since 2007 comes from salt cavern storage.** Although salt caverns account for only 9% of total U.S. working natural gas capacity, they deliver up to 25% of total U.S. daily withdrawal rate. Salt caverns offer several competitive advantages compared to depleted oil and gas reservoirs or aquifers: gas stored can be delivered quickly; they offer high rates of injection and withdrawal; and the working gas can be cycled several times per year.

The fast building of new cavern sites has occurred in the Producing region (mainly Texas, Louisiana and Mississippi). The region indeed concentrates most of the salt dome formations of the nation. The high gas price levels and strong price volatility observed from 2006 to 2009 enabled these types of storage projects to generate high revenues. Not only the negotiated rates for firm capacity at these projects increased by 50% or more, but hub-services revenues from advancing (loaning) or borrowing (parking) gas to support trading exploded. However, since 2010, the decrease in gas prices and the collapse in both winter-summer spreads and volatility have created a more challenging environment for storage operators. As a result, many storage projects have been put on hold or even cancelled. Nevertheless, **expansions of salt cavern sites are still ongoing and contribute to the growth in storage capacity.** Of the 17 new sites under construction and planned between 2013 and 2015, 12 are new salt cavern facilities.

Recent storage trends: a review of 48 countries

At worldwide level, there are 688 underground gas storage facilities in operation in the world at the beginning of 2013, representing a working gas capacity of 377 bcm, or 10.3% of 2012 world gas consumption. Working gas capacity has increased significantly since 2010 (+ 35 bcm), mainly under the impetus of Europe which added almost 14 bcm of capacity in the past three years. Due to long lead times, a large share of these storage facilities was decided in the mid-2000s, before the economic crisis and fall in European gas consumption.

Underground gas storage has been developed in four regions: North America, Europe, the Commonwealth of Independent States (CIS), and Asia-Oceania. **North America concentrates more than two thirds of the sites**, with 414 storages in the US, and 59 in Canada, and a combined capacity of 152 bcm (40% of the global total). **Europe holds the second rank in terms of number of facilities with 144 facilities** (99 bcm), followed by **the CIS** with 51 facilities, which is **in second position regarding in terms of working capacity** (115.5 bcm). Asia-Oceania has 18 sites (9.3 bcm of working capacity). There is one site in Argentina and one in Iran.

The breakdown of underground gas storage by type of storage shows the **predominance of depleted fields**, which allow storing large volumes of gas and are mainly used to balance seasonal swing in gas demand and constitute strategic reserves. With 509 facilities in the world, depleted fields represent 74% of the total number of sites.

However, market liberalization has brought some important changes in the gas storage market. Today, storage is also used as a financial tool to optimize gas portfolios at short term. This trend can be seen in the growing importance of salt cavern storage in North America and Europe. As of January 2013, **94 salt caverns facilities are in operation in the world** (76 in 2010), representing 14% of the total number of sites. **Although salt caverns account for only 7% of total working gas capacity, they deliver up to 22% of total global deliverability.**

A closer look on the type of facilities in operation in the world reveals important disparities from one region to another. If porous reservoirs (depleted fields and aquifers) largely dominate the number of storage facilities in North America (90%) and the CIS (96%), their share falls to 71% in Europe, where salt caverns represent a higher proportion than in other regions. Reversely, the CIS holds only two salt cavern facilities.

As of January 2013, the United States is by far the most important country in terms of installed working capacity, with almost 130 bcm out of a global volume of 377 bcm. Together with Russia and Ukraine, with respectively 69 bcm and 32 bcm of working capacity, Canada and Germany (22 bcm each), these five countries concentrate 73% of the worldwide capacities. Italy is in the sixth position with 16 bcm, followed by France, 13 bcm. Three other countries hold storage capacities over 5.4 bcm. Compared with 2010, CEDIGAZ's previous review of underground gas storage in the world, Austria entered in the Top 10 storage-holders thanks to the completion of the Haidach expansion and commissioning of the 7Fields and Aigelsbrunn facilities.

In terms of deliverability, the US and Russia remain the leading countries with withdrawal capacities of respectively 3,327 and 728 million cubic meters per day (mcm/d). Germany ranks third with 537 mcm/d. One significant development is the entrance of China in the Top 10 with the building of new storage facilities currently providing 102 mcm/d of deliverability.

CEDIGAZ
Centre International d'Information sur le Gaz Naturel et tous Hydrocarbures Gazeux
1 et 4, avenue de Bois-Préau, 92852 Rueil-Malmaison Cedex, France
Tel +33 1 47 52 67 20 – Fax +33 1 47 52 70 82
www.cedigaz.org – Contact : info@cedigaz.org

STRUCTURE OF THE SURVEY

346 pages, 70 tables, 72 charts & figures, 44 country maps.

"Underground gas storage in the World – 2013 Survey" details current storage activity and future projects in 48 countries. It describes the 688 existing storage facilities in the world and the 236 projects under construction and planned.

The Survey includes four main parts.

The first part gives an overview of underground gas storage in the world at the beginning of 2013 (Chapter 1) and analyzes future storage needs by 2030, at global and regional levels (Chapter 2).

The second part focuses on new trends and issues emerging or developing in key storage markets. Chapter 3 looks at the emerging storage market in China and analyzes future trends to 2030. Chapter 4 reviews recent storage business climate in Europe. Chapter 5 analyzes Gazprom's storage strategy in Europe and Chapter 6 reviews recent trends in storage development in the United States.

The third part gives some fundamental background on technical, economic and regulatory aspects of gas storage. It includes a description of the different types of underground gas storage (Chapter 7). It reviews the evolving role of underground gas storage according to the maturity of gas markets (Chapter 8). Chapter 9 gives estimates of storage costs and describes the range of storage valuation approaches used in different markets. Chapter 10 looks at regulatory developments pertinent to gas storage in North America and Europe.

The fourth part gives a countrywide analysis of the 48 main storage countries in the world. Regional markets are looked at in six chapters: North America (chapter 11), Central and South America (Chapter 12), Europe (Chapter 13), CIS (Chapter 14), Middle East (Chapter 15) and Asia-Oceania (Chapter 16).

CEDIGAZ
Centre International d'Information sur le Gaz Naturel et tous Hydrocarbures Gazeux
1 et 4, avenue de Bois-Préau, 92852 Rueil-Malmaison Cedex, France
Tel +33 1 47 52 67 20 – Fax +33 1 47 52 70 82
www.cedigaz.org – Contact : info@cedigaz.org