EFET Insight into Gas Storage and Flexibility

Why store gas?

In today's world, gas has many uses with many different drivers, from heating of residential and commercial premises, industrial production and use as a chemical feedstock, through to power generation. The use of gas for heating has a pronounced seasonal element and is influenced chiefly by weather; its use as a fuel for power generation complementary to intermittent renewable electricity production is not only much higher in winter compared to summer but is also highly variable on a short-term basis. Therefore, it is necessary to be able to adjust the supply of gas to match the changing demand on a month-to-month and on a day-to-day basis.

Different forms of flexibility have been developed alongside the growth of gas usage in order to deliver this, including different types of storage facilities that have become a key source of flexibility.

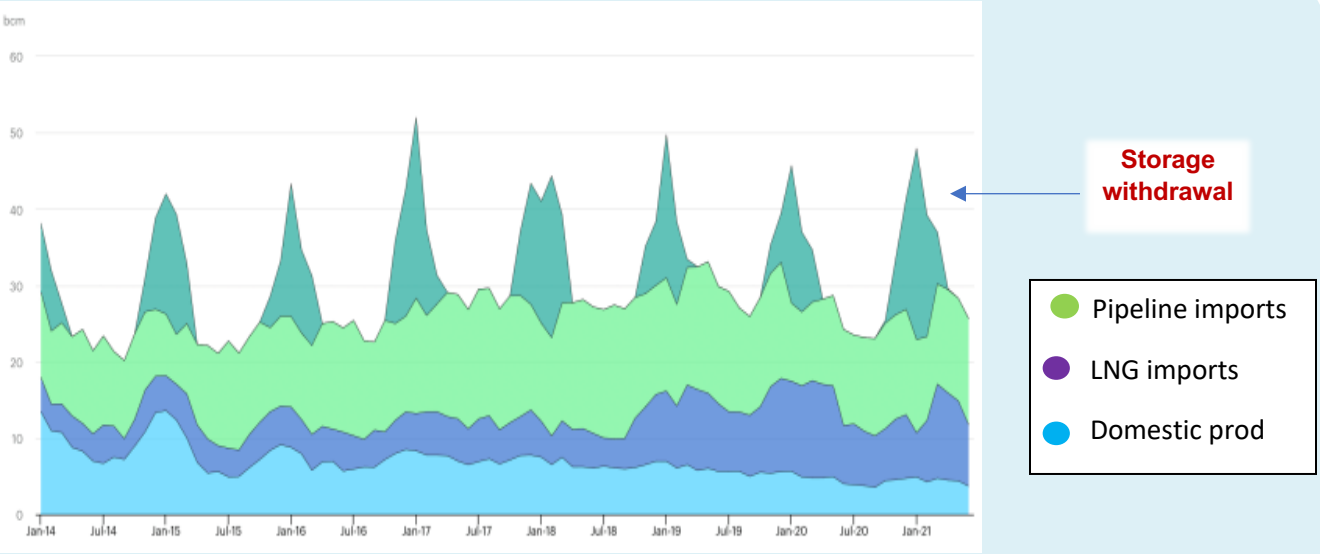

Figure 1. Gas Monthly Balance in the EU – Source: IEA

Economics of gas storage facilities

Historically, storage fulfilled a number of objectives:

- It helped satisfy seasonal swings in gas demand, especially where production sources were distant from consumption and not best placed to cover the fluctuations.
- Storage allowed production facilities to run at more constant rates throughout the year, with surplus gas in summer injected into storage and withdrawn during shortages in winter,

rather than turn gas production up and down which can reduce the overall amount of gas that can be recovered from a gas field.

- Variations in gas flow from temporary production outages or demand response to changing weather can be met – one example here could be gas-fired power plants which require to ramp up quickly (using large volumes of gas) when additional electricity is needed.
- In some locations, storage substitutes for transportation capacity – for example if it was not possible to expand pipeline capacity to meet a winter peak in a remote location, storage could be developed locally and filled in summer to have peak supplies available when needed.
- Some gas could be held in storage in case of emergencies, to allow an orderly run-down of the system in the event that gas can not be delivered to part of the network, or to allow gas to be supplied quickly in order to balance the system.

There are different forms of gas storage with individual characteristics

- Large quantities of gas are stored in depleted reservoirs where working gas can be injected in summer and withdrawn in winter. They take a long time to fill (150 days is not uncommon) and store large quantities of gas that can be withdrawn over several months. This makes them more useful and economic for seasonal storage
- Similar to depleted fields, gas may also be stored in aquifers. These are dome-shaped rock structures with an impermeable cap. The rock may have contained water that is displaced by injecting gas. These structures are less common in Europe
- A more frequent type of storage is in salt caverns. Caverns can be leached out of salt bed deposits and used for storage of gas or other fuels. These structures can have much higher injection and withdrawal rates for a limited amount of space. They are less economic for seasonal use and more likely to be cycled several times per year
- Gas can also be stored as LNG in tanks at import terminals or at strategic locations in the grid or – in extremis – in a tanker moored at an import terminal (though this is an expensive form of gas storage)

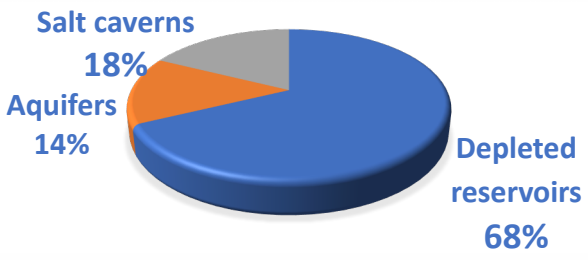

Figure 2. Total capacity of different types of storage facilities (%) – Source: GIE

As the gas market developed, these uses of storage remained in principle, but they no longer were the only source of seasonal flexibility when larger quantities of liquified natural gas (LNG) became available. Greater interconnection between national systems and greater levels of cross-border exchanges helped to improve security of supply while creating more opportunities to trade. Liquid markets for gas became capable of generating reliable price signals that became a reference for transactions both inside and outside Europe.

The emergence of a transparent wholesale price for gas became an important signal whereby different forms of flexibility can be valued and compared. The price for gas next winter can be determined by booking storage and injecting summer gas, or by importing LNG. The consumer can also reschedule activities to defer major consumption to off-peak periods when the cost of gas is lower. The wholesale price provides signals whereby market operators can optimise supplies and use of the system in meeting consumer demand.

One key difference arising from market liberalisation is the use of storage for commercial as well as physical optimisation. Multi-cycle facilities can be filled, emptied and refilled several times in a year: gas can be injected when prices are (relatively) low and withdrawn after a short period when prices are higher, between weekend and weekday or between warm and cold spells. Their ability to respond to price movements in this way helps partly to smooth some of the volatility that would otherwise exist.

The value of the storage therefore depends largely on the differential between the price of gas when purchased for injection and what it can be sold for on withdrawal. In the simplest terms, this differential must be big enough to cover the cost of storage, or it is not worthwhile to store the gas. If there is little price volatility, or insufficient seasonal spread (summer prices are too high or winter prices are too low), then the value of storage is reduced. The development of alternative supply options such as LNG also means that storage may no longer be the cheapest form of insurance.

Country	Capacity (TWh)	Country	Capacity (TWh)		
AT	95.5	HU	67.2		
BE	9.0	IT	197.7		
BG	5.8	LV	21.8		**EU Storage**
CZ	36.0	NL	143.8		**Source: EC**
DE	245.3	PL	35.8		
DK	9.1	PT	3.6		
ES	34.2	RO	33.0		
FR	128.5	SE	0.0		
HR	5.2	SK	38.7	EU TOTAL	1110.7

Challenges to storage utilization

In periods of low demand and plentiful supply, the value of storage both as a source of flexibility and of insurance has been considered to be low. Increased amounts of LNG production with a larger proportion being available on a spot basis has provided an economic alternative. Increased interconnection capacity between European markets has meant that the same amount of storage could have wider regional impact. Market participants could provide adequate flexibility and insurance more cheaply to the benefit of consumers using means other than storage.

Nevertheless, an exceptional series of unforeseen events in winter 2021/22 have led to a situation of relative scarcity in winter supply. One contributory factor was low storage-filling - in part because of weak commercial incentives and in part because of unexpected behaviour by a major market party which is under investigation. This has led some authorities to conclude that consumers would be better protected in future by requiring higher storage levels than may be determined by market forces alone.

Several mechanisms are currently under consideration, which will be addressed in a separate EFET paper. These must be designed carefully in order to ensure that are delivered at reasonable cost, they achieve the desired increase in protection, and do not have unintended side-effects that are more damaging than the improvements they are intended to bring. In order to achieve this, it is important to understand how any changes in storage rules will interact with the commercial use of storage. To ensure that the costs of the additional insurance are contained, these schemes should build on the established market mechanisms that can help optimizing the use of different types of storage.

In summary

Storage facilities

- Can cover both short-term and seasonal demand, supporting supply security and optimizing costs to consumers
- Compete against different sources of flexibility and should be able to adjust their services to the market needs
- Are optimally utilized when allocated through market mechanisms. Only then they can allow reacting to price volatility and help scaling the gas infrastructure over the medium- and long-term

For more information, feel free to contact us at secretariat@efet.org