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UNDERGROUND GAS STORAGE IN THE WORLD – 2019 STATUS

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1. CURRENT CAPACITY OF UNDERGROUND GAS STORAGE IN THE WORLD

Global working gas capacity reached 421 bcm in 2018

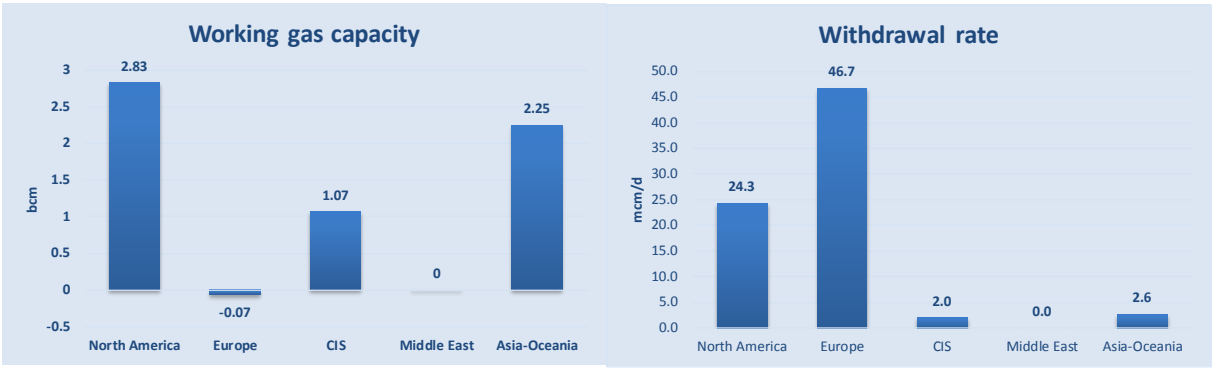
At the end 2018, there were 662 underground gas storage facilities in operation in the world. The global working gas capacity reached 421 bcm.

At the end 2018, there were 662 underground gas storage (UGS) facilities[1] in operation in the world. Only three new storage facilities were commissioned in 2018, in China (HK and China Gas Jintan UGS), Russia (Volgogradskoye UGS) and Italy (Cornegliano UGS). But at the same time, some sites were closed in the United States and Germany. The **global working gas capacity has increased to 421 bcm, up 1.5% from the end of 2017** (415 bcm revised).

This increase was driven by North America, Asia-Oceania and the Commonwealth of Independent States (CIS). European working gas capacity decreased marginally in 2018 (107.6 bcm at the end of 2018, of which 103.7 bcm in the European Union (EU)). Since 2015, EU working gas capacity has decreased by 6.5 bcm due to the closure of storage facilities in Germany, Ireland and the UK. The permanent closure of Rough UGS in June 2017 has sharply reduced UK storage capacity to only 1.3 bcm at the end of 2018.

The global peak deliverability rate increased to 7,280 million cubic meters per day (mcm/d) as of end 2018, up 1% from 2017. Most of the increase is due to flexible UGS in Europe and North America.

Figure 1: Major changes in working capacity and withdrawal rates (2018 vs. 2017)



Source: CEDIGAZ

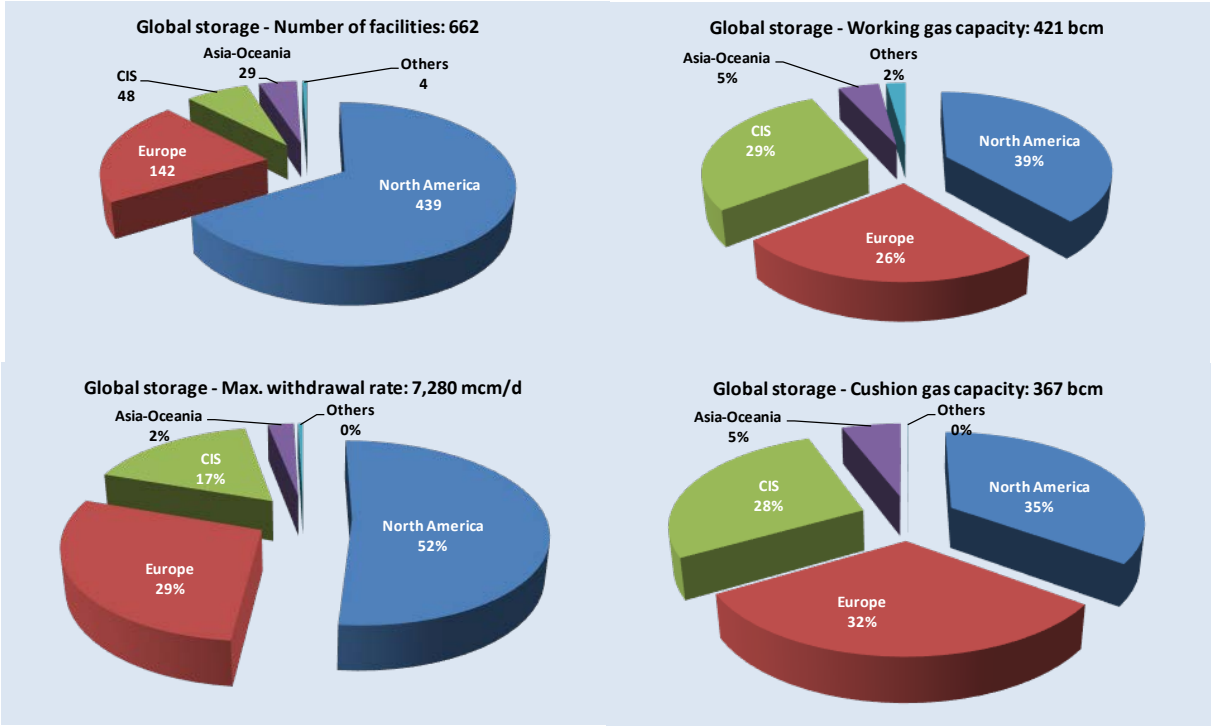
Regional breakdown: North America leads the market

North America concentrates more than two thirds of the sites and accounts for almost 40% of global working gas capacity and half of global deliverability

[1] Some individual storage sites are grouped into storage clusters (for instance in Canada, China and Russia). If counted as individual sites, there were 687 storage sites worldwide at the end of 2018. Some storage facilities were inactive, mothballed or closed (43 UGS). If added, the world total was 730 UGS.
The number of sites in 2018 is not directly comparable with that of 2017, as some sites were grouped in clusters, notably in Canada (see footnote 2).

UGS has been developed in five regions: North America, Europe, the CIS, Asia-Oceania, and the Middle East (mostly Iran). **North America concentrates more than two thirds of the sites**, with 386 active storages in the US, and 53 in Canada[2]. They have a combined working capacity of 163.5 bcm (39% of the world total), and a peak withdrawal rate of 3,755 mcm/d (52% of the world total). **There are 142 facilities in Europe** (107.6 bcm, 2,093 mcm/d), **48 in the CIS** (120.7 bcm, 1,209 mcm/d), **29 in Asia-Oceania** (19.8 bcm, 187 mcm/d), and **3 in the Middle East** (9.3 bcm, 34 mcm/d). There is also one small UGS in Argentina.

Figure 2: Global underground gas storage as of end 2018 – by region



'Others' includes the Middle East and Central and South America, but mainly refers to the Middle East.
Source: CEDIGAZ

Box 1: Focus on two growing storage markets: China and Iran

China plans huge storage expansion

For the second consecutive year, natural gas consumption in China registered a dramatic growth in 2018. With 276 bcm consumed, natural gas demand increased by 17%. China's natural gas demand is highly seasonal with a pronounced peak in winter due to heating demand. Gas shortages restricted gas demand during the heating season of 2017-18 (15 November-15 March), and exposed the key bottlenecks of the Chinese gas market: its still underdeveloped gas transport system and **a serious lack of storage capacity**, as well as a lack of adequate incentives for investment in the gas industry. The gas shortage has been the catalyst for adopting short-term measures to alleviate winter shortages, accelerating the construction of key infrastructure and deepening gas market reforms. These short-term measures and new policies have already had a positive effect on the rebalancing of

[2] The number of Canadian UGS facilities have been revised from 62 UGS in 2017 to 53 UGS in 2018. This is due to the grouping of storage sites into clusters, and not to the closure of UGS. The working gas capacity of Canadian UGS has increased by 1.2 bcm in 2018 to 27.8 bcm at the end of 2018.

gas supply and demand in winter 2018-19, also helped by mild temperatures in February and March 2019.

Today, the storage market is dominated by CNPC/PetroChina and Sinopec. At the end of 2018, **UGS working gas capacity reached 11.7 bcm (14 UGS in 27 reservoirs)**,[3] thanks to the expansion of CNPC Hutubi UGS (Xinjiang) and the commissioning of the first private gas storage: the first phase of a salt cavern site at Jintan (Jiangsu), owned by Hong Kong and China Gas Company (Towngas). The maximum withdrawal capacity is estimated at 156 mcm/d. Most facilities use depleted gas fields. Only a few facilities use salt caverns which require higher building costs and longer construction periods.

Table 1: UGS facilities in China in operation at the end of 2018

Name of UGS Facility	State/Province	Operator	Type of Storage	Start-up date	Working Gas Capacity (bcm)	Peak Withdrawal Rate (mmcm/d)
Dagang Bannan cluster (3 UGS)	Tianjin	CNPC E&P	Depleted field	2014	0.26	4.3
Dagang Banqiao cluster (6 UGS)	Tianjin	CNPC E&P	Depleted field	2000	1.92	34.0
Hutubi	Xinjiang	CNPC E&P	Depleted field	2013	4.20	28.0
Jin 58 cluster (3 UGS)	Beijing	CNPC E&P	Depleted field	2010	0.52	5.6
Jintan (HK and China Gas) First phase	Jiangsu	HK and China Gas	Salt Cavern	2018	0.09	5.0
Jintan CNPC (First phase)	Jiangsu	CNPC E&P	Salt Cavern	2007	0.60	12.0
Jintan Sinopec (first phase)	Jiangsu	Sinopec	Salt Cavern	2016	0.04	6.0
Lamadian (reconstruction)	Sangliao basin	CNPC E&P	Depleted field	2014	0.08	1.0
Liuzhuang	Jiangsu	CNPC E&P	Depleted field	2011	0.25	1.5
Shaan 224	Ordos, Changqing	CNPC E&P	Depleted field	2014	0.26	4.2
Shuang 6 (Liahoe)	Liaoning	CNPC E&P	Depleted field	2016	1.26	12.5
Suqiao cluster (5 UGS)	Hebei	CNPC E&P	Depleted field	2013	0.39	15.2
Wen 96	Henan	Sinopec	Depleted field	2013	0.21	5.0
Xiangguosi	Sichuan	CNPC E&P	Depleted field	2014	1.64	22.0
TOTAL					**11.71**	**156.3**

Source: CEDIGAZ

Gas withdrawn from UGS facilities reached 9.3 bcm in 2018, compared to 7.4 bcm in 2017. However, it only contributed 3.4% of the country's total gas consumption, far lower than the world average of 11% and 20% for top consuming nations such as the United States and Europe. In winter 2018-19, storage contributed 100 mcm/d to the average winter demand of 900 mcm/d.

To ease seasonal infrastructure bottlenecks, **the government has prioritised the development of storage infrastructure** (UGS and LNG tanks) and peak shaving mechanisms **and set specific targets in its development plans.** The working gas capacity of UGS is planned to be raised to **14.8 bcm by 2020 and to over 35 bcm by 2030**. In addition, the government issued a decree in March 2018 requiring

[3] Information about China's effective working capacity varies according to sources. Chinese sources indicate a working gas capacity of 13 bcm or of 16 bcm. However, they include Sinopec Wen 23 UGS (Henan province), which was officially commissioned in March 2019.

suppliers, distributors and local governments to build gas storage facilities for peak shaving purposes to avoid future supply cuts to industrial users during the heating season. Gas suppliers — mainly state-owned companies— will be required to have storage facilities able to meet at least 10% of their contracted sales by 2020. City gas distributors must have storage equal to 5% of their annual supplies within the same time frame and local governments will need to have enough storage to cover three days of consumption in their administrative regions.

The government is encouraging all kinds of investment entities to participate in the construction and operation of gas storage facilities, including gas suppliers, pipeline operators, city gas providers, large users and independent third parties. The government's storage targets are not technology specific and can be met with underground storage, LNG terminal storage, small-scale emergency LNG or compressed natural gas station storage, and demand management contracts.

CNPC, owner of 24 gas storage reservoirs, has vowed to raise its total working underground gas storage capacity to 15 bcm by 2025 (11 bcm in 2020), able to meet 10% of the peak seasonal demand. CNPC will invest over $10 billion to build seven new gas storage clusters and improve existing storage bases. The seven UGS are located at Daqing Shengping, Pingdingshan, Huai'an, Chuzhou, Liaohe Lei-61, Lujuhe at Dagang and Baiju in Zhejiang province. Daqing Shengping UGS in northeast China will be the first volcanic rock gas storage facility in the world. The facility, due to be in operation by 2025, will serve the Russia-China East Trunk Line (Power of Siberia). In addition, PetroChina Southwest Oil and Gas Field Company plans to build eight UGS facilities in three phases in the Sichuan province and the municipality of Chongqing. The facilities, with a total capacity of 21.7 bcm, a working gas capacity of 10 bcm and a peak withdrawal rate of 83 mcm/d, would cost more than 21 billion yuan. The first stage consists of converting the depleted gas fields in Tongluoxia (construction started in May 2018) and Huangcaoxia into gas storage. The two gas fields are close to the backbone network and Chongqing City. They are due to be completed by 2022, ensuring an annual supply of 1.28 bcm of gas. The second phase comprises converting gas fields in Mujiaping, Shengongshan, Xinglongchang, Zhaigouwan and Wanshunchang. These UGS facilities are close to gas production sources and the pipeline network and are aimed at guaranteeing gas demand in Chengdu (Sichuan province). The third phase is the development of strategic gas storage, in the Shapingchang gas field located near Chongqing city, a facility designed to have a high peak load capacity.

Sinopec, owner of two existing UGS facilities in 2018, **has also announced a huge development of its storage capacity, mainly in the central Henan province**. Sinopec opened its third facility, Wen 23 UGS (northern Henan province), in March 2019. Wen 23 has a designed capacity of 10.43 and a working capacity of 4.47 bcm (full development). It will supply gas to northern cities during the winter season. In addition to Wen 23 UGS, Sinopec plans to build 16 facilities at the site of non-operating oil and gas fields in the Henan province. The total new capacity has been reported at 55.6 bcm.

Iran expects to start two new facilities shortly

Natural gas is vital for Iran's economy, notably under renewed US sanctions. Natural gas provided 68% of total energy supply in 2018 when gas consumption reached 222 bcm. The residential and the power sectors are the largest consumers. **Natural gas demand is highly seasonal**. Demand spikes in the winter months when temperatures are low and natural gas is used for heating. In January 2018, gas demand hit 550 mcm/d, well over the average range of 420 to 470 mcm/d. This regularly leads to domestic demand outstripping supply. In response, industrial consumers have repeatedly been cut off from supplies to ensure households are provided with enough natural gas. To overcome the seasonality issue and optimize its gas transmission system, Iran has embarked on a huge UGS storage development. **Iran expects to bring its UGS capacity to 14 bcm in the 2020s and the peak withdrawal rate to 120-130 mcm/d**. In the longer term, about 10% of the country's annual gas consumption should be stored in UGS facilities.

At the end of 2018, Iran had two UGS in operation, with a working gas capacity of 6 bcm and a withdrawal rate of 30 mcm/d (revised data). The country commissioned its first UGS facility in August 2012, the **Sarajeh** UGS, built in a depleted gas field. Located 40 km southeast of the city of Qom and 140 km from Tehran, the facility has a working capacity of 3.3 bcm and a maximum withdrawal rate of 36 mcm/d when the full development will be completed. The project is carried out jointly by NIGC and NIOC. A second facility in a depleted gas field, the **Shourijeh** UGS, was commissioned in 2014. Located in northeastern Iran, 25 km southeast of Sarakhs, the facility has a working capacity of 4.8 bcm (full development) and a maximum withdrawal rate of 40 mcm/d.

Two other facilities are under construction. The **Yortsha** aquifer reservoir in Khorasan province is expected to have 570 mcm of working gas capacity and 4.8 mcm/d of peak withdrawal capacity. The **Nasrabad** UGS, near Kashan, built in salt domes, will have 2 bcm of working capacity when fully developed. Construction started in March 2013. In addition, several other storage facilities are planned in the country (Qhezel Tapeh in Khorasan province, Baba Ghir/Bankul UGS in Ilam province, Imam Hassan UGS in Kermanshah province, Mokhtar UGS in Kohgiluyeh province and Sorkheh and Talkheh reservoirs in Semnan province).

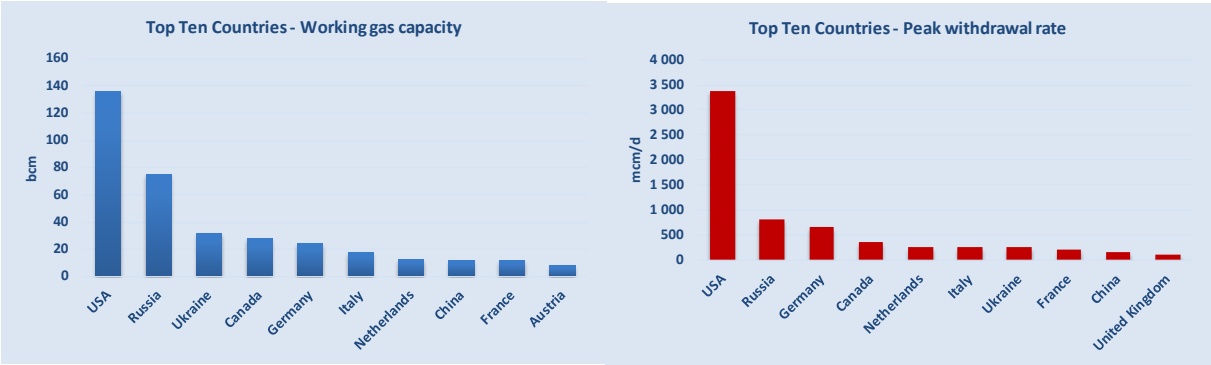
Top Ten league

The top five countries (United States, Russia, Ukraine, Canada and Germany) account for 70% of the worldwide capacities

The **United States** is by far the most important country in terms of installed working gas capacity, with 136 bcm in 2018, out of a global volume of 421 bcm. Together with **Russia** and **Ukraine**, with respectively 75 bcm and 32 bcm of working gas capacity, **Canada** and **Germany** (28 bcm and 24 bcm respectively), **these five countries concentrate 70% of the worldwide capacities.** Italy, with 18 bcm of working gas capacity, remains in the sixth place, while the Netherlands now ranks seventh. The Netherlands entered the Top Ten league in 2015, following expansion of storage sites associated with the Groningen field and the commissioning of a large seasonal field (Bergermeer). However, the announced closure of Grijpskerk UGS in the fourth quarter of 2021, will significantly reduce Dutch gas storage capacity. Grijpskerk, operated by NAM, is one of the last remaining large seasonal storage sites in Europe. China, which also entered the league in 2015, now ranks eighth, ahead of France and Austria.

In terms of deliverability, the US and Russia remain the leading countries with withdrawal capacities of 3,375 and 812 mcm/d, respectively. Together they account for 58% of the global deliverability. Germany ranks third with 676 mcm/d.

Figure 3: World Top Ten storage countries, as of end 2018



Source: CEDIGAZ

Historical evolution: a return to moderate growth in 2018

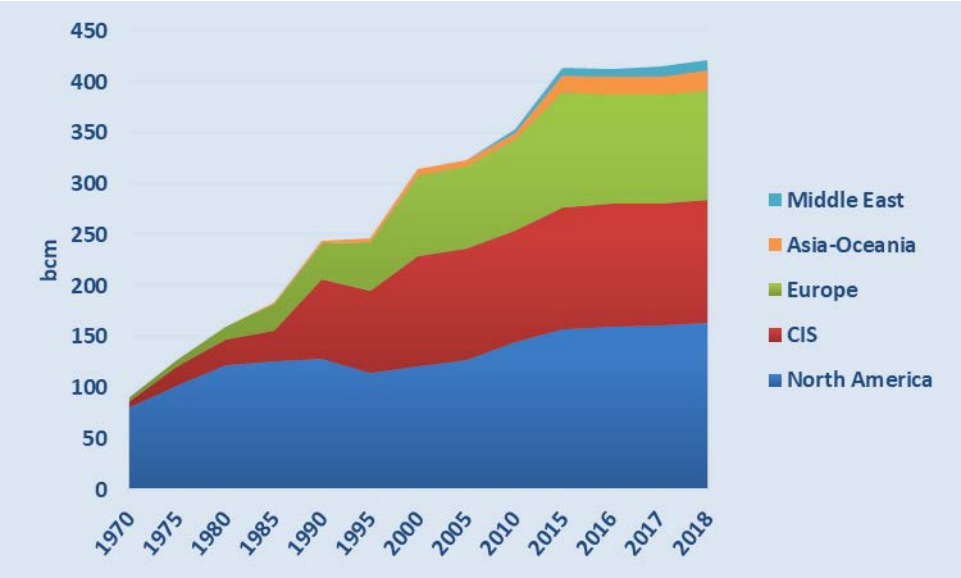
In 2018, the growth in gas storage capacity contrasted with the trends observed since 2015

Global working gas capacity has increased significantly since 2010 (+68 bcm, or a Compound Annual Growth Rate (CAGR) of +2.2%). All regions participated in this growth until 2015. However, **since 2015, the growth has moderated (with a CAGR of +0.7%) and even reversed in some regions (Europe)**. With an increase by 1.5% in 2018, the growth in gas storage capacity contrasted with the trends observed since 2015. Thus, 2018 is marked by a return to moderate growth in gas storage capacity.

In North America, most increase in working gas capacity is due to expansion of current sites, while in the CIS, new sites are developed to cope with rising gas demand. Asia-Oceania and the Middle East are the only two regions where growth in storage capacity is significant, but from a low base. In Europe, only Turkey and Italy are building substantial storage capacities.

Since 2015, the stagnation of storage capacity in mature markets has occurred despite the increase in their gas consumption. Thus, the **ratio Global working gas capacity on Gas consumption decreased to 10.9% in 2018** (11.8% in 2015).

Figure 4: Evolution of global working gas capacity, 1970-2018



Source: CEDIGAZ

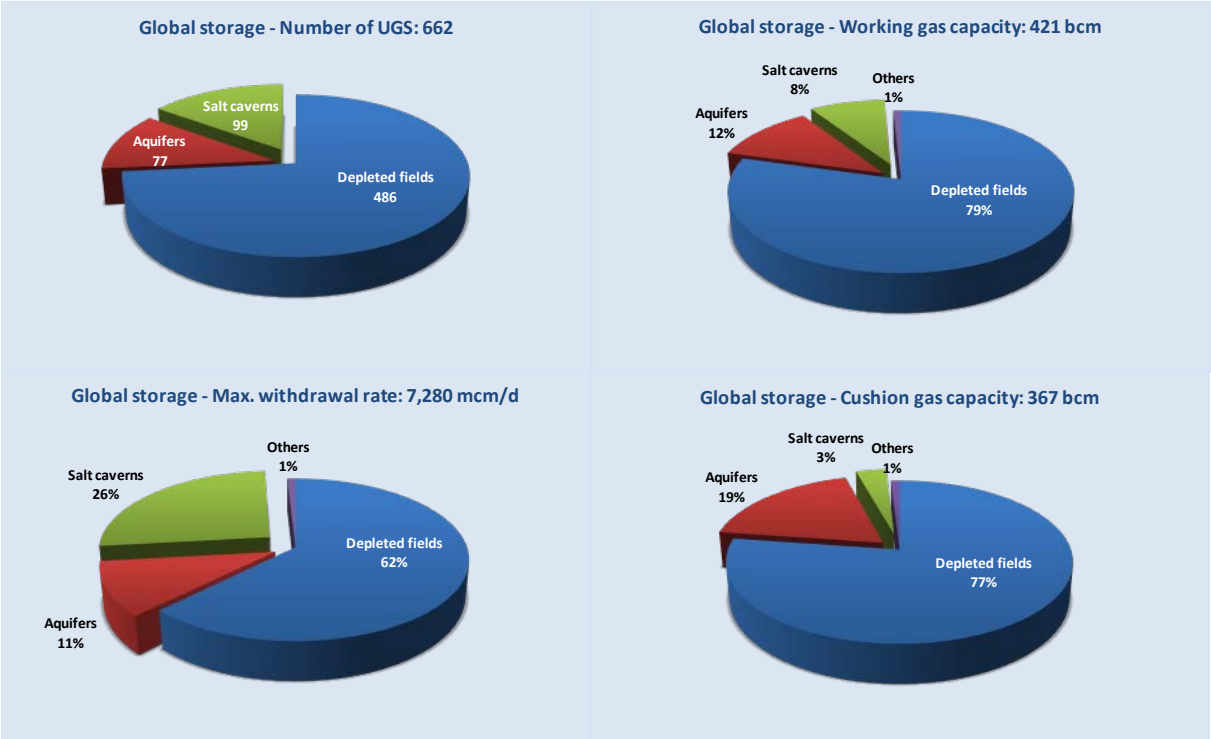
Depleted fields dominate, but UGS in salt caverns is key to deliverability

Storage in depleted fields dominate with 79% of global working gas volumes, but storage in salt caverns now accounts for 26% of global deliverability

The breakdown of underground gas storage by type of storage shows the **dominance of depleted fields**, which allow storing large volumes of gas and are mainly used to balance seasonal swing in gas demand. With 486 facilities in the world, depleted fields represent 73% of the total number of sites and 79% of global working gas volume.

However, market liberalization has brought some important changes in the gas storage market. Today, flexibility is a key asset in liberalized markets. This trend can be seen in the **growing importance of salt cavern storage** in North America and Europe. This type of storage allows high injection and withdrawal rates, and the working gas can be cycled several times per year. At the of end 2018, **99 salt caverns facilities were in operation in the world** (76 in 2010), representing 15% of the total number of sites. Although **salt caverns account for only 8% of global working gas capacity,** they can be rapidly cycled, and **they deliver up to 26% of global deliverability.**

Figure 5: Global underground gas storage as of end 2018 – by type



Notes: 'Salt caverns' includes rock cavern facilities. 'Others': Storage groups including different types of UGS

Source: CEDIGAZ

A closer look on the type of facilities in operation in the world reveals important disparities from one region to another. Even if porous reservoirs (depleted fields and aquifers) largely dominate the total number of storage facilities in all regions, their share falls to 66% in Europe, where salt caverns represent a higher proportion than in other regions. Conversely, the CIS holds only three salt cavern facilities, Asia-Oceania only four and the Middle East none.

Table 2: Distribution of UGS facilities by region, as of end 2018

Regions	Number of UGS facilities		Working gas capacity		Max. withdrawal rates	
	Salt caverns	Porous reservoirs	Salt caverns	Porous reservoirs	Salt caverns	Porous reservoirs
North America	10%	90%	9%	91%	28%	72%
Europe	34%	66%	18%	82%	39%	61%
CIS	8%	92%	1%	99%	3%	97%
Middle East	0%	100%	0%	100%	0%	100%
Asia-Oceania	10%	90%	4%	96%	12%	88%
WORLD TOTAL	**15%**	**85%**	**8%**	**92%**	**26%**	**74%**

Note: Porous reservoirs include depleted fields and aquifers.

Source: CEDIGAZ

Table 3: Overview of underground gas storage in the world – Storage in operation as of end 2018

	Number of UGS facilities				Working gas capacity (bcm)			Max. withdrawal rate (mcm/d)		
	Salt caverns	Depleted fields	Aquifers	Total	Salt caverns	Porous reservoirs	Total	Salt caverns	Porous reservoirs	Total
NORTH AMERICA	**44**	**350**	**45**	**439**	**14.5**	**149.0**	**163.5**	**1 039**	**2 716**	**3 755**
Canada	6	47		53	0.5	27.3	27.8	18	362	380
United States	38	303	45	386	13.9	121.8	135.7	1 021	2 354	3 375
CENTRAL AND SOUTH AMERICA		**1**		**1**		**0.1**	**0.1**		**2**	**2**
Argentina		1		1		0.1	0.1		2	2
EUROPE	**48**	**74**	**20**	**142**	**19.6**	**88.1**	**107.6**	**806**	**1 288**	**2 093**
Austria		8		8		8.2	8.2		93	93
Belgium			1	1		0.7	0.7		15	15
Bulgaria		1		1		0.6	0.6		4	4
Croatia		1		1		0.6	0.6		6	6
Czech Republic	1	7	1	9		3.8	3.8		67	67
Denmark	1		1	2	0.4	0.4	0.8	13	13	25
France	3		10	13	1.1	10.6	11.7	56	167	224
Germany	31	11	5	47	15.2	9.1	24.3	530	146	676
Hungary		5		5		6.1	6.1		76	76
Italy		13		13		17.9	17.9		269	269
Latvia			1	1		2.3	2.3		30	30
Netherlands	1	4		5	0.3	12.1	12.4	44	234	278
Poland	2	7		9	0.7	2.5	3.2	28	24	52
Portugal	1			1	0.2		0.2	7		7
Romania		7		7		3.1	3.1		33	33
Serbia		1		1		0.5	0.5		5	5
Slovakia		3		3		3.6	3.6		44	44
Spain		3	1	4		2.9	2.9		28	28
Sweden	1			1	0.0		0.0	1		1
Turkey	1	1		2	0.6	2.8	3.4	20	25	45
United Kingdom	6	2		8	1.0	0.4	1.3	107	9	116
CIS	**4**	**32**	**12**	**48**	**0.9**	**119.8**	**120.7**	**31**	**1 178**	**1 209**
Armenia	1			1	0.2		0.2	6		6
Azerbaijan		2		2		3.3	3.3		13	13
Belarus	1	1	1	3	0.5	1.0	1.5	20	11	31
Kazakhstan		1	2	3		4.7	4.7		34	34
Kyrgystan		1		1		0.1	0.1		1	1
Russia	2	14	7	23	0.3	74.6	74.8	5	808	812
Ukraine		11	2	13		32.2	32.2		265	265
Uzbekistan		2		2		4.0	4.0		47	47
MIDDLE EAST		**3**		**3**		**9.3**	**9.3**		**34**	**34**
Dubai		1		1		3.3	3.3		4	4
Iran		2		2		6.0	6.0		30	30
ASIA-OCEANIA	**3**	**26**		**29**	**0.7**	**19.1**	**19.8**	**23**	**164**	**187**
Australia		8		8		7.2	7.2		27	27
China	3	11		14	0.7	11.0	11.7	23	133	156
Japan		5		5		0.7	0.7		2	2
New Zealand		1		1		0.3	0.3		1	1
Taiwan		1		1						
WORLD TOTAL	**99**	**486**	**77**	**662**	**35.7**	**385.4**	**421.1**	**1 899**	**5 382**	**7 280**

Notes:

'Salt caverns' include rock caverns.

The breakdown of capacity and withdrawal rates for storage groups in the Czech Republic and Denmark has been estimated as follows: Czech Republic: all in porous reservoirs, Denmark: half in salt caverns, half in porous reservoirs.

The table excludes mothballed or inactive storage facilities as well as strategic reserves.
Source: CEDIGAZ

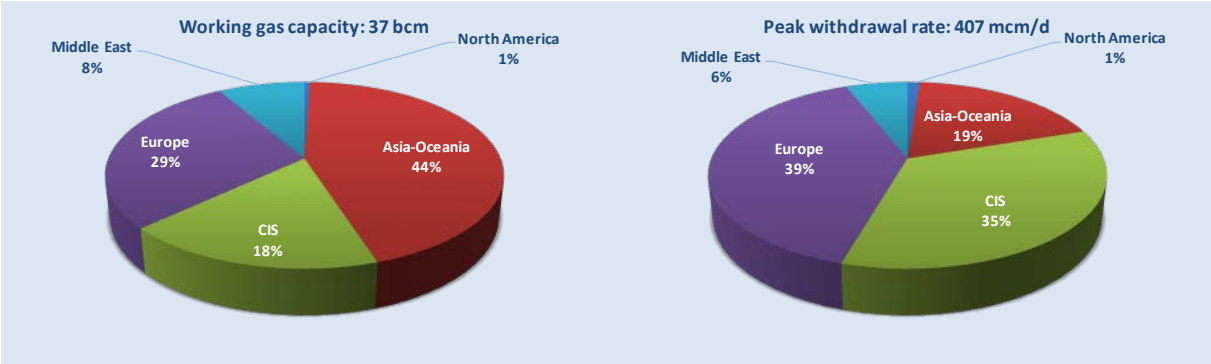
2. STORAGE PROJECTS

37 bcm of working capacity are under construction

The construction activity is dominated by China, which alone accounts for almost half of the 37 bcm of working gas capacity under construction

At worldwide level, there are 52 storage projects[4] under construction adding 37 bcm of working gas capacity. This includes 10 new storage sites (12 bcm) and 42 expansions (25 bcm). All regions, but Central and South America, participate in the construction activity, but there is a **shift of storage investment towards new emerging and growing gas consuming countries**. **China alone accounts for 44% of the capacity under construction.** It is worth noting that Europe ranks second with 28.5% of the global capacity under construction, but this activity is concentrated in two countries: Italy (7.1% of global capacity under construction) and Turkey (17.7%). Other regions/countries with significant projects include the CIS (18.1%) and Iran (8.3%). More than half of the capacity under construction in the world will be completed by 2021, continuing the recent trend of around 5 bcm of working gas capacity added each year. Additions to withdrawal capacity are largely dominated by Europe reflecting the focus towards highly flexible storage in the region.

Figure 6: Storage under construction as of end 2018 - by region

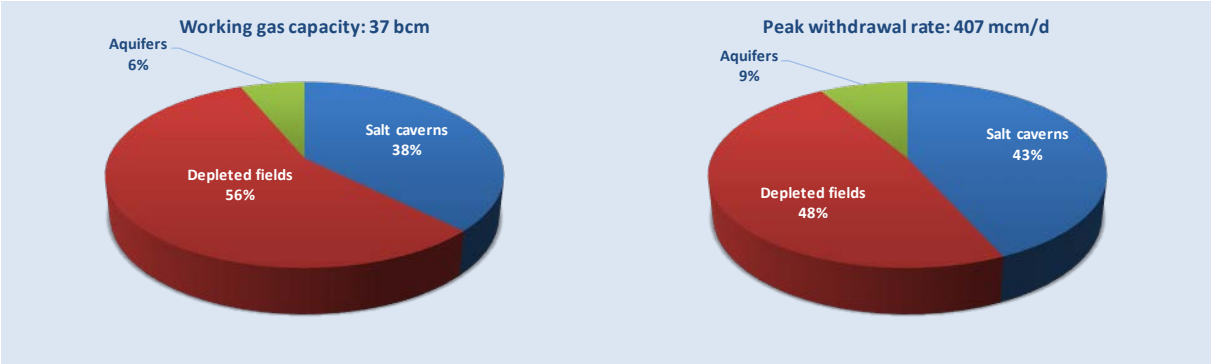


Source: CEDIGAZ

By type of storage, **salt cavern projects dominate in mature markets, while storage in depleted fields dominate in emerging markets**. At worldwide level, there are 32 UGS projects in depleted fields, totalling 21 bcm of working gas capacity (56% of the global capacity under construction). There are only two UGS in aquifers currently under construction (in Russia and Iran). Environmental issues make their construction more difficult and their relative low flexibility makes them less suitable to market needs in liberalized markets. There are 18 salt caverns projects. Most of them are built in Europe (mainly Turkey), but emerging markets (China, Iran) are also building this type of UGS. The working capacity (14 bcm) of salt caverns projects accounts for 38% of the total capacity under construction and their combined withdrawal rate for 43% of the total deliverability.

[4] Each phase of a multi-phase storage expansion is considered as one UGS project (when such information is available).

Figure 7: Storage under construction as of end 2018 - by type



'Salt caverns' includes one UGS in volcanic rock

Source: CEDIGAZ

Table 4: Storage projects under construction, as of end 2018

	Number of UGS facilities				Working gas capacity (bcm)				Max. withdrawal rate (mcm/d)			
	Salt caverns	Depleted fields	Aquifers	Total	Salt caverns	Depleted fields	Aquifers	Total	Salt caverns	Depleted fields	Aquifers	Total
NORTH AMERICA	**1**	**2**		**3**	**0.2**	**0.1**		**0.3**		**4.9**		**4.9**
Canada	1	1		2	0.2			0.2		1.5		1.5
United States		1		1		0.1		0.1		3.4		3.4
EUROPE	**6**	**11**		**17**	**5.7**	**4.9**		**10.6**	**72.6**	**88.2**		**160.8**
Czech Republic		3		3		0.2		0.2				
Germany	2			2	0.8			0.8	4.4			4.4
Italy		6		6		2.6		2.6		33.2		33.2
Serbia		1		1		0.3		0.3		5.0		5.0
Turkey	2	1		3	4.8	1.8		6.6	60.0	50.0		110.0
United Kingdom	2			2	0.1			0.1	8.2			8.2
CIS	**5**	**4**	**1**	**10**	**1.3**	**3.7**	**1.7**	**6.7**	**75.0**	**36.0**	**29.8**	**140.8**
Armenia	1			1	0.0			0.0	5.0			5.0
Azerbaijan		1		1		0.5		0.5		3.0		3.0
Belarus	1			1	0.5			0.5				
Georgia		1		1		0.3		0.3		2.0		2.0
Russia	3	1	1	5	0.8		1.7	2.5	70.0	5.0	29.8	104.8
Uzbekistan		1		1		2.9		2.9		26.0		26.0
MIDDLE EAST	**1**	**1**	**1**	**3**	**2.0**	**0.5**	**0.6**	**3.1**	**15.0**	**4.4**	**4.8**	**24.2**
Iran	1	1	1	3	2.0	0.5	0.6	3.1	15.0	4.4	4.8	24.2
ASIA-OCEANIA	**5**	**14**		**19**	**4.7**	**11.7**		**16.5**	**13.5**	**62.4**		**75.9**
Australia		2		2						5.2		5.2
China	5	12		17	4.7	11.7		16.5	13.5	57.2		70.7
WORLD TOTAL	**18**	**32**	**2**	**52**	**13.9**	**20.9**	**2.3**	**37.1**	**176.1**	**195.9**	**34.6**	**406.6**

Source: CEDIGAZ

Identified projects would add 69 bcm, but remain uncertain

At worldwide level, there are 102 identified projects at different stages of planning

At worldwide level, there are **102 identified projects** at different stages of planning (93 planned and 9 potential projects). **If all built, these projects would add 69 bcm of working gas capacity**. Data given in Tables 5 and 6 are only relevant for the three traditional storage regions (Europe, CIS and North America). Data on working gas capacity are missing for several announced projects in emerging gas countries. Therefore, although there is a clear shift of storage activity to emerging gas countries, the trend is not fully depicted by data on planned and potential projects.

Table 5: Planned storage projects, as of end 2018

	Number of UGS facilities				Working gas capacity (bcm)				Max. withdrawal rate (mcm/d)			
	Salt caverns	Depleted fields	Aquifers	Total	Salt caverns	Depleted fields	Aquifers	Total	Salt caverns	Depleted fields	Aquifers	Total
NORTH AMERICA	**6**	**3**		**9**	**0.9**	**1.3**		**2.2**	**40.9**	**14.0**		**54.9**
Mexico	1	3		4		1.3		1.3		14.0		14.0
USA	5			5	0.9			0.9	40.9			40.9
CENTRAL AND SOUTH AMERICA		**2**		**2**		**2.2**		**2.2**				
Brazil		2		2		2.2		2.2				
EUROPE	**16**	**22**	**1**	**39**	**8.8**	**11.0**	**0.5**	**20.3**	**208.3**	**74.2**	**5.2**	**287.7**
Albania	1			1	1.2			1.2	6.0			6.0
Bulgaria		1		1		0.5		0.5		4.6		4.6
Croatia		1		1						2.4		2.4
France	3			3	0.4			0.4	21.6			21.6
Germany	2			2	2.1			2.1				
Greece		1		1		0.4		0.4		4.0		4.0
Italy		9		9		3.1		3.1		36.2		36.2
Latvia			1	1			0.5	0.5			5.2	5.2
Netherlands	1			1	0.1			0.1				
Poland	3	2		5	0.8	0.2		0.9	39.5	5.0		44.5
Romania		4		4		1.2		1.2		8.2		8.2
Serbia		2		2		0.8		0.8		10.0		10.0
Slovakia		1		1		0.3		0.3		3.8		3.8
Turkey	1			1	1.0			1.0	19.2			19.2
United Kingdom	5	1		6	3.3	4.6		7.9	122.0			122.0
CIS	**4**	**3**	**3**	**10**	**1.3**	**5.9**	**3.0**	**10.2**	**47.2**	**7.6**	**74.0**	**128.8**
Armenia	1			1	0.1			0.1				
Azerbaijan	1	1		2	0.3	1.2		1.5				
Russia	2	1	3	6	0.9	0.7	3.0	4.6	47.2	7.6	74.0	128.8
Uzbekistan		1		1		4.0		4.0				
MIDDLE EAST		**7**		**7**		**3.7**		**3.7**		**60.0**		**60.0**
Iran		7		7		3.7		3.7		60.0		60.0
ASIA-OCEANIA	**8**	**18**		**26**	**4.0**	**21.6**		**25.6**		**106.1**		**106.1**
Australia	1	2		3						0.3		0.3
China	7	14		21	4.0	21.6		25.6		105.3		105.3
New Zealand		1		1						0.5		0.5
South Korea		1		1								
WORLD TOTAL	**34**	**55**	**4**	**93**	**15.0**	**45.7**	**3.5**	**64.1**	**296.4**	**261.9**	**79.2**	**637.5**

Source: CEDIGAZ

Table 6: Potential storage projects, as of end 2018

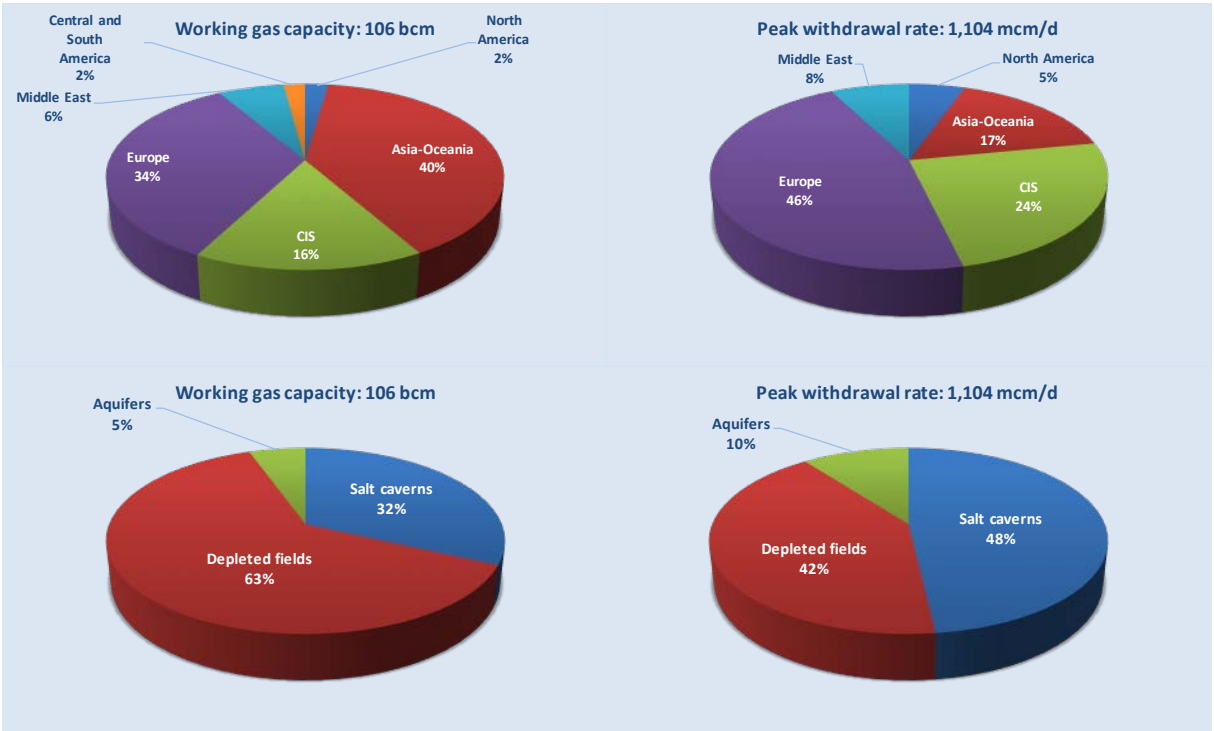
	Number of UGS facilities				Working gas capacity (bcm)				Max. withdrawal rate (mcm/d)			
	Salt caverns	Depleted fields	Aquifers	Total	Salt caverns	Depleted fields	Aquifers	Total	Salt caverns	Depleted fields	Aquifers	Total
EUROPE	**5**	**1**		**6**	**5.1**	**0.1**		**5.2**	**59.5**	**0.5**		**60.0**
Albania		1		1		0.1		0.1		0.5		0.5
Bosnia & Herzegovina	1			1	0.1			0.1	1.9			1.9
Portugal	1			1	0.1			0.1	3.1			3.1
Turkey	3			3	5.0			5.0	54.5			54.5
AFRICA				**1**								
Morocco				1								
ASIA-OCEANIA		**2**		**2**								
Australia		2		2								
WORLD TOTAL	**5**	**3**		**9**	**5.1**	**0.1**		**5.2**	**59.5**	**0.5**		**60.0**

Note: The number of total projects may differ from the sum of the different types of projects as some countries do not specify which kind of storage they plan to develop.

Source: CEDIGAZ

Altogether, **there are 154 projects under construction, planned or potential, totalling 106 bcm of working gas capacity**. This figure shows the readiness of the storage industry to continue investing in this key asset to support the expansion of the global gas market. However, the figure is much lower than in 2013 (peak year for storage projects) when 236 projects totalling 153 bcm of working gas capacity were either under construction or identified. This is due to two factors: in mature markets, numerous projects have been put on hold or even cancelled. In new and growing markets, there are numerous projects, but they are not yet identified precisely.

Figure 8: Storage facilities under construction, planned and potential, as of end 2018 - by region and by type



Source: CEDIGAZ

ANNEX: METHODOLOGY

CEDIGAZ UGS database compiles the existing and future Underground Gas Storage facilities in the World (under construction, Planned and Potential). The indicators have been selected to provide a database as close as possible from the reality of the market. You will find below some details about the chosen classification:

Type of data	Comments
Name of UGS facility	Some facilities are known under different names or belong to a storage complex/cluster: this information is listed next to the common name in order to give the clearest view of the UGS name. Expansions and their different phases are listed on separated lines so they can be clearly identified from the existing part of the storage. However, this information can not be given for storage groups (or virtual storage), for which data is given for the year.
Class	E (existing), N (new facility), or X (expansion of existing storage:additional caverns, new phase of development, increase of working gas capacity,...)
Type of storage	Depleted field, Aquifer, Salt cavern, Abandoned mine, Rock cavern, Volcanic Rock. 'Other' is used for a grouping of different types of UGS into a virtual gas storage
Status	In operation: UGS commissioned or technically ready (filling phase) Under construction: physical works on the facility have begun Planned: the project is referenced with at least a minimum of information though it may never be constructed Potential: under consideration for a possible development Other Status: * for existing facilities: Closed / Inactive / Mothballed * Strategic reserves: for instance in Russia, where some 40 bcm are being stored as long term reserves and could be technically considered as working gas * for projects: Cancelled / On hold * Unknown
Year UGS commissioned	Indicates the year of commissioning of the initial site. The year of commissioning of an expansion of an existing site is given separately, when known
Working Gas Capacity (WGC)	The maximum working gas capacity has been selected for the facilities in operation. Concerning the projects, this indicator reflects the designed working gas capacity, and can be adjusted once the storage is put in operation.
Cushion gas	Cushion gas is the volume of gas required as permanent inventory in a storage reservoir to maintain adequate pressure to ensure the deliverability of the working gas throughout the withdrawal season.
Peak withdrawal rate	Maximum delivery rate recorded for the facilities in operation. Expected maximum delivery rate for the projects.

CEDIGAZ UGS Excel file allows you to make your own research and tables, by country, region, type of storage, status (existing, under construction, planned, mothballed, closed, etc.), working capacity, withdrawal rates, year of commissioning, etc.

The file also includes tables for UGS in operation, under construction, planned and potential.

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