#31
November
2018

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INSIGHTS

UNDERGROUND GAS STORAGE IN THE WORLD - 2018 STATUS

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1. CURRENT CAPACITY OF UNDERGROUND GAS STORAGE IN THE WORLD

A slight increase in global working gas capacity

At the end 2017, there were 671 underground gas storage facilities in operation in the world. The global working gas capacity has slightly increased to 417 bcm, up 0.4% from the end of 2016

At the end 2017, there were 671 underground gas storage (UGS) facilities[1] in operation in the world (unchanged from the end of 2016). Only three new storage facilities were commissioned in 2017, in China, Turkey and the United States. But at the same time, some sites were closed in the United States and Europe. The **global working gas capacity has slightly increased to 417 bcm, up 0.4% from the end of 2016** (415 bcm revised).

In mature markets (North America, the European Union (EU) and the Commonwealth of Independent States (CIS)), storage capacity is stagnating, or even decreasing. Thanks to additional capacity in Turkey, total European capacity increased marginally. Turkey's Tuz Lake gas storage facility, which is expected to increase capacity from 1.2 bcm to as much as 5 bcm per year, was opened in February 2017.

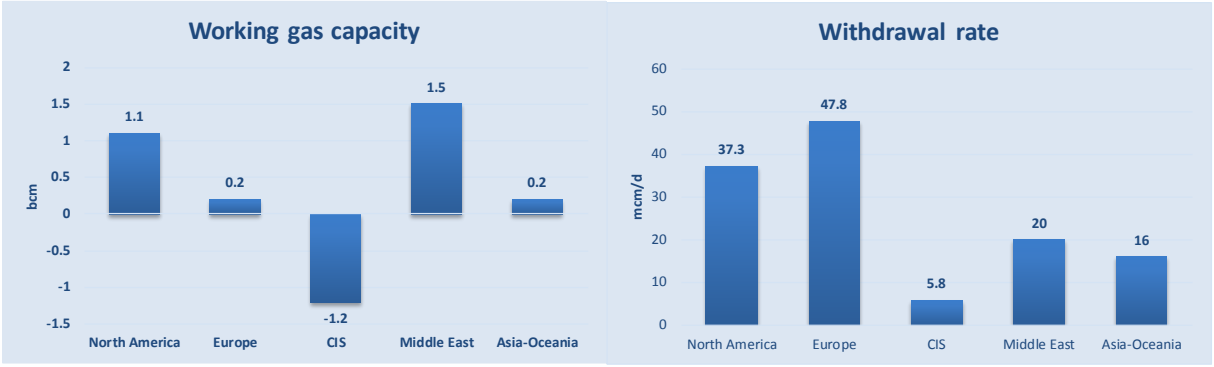
EU working gas capacity decreased again in 2017 (103.9 bcm at the end of 2017 compared to 104.4 bcm at the end of 2016), although the decline was much lower than that observed in 2016. Over the past two years, EU working gas capacity has decreased by 6.3 bcm due to the closure of storage facilities in Germany, Ireland and the UK. The temporary closure in 2016 of the Rough depleted field was confirmed as a permanent one in June 2017. This sharply reduces UK storage capacity, and notably its seasonal storage capacity.

On the contrary, **the storage market is driven by expansions in the Middle East (Iran) and China** (see Box 1).

The global peak deliverability rate increased to 7,251 million cubic meters per day (mcm/d) as of end 2017, up 1.8% from 2016. Most of the increase is due to flexible UGS in Europe and North America.

[1] Some individual storage sites are grouped into storage clusters (for instance in China and Russia). If counted as individual sites, there were 686 storage sites worldwide. Some storage facilities are inactive, mothballed or closed (41 UGS). If added, the world total was 727 UGS.

Figure 1: Major changes in working capacity and withdrawal rates (2017 vs. 2016)



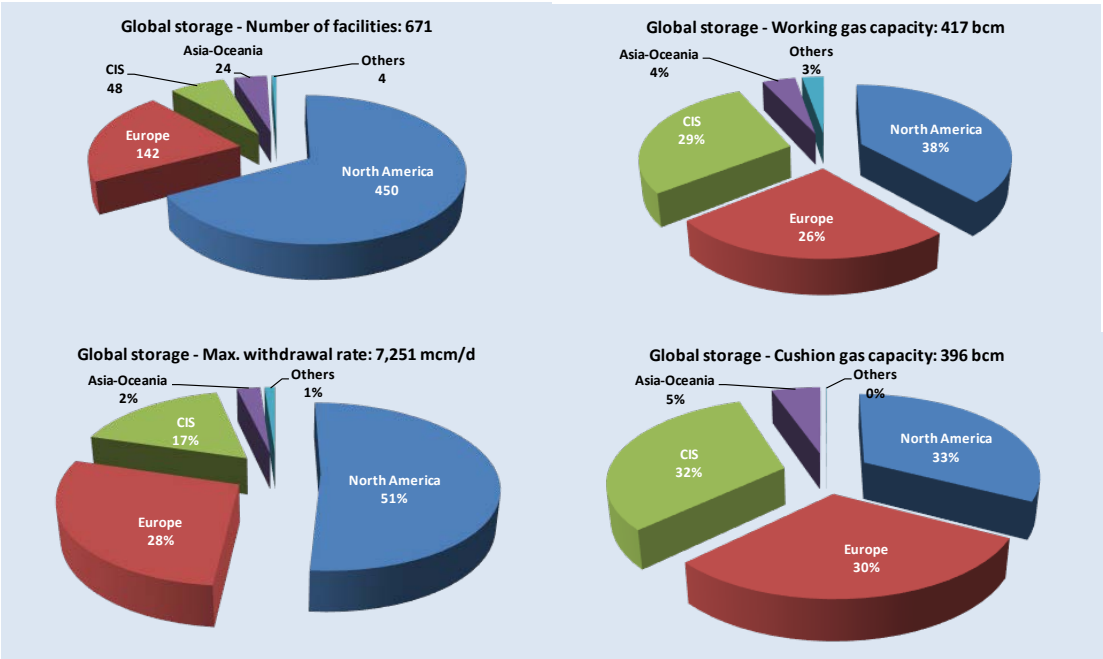
Source: CEDIGAZ

North America leads the market

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

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 388 active storages in the US, and 62 in Canada. They have a combined working capacity of 161 bcm (38.5% of the world total), and a peak withdrawal rate of 3,781 mcm/d (51% of the world total). **There are 142 facilities in Europe** (107.7 bcm, 2,047 mcm/d), **47 in the CIS** (119.6 bcm, 1,203 mcm/d), **28 in Asia-Oceania** (17.6 bcm, 184 mcm/d), and **3 in the Middle East** (11.4 bcm, 81 mcm/d). There is also one small UGS in Argentina.

Figure 2: Global underground gas storage as of end 2017 – 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

With the spectacular rise in its gas demand in 2017 to 235 bcm, up 15% over 2016, and the rapid implementation of the coal-to-gas policy, gas shortages across China have 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 a catalyst for accelerating gas market reforms and the construction of key infrastructure necessary to the continuation of the rapid development of the gas market.

At the end of 2017, China had 14 UGS in 27 reservoirs. CNPC operated 11 UGS in 24 reservoirs with a combined working capacity of 17.4 bcm (designed capacity). Sinopec operated 2 UGS with a working gas capacity of 1.5 bcm (designed capacity). In addition, the first phase of a salt cavern UGS project at Jintan in Jiangsu province, owned by The Hong Kong and China Gas Company Limited (Towngas), had been completed and commenced operation in 2017.

Information about China's effective working capacity varies but according to the International Gas Union, **total working capacity reached 10.5 bcm at the end of 2017.** The maximum withdrawal capacity is estimated at 151 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 2017

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
Dagang Banqiao cluster (6 UGS)	Tianjin	CNPC E&P	Depleted field	2000	1.92	34
Hutubi	Xinjiang	CNPC E&P	Depleted field	2013	3.50	28
Jin 58 cluster (3 UGS)	Beijing	CNPC E&P	Depleted field	2010	0.52	6
Jintan (HK and China Gas) First phase	Jiangsu	HK and China Gas	Salt Cavern	2017	0.06	
Jintan CNPC	Jiangsu	CNPC E&P	Salt Cavern	2007	0.18	12
Jintan Sinopec (first phase)	Jiangsu	Sinopec	Salt Cavern	2016	0.04	6
Lamadian (reconstruction)	Sangliao basin	CNPC E&P	Depleted field	2014	0.08	1
Liuzhuang	Jiangsu	CNPC E&P	Salt Cavern	2011	0.25	1.5
Shaan 224	Ordos, Changqing	CNPC E&P	Depleted field	2014	0.26	4
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
Wen 96	Henan	Sinopec	Depleted field	2013	0.21	5
Xiangguosi	Sichuan	CNPC E&P	Depleted field	2014	1.64	22
TOTAL					**10.55**	**151**

Source: CEDIGAZ

During the four months of the heating season in 2017-18, China withdrew 7.4 bcm, an increase of 21% compared with the same period in 2016-17, and the daily withdrawal rate reached 90 mcm/d, equivalent to 11% of peak daily gas consumption. **UGS accounts for only 3% of gas consumption, which is not compatible with China's rapidly developing natural gas demand and imports.** This means there is very limited ability to respond to the seasonality of gas demand or to supply issues.

To tackle the lack of gas storage, **the government has prioritised the development of storage infrastructure 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**. Although this would mark a large increase, this would still represent a tiny share of gas demand (less than 5% in 2020 and some 7% in 2030).

Development of gas storage (underground gas facilities and LNG tanks) and peak shaving mechanisms are the key focus in easing seasonal infrastructure bottlenecks.

CNPC 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 serve the Russia-China East Trunk Line. 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 bcm, would cost more than 21 billion yuan ($3.3 billion). PetroChina will start building two facilities in 2018 (Tongluoxia and Huangcaoxia UGS with a working gas capacity of 1.28 bcm).

Sinopec has also announced a huge development of its storage capacity, mainly in the central Henan province. In 2018, its UGS working capacity will be increased thanks to the commissioning of Wen 23 UGS. In addition to Wen 23 UGS, Sinopec plans to build 16 facilities at the site of non-operating oil and gas fields in the province, such as the Zhongyuan oilfield. The total new capacity has been reported at 55.6 bcm.

The expansion of UGS will help stabilize seasonal demand and price fluctuations in the wider Asian LNG markets. However, due to the long lead time necessary to develop UGS, **the new sites will not solve the immediate seasonal imbalance between supply and demand.** In the meantime, the government is promoting **a compulsory peak shaving mechanism for 200 mcm/d of supply**, half of which would be provided by the three NOCs and the other half by local governments. The level of the peaking mechanism **corresponds to 20% of future peak gas demand**. The NDRC issued a decree in March 2018 requiring 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.

Iran expects to start three new facilities shortly

Natural gas is vital for Iran’s economy, notably under renewed US sanctions. Natural gas provided 67% of total energy supply in 2017 when gas consumption reached 209 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 by 2020 and the peak withdrawal rate to 120-130 mcm/d**. In the longer term, about 10 percent of the country's annual gas consumption should be stored in UGS facilities.

At the end of 2017, Iran had two UGS in operation, with a working gas capacity of 8.1 bcm and a withdrawal rate of 76 mcm/d. 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.

Three other facilities are under construction. The **Yortsha** (or Yurtesha) 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. Studies on **Ghezel Tapeh** UGS started at the beginning of 2013 and NIGC published an engineering, procurement and drilling (EDP) tender for drilling and completion of an appraisal well in Qhezel Tapeh reservoir in February 2015. The facility developed with Khazar Oil Company will have a working capacity of 1.2 bcm.

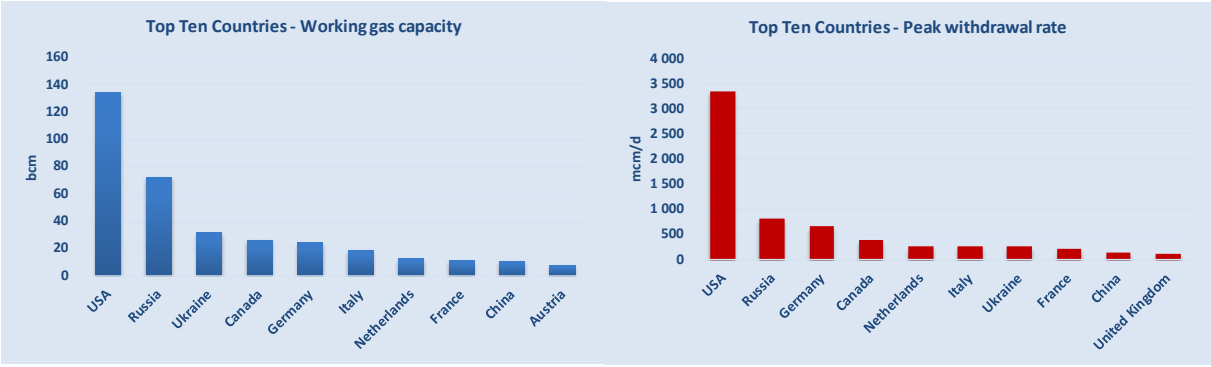
When fully developed, the five above-mentioned facilities will be able to store 11.9 bcm. In addition, several other storage facilities are planned in the country (Babaghir/Bankul UGS in Ilam Province, Mokhtar UGS in Kohgiluyeh and Boyer-Ahmad province and Ahmadi UGS in Fars). Studies are also underway for the construction of a storage facility at salt dome in Kashan, Isfahan 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 capacity, with 134 bcm out of a global volume of 417 bcm. Together with **Russia** and **Ukraine**, with respectively 72 bcm and 32 bcm of working capacity, **Canada** and **Germany** (26.5 bcm and 24 bcm respectively), **these five countries concentrate 70% of the worldwide capacities.** Italy, with 18.4 bcm of working capacity, remains in the sixth place, while France ranks seventh. Major changes have occurred since 2010: The Netherlands, China and Austria have entered in the Top Ten league. The Netherlands entered the league in 2015, following expansion of storage sites associated with the Groningen field and the commissioning of a large seasonal field (Bergermeer). China also entered the league in 2015 as several new storage facilities were commissioned in 2014 and 2015, following the policy adopted in 2012 favouring the development of storage. Austria is also among the Top Ten storage-holders thanks to the completion of the Haidach expansion and the commissioning of the 7Fields UGS in 2013. In terms of deliverability, the US and Russia remain the leading countries with withdrawal capacities of 3,344 and 808 mcm/d, respectively. Germany ranks third with 668 mcm/d.

Figure 3: World Top Ten storage countries, as of end 2017



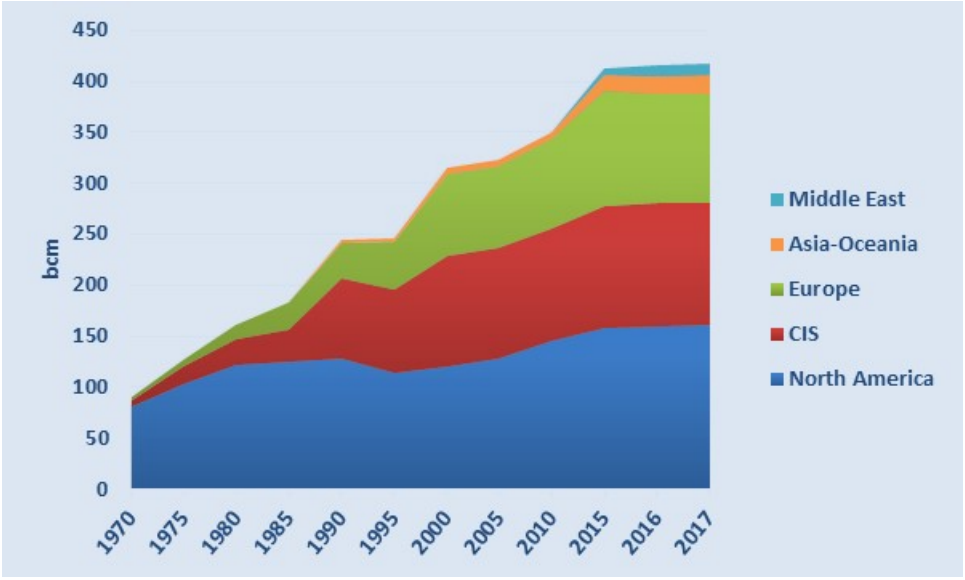
Source: CEDIGAZ

Historical evolution: the growth continues its slowdown

Despite rising gas demand, the growth in gas storage capacity has stalled since 2015

Global working gas capacity has increased significantly since 2010 (+67 bcm, or +19%). All regions participated in this growth until 2015. However, **since 2015, the growth has moderated and even reversed in some regions**. Asia-Oceania and the Middle East are the only two regions where growth in storage capacity is still significant. In Europe, only Turkey is building substantial storage capacities. The stagnation of storage capacity in mature markets has occurred despite the increase in their gas consumption.

Figure 4: Evolution of global working gas capacity, 1970 -2017



Source: CEDIGAZ

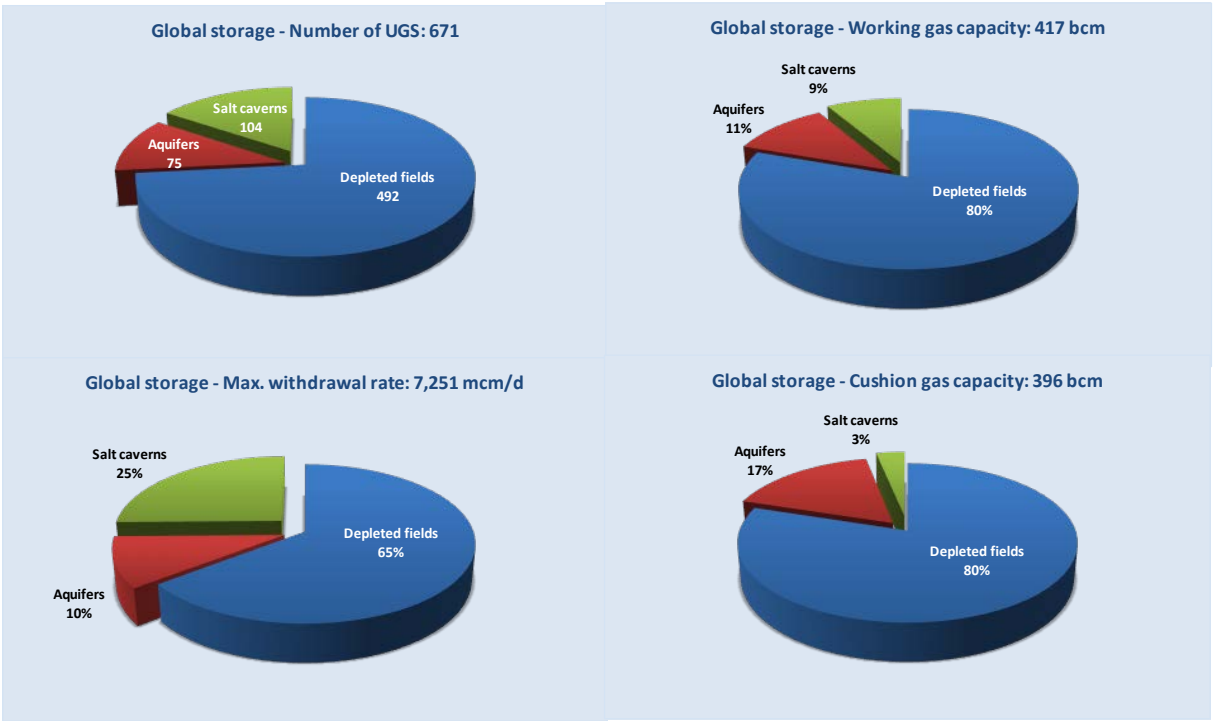
Depleted fields dominate, but UGS in salt caverns is key to deliverability

Storage in depleted fields dominate with 80% of global working gas volumes, but storage in salt caverns now accounts for 25% 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 492 facilities in the world, depleted fields represent 73% of the total number of sites and 80% 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 2017, **104 salt caverns facilities were in operation in the world** (76 in 2010), representing 15% of the world total. Although **salt caverns account for only 8.5% of global working gas capacity,** they can be rapidly cycled, and **they deliver up to 25% of global deliverability.**

Figure 5: Global underground gas storage as of end 2017 – by type



Note: Salt caverns include two rock cavern facilities and one abandoned mine.
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 65% 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

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	11%	89%	9%	91%	26%	74%
Europe	35%	65%	18%	82%	40%	60%
CIS	6%	94%	1%	99%	3%	97%
Middle East	0%	100%	0%	100%	0%	100%
Asia-Oceania	14%	86%	3%	97%	11%	89%
WORLD TOTAL	**15%**	**85%**	**8%**	**92%**	**25%**	**75%**

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 2017

	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	**48**	**359**	**43**	**450**	**14.7**	**146.0**	**160.7**	**958**	**2 773**	**3 731**
Canada	9	53		62	0.6	25.9	26.6	19	368	387
United States	39	306	43	388	14.1	120.0	134.1	939	2 405	3 344
CENTRAL AND SOUTH AMERICA		**1**		**1**		**0.1**	**0.1**		**2**	**2**
Argentina		1		1		0.1	0.1		2	2
EUROPE	**49**	**73**	**20**	**142**	**19.4**	**88.3**	**107.7**	**816**	**1 231**	**2 047**
Austria		8		8		8.1	8.1		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		7	7
Czech Republic	1	7	1	9	0.1	3.7	3.8	6	58	64
Denmark	1		1	2	0.4	0.4	0.9	14	11	25
France	3		10	13	1.1	10.6	11.7	77	132	210
Germany	32	11	5	48	14.9	9.1	24.0	519	149	668
Hungary		5		5		6.1	6.1		76	76
Italy		12		12		18.4	18.4		266	266
Latvia			1	1		2.3	2.3		30	30
Netherlands	1	4		5	0.3	12.1	12.4	45	232	277
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		32	32
Serbia		1		1		0.5	0.5		5	5
Slovakia		3		3		3.6	3.6		44	44
Spain		3	1	4		2.7	2.7		19	19
Sweden	1			1	0.01		0.01	1		1
Turkey	1	1		2	0.5	2.8	3.4	20	25	45
United Kingdom	6	2		8	1.1	0.4	1.5	98	9	107
CIS	**3**	**32**	**12**	**47**	**0.8**	**118.8**	**119.6**	**37**	**1 170**	**1 207**
Armenia	1			1	0.2		0.2	6		6
Azerbaijan		2		2		4.7	4.7		15	15
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	1	14	7	22	0.2	72.2	72.4	11	798	808
Ukraine		11	2	13		32.2	32.2		265	265
Uzbekistan		2		2		4.0	4.0		47	47
MIDDLE EAST		**3**		**3**		**11.4**	**11.4**		**81**	**81**
Dubai		1		1		3.3	3.3		4	4
Iran		2		2		8.1	8.1		76	76
ASIA-OCEANIA	**4**	**24**		**28**	**0.5**	**17.1**	**17.6**	**20**	**165**	**184**
Australia		7		7		6.1	6.1		29	29
China	4	10		14	0.5	10.0	10.6	20	132	151
Japan		5		5		0.7	0.7		2	2
New-Zealand		1		1		0.3	0.3		1	1
Taiwan		1		1						
WORLD TOTAL	**104**	**492**	**75**	**671**	**35.4**	**381.6**	**417.0**	**1 830**	**5 421**	**7 251**

Notes:

Salt caverns Include one abandoned mine and two rock caverns in Europe.

The table excludes mothballed or inactive storage facilities as well as strategic reserves (in Russia).

Source: CEDIGAZ

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- Monthly LNG flows and prices

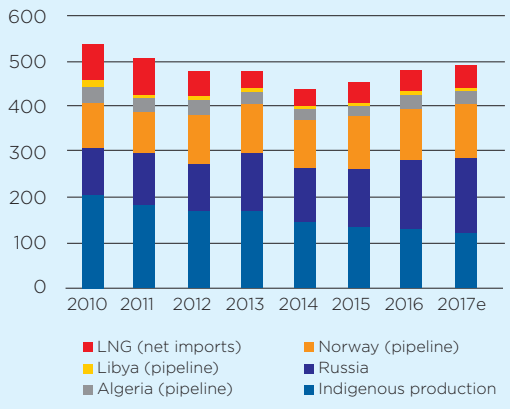
Planned and Existing Infrastructure

- LNG liquefaction plants
- LNG regasification plants
- Underground gas storage facilities

Contracts

- Long-term LNG supply contracts
- Long term pipeline gas supply contracts – Europe

Evolution of EU gas supplies



2. STORAGE PROJECTS

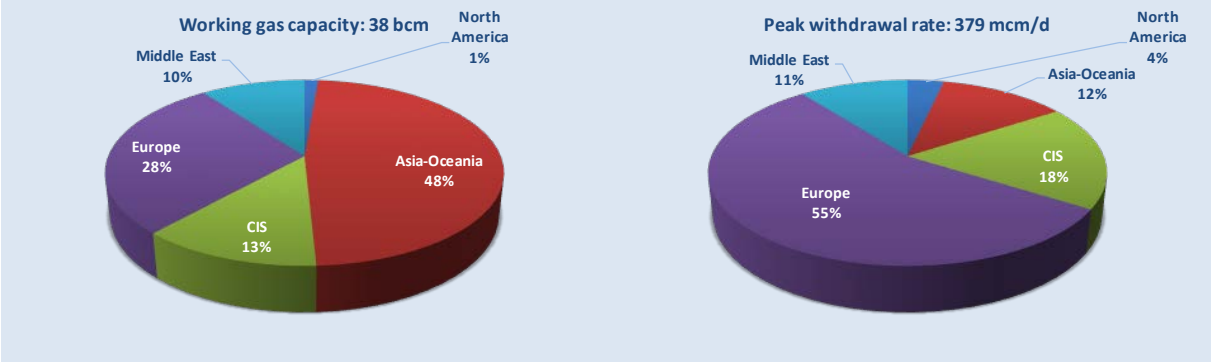
38 bcm of working capacity are under construction

The construction activity is dominated by China, which alone accounts for half of the 38 bcm of working capacity under construction

The capacity currently under construction has significantly increased in 2017, following major projects announced in China. **At worldwide level, there are 45 storage projects[2] under construction adding 38 bcm of working capacity (compared with 25 bcm at the end of 2016)**. This includes 16 new storage sites (17 bcm) and 29 expansions (21 bcm). Despite the lower number of projects under construction compared to past years' reports (48 projects in 2016 and 58 projects in 2015), the numerous projects in China have revitalized the storage market. **China alone accounts for half of the capacity under construction.** All other regions, but Central and South America, participate in the additions to storage capacity. It is worth noting that Europe ranks second, but capacity under construction is concentrated in Turkey, where expansion of current storage sites and a large new project will significantly increase storage capacity by 2023.

Most of the projects under construction in the world will be completed by 2020/25. The **shift of storage investment to new emerging and growing gas consuming countries** (mainly China and Iran) has continued with the two countries now representing almost 60% of all capacities under construction. Additions to withdrawal capacity are largely dominated by Europe reflecting the focus towards highly flexible storage in the region.

Figure 6: Storage under construction by region, as of end 2017



Source: CEDIGAZ

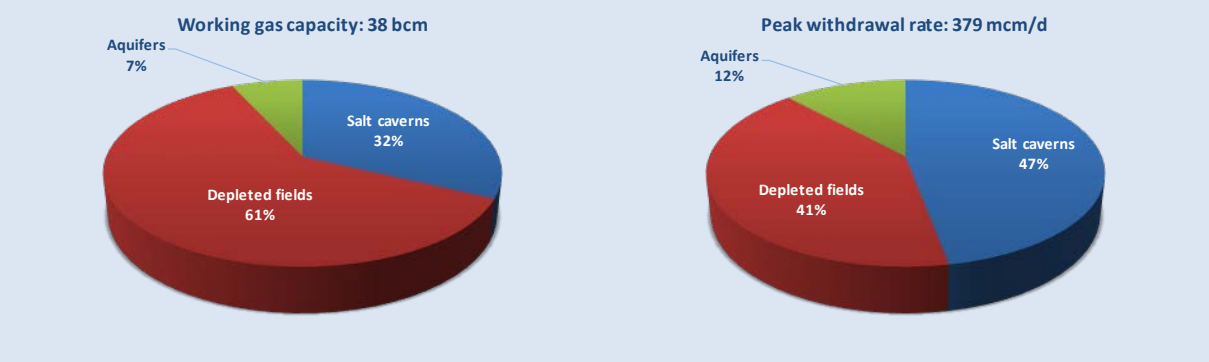
By type of storage, **salt cavern projects dominate in mature markets, while storage in depleted fields dominate in emerging markets**. There are only two UGS in aquifers currently under construction (in Russia and Iran). Environmental issues make their construction more difficult and their relative low flexibility makes them less suitable to market needs in liberalized markets.

Salt caverns projects represent almost 40% of projects under construction (17 projects). Most of them are built in Europe (mainly Turkey), but emerging markets (China, Iran) are also building this

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

type of UGS. The working capacity (12.2 bcm) of salt caverns projects accounts for 32% of the total capacity under construction and their combined withdrawal rate for 47% of the total deliverability.

Figure 7: Storage under construction by type, as of end 2017



Source: CEDIGAZ

Table 4: Storage projects under construction, as of end 2017

	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	**3**			**3**	**0.5**			**0.5**	**13.3**			**13.3**
Canada	1			1	0.2			0.2				
United States		2		2	0.3			0.3	13.3			13.3
EUROPE	**7**	**6**		**13**	**6.3**	**4.5**		**10.7**	**107.6**	**102.7**		**210.3**
Czech Republic		1		1		0.3		0.3		3.0		3.0
France	2			2	0.2			0.2	32.0			32.0
Germany	2			2	1.1			1.1	9.6			9.6
Italy		3		3		2.2		2.2		34.7		34.7
Serbia		1		1		0.3		0.3		5.0		5.0
Turkey	2	1		3	4.7	1.8		6.5	50.0	60.0		110.0
United Kingdom	1			1	0.2			0.2	16.0			16.0
CIS	**3**	**3**	**1**	7	**0.8**	**1.9**	**2.0**	**4.7**	**29.0**		**40.0**	**69.0**
Armenia	1			1	0.0			0.0	5.0			5.0
Azerbaijan		1		1		0.9		0.9				
Belarus	1			1	0.5			0.5				
Kazakhstan		1		1								
Russia	1	1	1	3	0.3	1.0	2.0	3.3	24.0		40.0	64.0
MIDDLE EAST	**1**	**1**	**1**	**3**	**2.0**	**1.2**	**0.6**	**3.8**	**15.0**	**20.0**	**4.8**	**39.8**
Iran	1	1	1	3	2.0	1.2	0.6	3.8	15.0	20.0	4.8	39.8
ASIA-OCEANIA	**3**	**16**		**19**	**2.6**	**15.6**		**18.1**	**13.5**	**33.0**		**46.5**
Australia		1		1						1.5		1.5
China	3	15		18	2.6	15.6		18.1	13.5	31.5		45.0
WORLD TOTAL	**17**	**26**	**2**	**45**	**12.2**	**23.2**	**2.6**	**37.8**	**178.4**	**155.7**	**44.8**	**378.9**

Source: CEDIGAZ

Identified projects would add 64 bcm, but remain uncertain

At worldwide level, there are 97 identified projects at different stages of planning

At worldwide level, there are **97 identified projects** at different stages of planning (planned and potential). **If all built, these projects would add 64 bcm of working 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, it is not possible to evaluate the shift of storage activity to emerging gas countries based on planned and potential projects.

Table 5: Planned storage projects, as of end 2017

	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	**4**	**3**		**7**	**0.5**	**1.3**		**1.8**	**15.3**	**14.0**		**29.3**
Mexico	1	3		4	0.0	1.3		1.3		14.0		14.0
USA	3			3	0.5			0.5	15.3			15.3
CENTRAL AND SOUTH AMERICA		**2**		**2**		**2.2**		**2.2**				
Brazil		2		2		2.2		2.2				
EUROPE	**15**	**23**	**1**	**39**	**10.6**	**10.6**	**0.5**	**21.7**	**245.8**	**63.9**	**5.2**	**314.9**
Bulgaria		1		1		0.5		0.5		4.6		4.6
Croatia		1		1						2.4		2.4
Czech Republic	1			1	0.2			0.2	23.6			23.6
Germany	2			2	2.1			2.1				
Greece		1		1		0.4		0.4		4.0		4.0
Italy		12		12		3.6		3.6		34.8		34.8
Latvia			1	1			0.5	0.5			5.2	5.2
Netherlands	1			1	0.1			0.1				
Poland	3	1		4	0.8			0.8	39.5	5.0		44.5
Portugal	1			1	0.1			0.1	3.1			3.1
Romania		4		4		1.2		1.2		9.3		9.3
Slovakia		1		1		0.3		0.3		3.8		3.8
Turkey	3			3	5.5			5.5	57.6			57.6
United Kingdom	4	2		6	1.9	4.6		6.6	122.0			122.0
CIS	**6**	**2**	**2**	**10**	**2.7**	**0.9**	**4.5**	**8.1**	**120.0**	**7.6**	**44.0**	**171.6**
Azerbaijan	1			1	0.3			0.3				
Georgia		1		1		0.3		0.3				
Russia	5	1	2	8	2.4	0.7	4.5	7.5	120.0	7.6	44.0	171.6
MIDDLE EAST		**3**		**3**								
Iran		3		3								
ASIA-OCEANIA	**7**	**16**	**1**	**24**	**1.9**	**22.7**		**24.6**		**92.4**		**92.4**
Australia	1	3		4		1.1		1.1		3.0		3.0
China	6	12	1	19	1.9	21.6		23.5		89.4		89.4
South Korea		1		1								
WORLD TOTAL	**32**	**49**	**4**	**85**	**15.7**	**37.7**	**5.0**	**58.3**	**381.1**	**177.9**	**49.2**	**608.2**

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

Table 6: Potential storage projects, as of end 2017

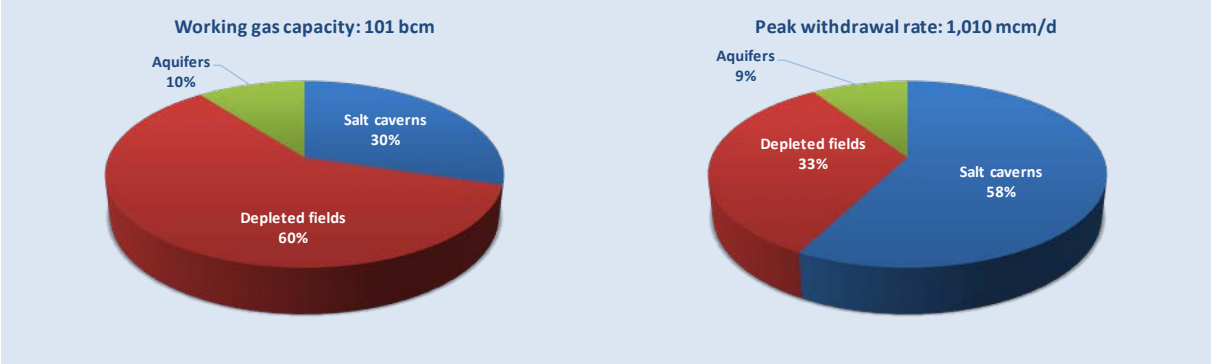
	Number of UGS facilities				Working gas capacity (bcm)				Max. withdrawal rate (mcm/d)			
	Salt caverns	Depleted fields	Aquifers	Total	Salt caverns	Depleted fields	Aquifers	Total	Salt caverns	Depleted fields	Aquifers	Total
EUROPE	**3**	**1**		**4**	**2.3**	**0.1**		**2.3**	**24.0**	**0.5**		**24.5**
Albania	1	1		2	1.2	0.1		1.3	6.0	0.5		6.5
Bosnia & Herzegovina	1			1	0.1			0.1	1.9			1.9
Turkey	1			1	1.0			1.0	16.1			16.1
CIS	**1**		**1**	**7**			**3.0**	**3.0**				
Russia	1		1	7			3.0	3.0				
AFRICA				**1**								
Morocco				1								
WORLD TOTAL	**4**	**1**	**1**	**12**	**2.3**	**0.1**	**3.0**	**5.3**	**24.0**	**0.5**		**24.5**

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 142 projects under construction, planned or potential, totalling 101 bcm of working 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 and accompany the trend towards more variable renewable energy sources. However, the figure is much lower than in 2013 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 identified precisely.

Figure 8: Storage facilities under construction, planned and potential, as of end 2017 - Working gas capacity and withdrawal rates



Source: CEDIGAZ

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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: 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.
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. - Adjustment: An adjustment has been added to reconcile data published by Storage groups with data from individual sites
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 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	- Can include working gas being kept as strategic storage, like in Russia where more than 40 bcm of cushion gas are being stored as long term reserves and could be technically considered as working gas
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.

LIST OF TABLES, FIGURES AND BOXES

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