

## NATURAL GAS STORAGE ROLE IN ENERGY SAFETY ASSURANCE IN POLAND

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**Abstract:** In the paper author considers possibility of natural gas storage in natural underground stores in large scale. The author presents natural gas stores in Poland with their technical and economical features and chances of their extension. He also presents influence of large scale gas storage on energy safety assurance.

**Keywords:** gas storage, energy safety

Natural gas storage is the primary means for the gas industry to manage fluctuations in supply and demand. Because of gas storage, gas production fields and transmission pipelines can function at a more constant and efficient rate. During times when consumers need less gas (typically during the summer), excess supply is sent into storage. When demand peaks (primarily during the winter) the stored gas can be withdrawn to meet the additional seasonal need. Some gas is also stored to meet short-term peaks in demand which can range from a few hours to a few days.

Natural gas storage can be also used for energy safety assurance of country and regions in case of large scale storage [1]. If there is a possibility of gas large volume storage fulfilling of three month and more demand, it is possible of independence achievement of price and supply volumes fluctuations, supply breaks and problems with suppliers because that case the storage owner achieve long time for negotiation and better negotiation position as well as possibility of other solution finding.

Natural gas can be stored in a variety of ways. It is most commonly held in natural underground stores under pressure in three types of facilities. These are: (1) depleted reservoirs in oil and/or gas fields, (2) aquifers, and (3) salt cavern formations. Natural gas is also stored in liquid form in above-ground tanks.

Each storage type has its own physical characteristics (porosity, permeability, retention capability) and economics (site preparation and maintenance costs, deliverability rates, and cycling capability), which govern its suitability to particular applications. Two of the most important characteristics of an underground storage reservoir are its capacity to hold natural gas for future use and the rate at which gas inventory can be withdrawn-its deliverability rate.

Most existing gas storage is in depleted natural gas or oil fields that are close to consumption centers. Conversion of a field from production to storage duty takes advantage of existing wells, gathering systems, and pipeline connections. Depleted oil and gas reservoirs are the most commonly used underground storage sites because of their wide availability.

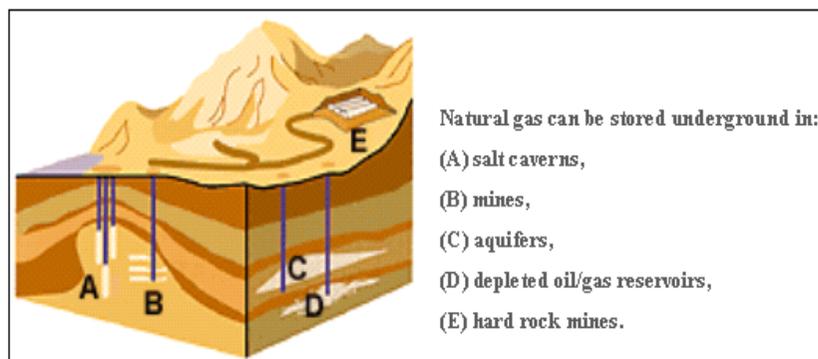


Figure 1 Natural underground gas storage types [2]

In some areas, natural aquifers have been converted to gas storage reservoirs. An aquifer is suitable for gas storage if the water bearing sedimentary rock formation is overlaid with an impermeable cap rock. While the geology of aquifers is similar to depleted production fields, their use in gas storage usually requires more base (cushion) gas and greater monitoring of withdrawal and injection performance. Deliverability rates may be enhanced by the presence of an active water drive.

Salt caverns provide very high withdrawal and injection rates relative to their working gas capacity. Base gas requirements are relatively low. Cavern construction is more costly than depleted field conversions when measured on the basis of dollars per thousand cubic feet of working gas capacity, but the ability to perform several withdrawal and injection cycles each year reduces the per-unit cost of each thousand cubic feet of gas injected and withdrawn.

There have been efforts to use abandoned mines to store natural gas. Further, the potential for commercial use of hard-rock cavern storage is currently undergoing testing in some countries. None are commercially operational as natural gas storage sites at the present time.

By 2006 PGNiG (the largest Polish oil and gas exploration and production company) owned 6 underground gas storage facilities which storage capacities amounts to 1.49 bcm. In total sale which amounts in 2004 to 13.1 bcm (converting into high methane natural gas), which gives 11.4% of annual consumption or 42 days of average consumption.

Table 1 Natural gas storage system in Poland

Underground gas storage facilities	Name	Working capacity (mln m <sup>3</sup> )	Max collecting capacity (mln m <sup>3</sup> /day)
<p>▲ Existing store ● Stores in extension</p>	<b>Working</b>		
	Strachocina	100	1,2
	Husów	400	5,7
	Brzeźnica	65	0,9
	Swarzędz	90	1,2
	<b>In development</b>		
	Mogilno	331	20,0
	Wierzchowice	500	4,3
	<b>Total</b>	1486	33,3

The level of demand for natural gas is not steady, but it changes throughout the year. Periodically the peak period is declared to be in winter season (heating). Because of the fact that the level of delivery is constant throughout the year it must be stored in summer season and efficiently transferred into the gas transfer system in winter season (peak period). Security of the State in gas supply requires its storage.

Idea of underground natural gas storage (Polish abbreviation: PMG) for assurance of gas supply continuity is based on the development of existing underground stores capability it is also important because of the gas underground storage facilities features:

- secure safety of deliveries to end-users
- enable balance of seasonal differences between demand and gas supply
- enable us to lead in rational way exploitation of natural gas deposits
- enable us to create economic and strategic reserves of natural gas

As it was noticed above, at present PGNiG posses 6 underground stores with 1.486 mln m<sup>3</sup> of total capacity and maximum ability of daily receive 26,5 mln m<sup>3</sup>.

However as the Author researches show the storage capability can be extended and in effect the independence on the short term gas market fluctuation can be higher and higher. Below there are some calculations and features describing development possibilities of natural gas storage in PGNiG facilities:

- a) PMG – Wierzchowice – in dolnoslaskie voivodoship villages Krosnice i Milicz. It is created in partly used natural gas deposit. About 12,4 mld m<sup>3</sup> were exploited during dozen years. At present 500 mln m<sup>3</sup> of natural gas can be stored and 4,3 mln m<sup>3</sup> can be receive daily. The purpose is to store 4,3 mld m<sup>3</sup> and receive 50 mln m<sup>3</sup> daily.

Net value of assets:	43 mln PLN
Annual costs of storage:	
Exploitation costs:	13 mln PLN
Amortization:	17,9 mln PLN
Storage cost of 1000 m <sup>3</sup>	61,9 PLN
Personnel	50 persons

- b) PMG – Husow – located near Lancut in podkarpackie voivodoship. About 1.627 mln m<sup>3</sup> were exploited. In created store 400 mln m<sup>3</sup> of natural gas can be kept. Maximum capacity of the sore is 562 mln m<sup>3</sup> of natural gas and 5,76 mln m<sup>3</sup> can be received daily.

Net value of assets:	136,9 mln PLN
Annual costs of storage:	
Exploitation costs:	14 mln PLN
Amortization:	13,2 mln PLN
Storage cost of 1000 m <sup>3</sup>	68,1 PLN
Personnel	53 persons

- c) PMG – Mogilno – located near Mogilno in kujawsko-pomorskie voivodoship. Sore has been created in salt diapir. At present there are 8 chambers with 441 mln m<sup>3</sup> of total capacity. It is possible to extend this store for next 12-15 chambers and obtain 1,1 mld m<sup>3</sup> of total capacity. The possibilities of receiving are about 13 mln m<sup>3</sup> daily.

Net value of assets:	353,6 mln PLN
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Annual costs of storage:	
Exploitation costs:	13,5 mln PLN
Amortization:	37,8 mln PLN
Storage cost of 1000 m <sup>3</sup>	155,4 PLN
Personnel	26 persons

*Local underground storages of natural gas*

- d) PMG Strachocina – near Sanok in podkarpackie voivodoship.  
Storage created in former gas main where 3.914 mln m<sup>3</sup> of natural gas has been got out. At present total capacity of this store is about 100 mln m<sup>3</sup> and 12 mln m<sup>3</sup> can be received daily. It is possible to extend of cubic capacity of this store.

Net value of assets:	8,4 mln PLN
Annual costs of storage:	4,5mln PLN
Storage cost of 1000 m <sup>3</sup>	45 PLN
Personnel	22 persons

- e) PMG Swarzędów – w pobliżu Dąbrowy Tarnowskiej i Oleska w woj. małopolskim.  
Storage created in former natural gas main. At present total capacity of this store is about 90 mln m<sup>3</sup> and 1,3 mln m<sup>3</sup> can be received daily. There is no possibilities to extend this storage.

Net value of assets:	881 tys. mln PLN
Annual costs of storage:	5 mln PLN
Storage cost of 1000 m <sup>3</sup>	55,5 PLN
Personnel	25 persons

- f) PMG Brzezница - near Debica in podkarpackie voivodoship.  
Storage created in former natural gas main. At present total capacity of this store is about 65 mln m<sup>3</sup> and 1,0 mln m<sup>3</sup> can be received daily. There is no possibilities to extend this storage.

Net value of assets:	323 tys. mln PLN
Annual costs of storage:	1,5 mln PLN
Storage cost of 1000 m <sup>3</sup>	23 PLN
Personnel	16 persons

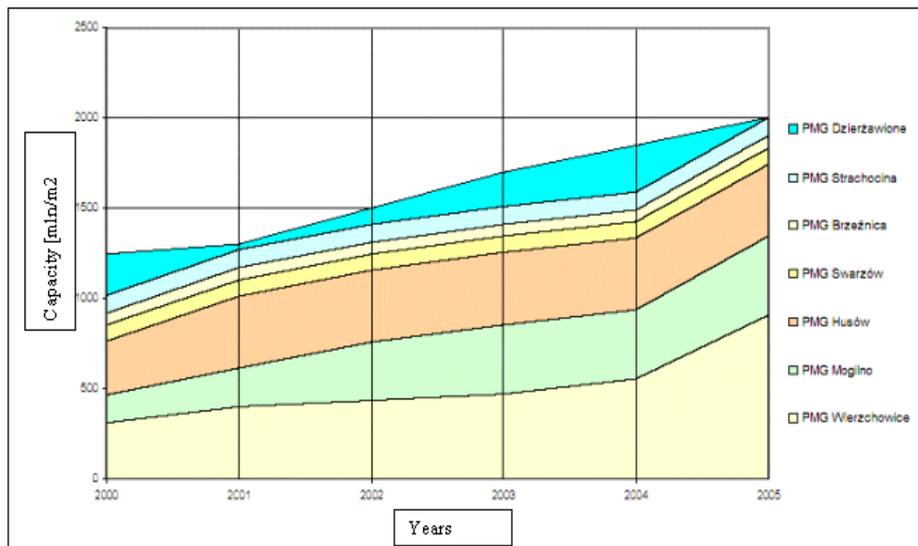
Relation between active capacity of underground natural gas stores and annual gas consumption by PGNiG S.A. customers in the year 2006 is 13,4% which covers average demand for 49 days. However the the capability can be extended.

It is necessary to built more storage places from 1,4 mld m<sup>3</sup> to 3,0 mld m<sup>3</sup> and more in nearest years to achieve 90 days demand capacity. It help to rise independency from market fluctuation and allow to avoid threaten of terrorism attacks because of storage location in exploited salt of natural gas mines.

Caring about continuity of deliveries, ability to store natural gas by PGNiG is being gradually increased. (see Figure 2).

PGNiG is executing plan of increasing capacity of gas storage facilities from 2,8 billions m<sup>3</sup> to 17% of annual gas consumption by 2012. Investment in storage infrastructure is strategic decision of PGNiG [4]. Not only is it an element of preparation to new requirements of Law on reserves of oil, oil products and natural gas, which came into operation in 2007 but also an element of preparation to act on very competitive European natural gas market. In 2006

PGNiG started building of two new caverns in Cavern Underground Gas Storage Facility in Mogilno prepared to new investments connected with development of Underground Gas Storage Facility in Wierzchowice and Underground Gas Storage Facility in Strachocina. It is expected that capital expenditure will amount to 1,4 billion złotych.



**Figure 2 Capacity PMG necessary to cover business requirements [3]**

PGNiG data says that peak demand for high methane natural gas reached 46,6 mln m<sup>3</sup>/day in winter season 2000/2001, 62,7 mln m<sup>3</sup>/day in winter season 2003/2006 and 70 mln m<sup>3</sup>/day in winter season 2005/2006. Designed storage demands are estimated as 4,1-5,1 billions m<sup>3</sup> in 2010 and 5,3-6,8 billions m<sup>3</sup> in 2020.

There are favorable conditions to build underground gas storage facilities in used up deposits of natural gas in Poland. They are situated both on Niż Podolski and Podkarpacie and in salt deposits. It is also considered to build small local storage facilities in used up mine workings. Gas storage serves as method of securing gas deliveries to end-users that is balance of gas system, securing gas deliveries in peak periods and safety of deliveries. Storage facilities take in surplus of gas from system in summer season and replenish system in natural gas in winter season.

## Literature

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