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# Impact of European Liberalization on Development of Gas Storage Prices in Europe

*Bakalářská práce*


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## Abstrakt

Hlavním tématem této práce jsou podzemní zásobníky plynu a jejich vývoj v důsledku evropské liberalizace plynu. Začátek práce je věnován samotné liberalizaci plynu a prostředkům, které používá. Historie liberalizace je zmíněna a také její následky pro trh zásobníků plynu. Druhá část je věnována samotným zásobníkům. Jednotlivé typy zásobníků jsou charakterizovány podle svých vlastností. Práce se zde zajímá o vztah mezi zásobníky plynu a forwardovým trhem s plynem, který se v Evropě rozvinul v posledním desetiletí. Závěrečná část je věnována budoucnosti zásobníků a jejich roli v Evropě závislé na dovozu plynu.

## Klíčová slova

podzemní zásobníky plynu, evropská liberalizace, investice do zásobníků plynu, forwardové trhy, ohodnocování zásobníků plynu

## Abstract

Gas storages are the main topic of this thesis and their development as a result of European gas liberalization. The beginning of this work is dedicated to the liberalization itself and to the instruments it uses. History of liberalization is mentions and also their consequences for gas storage market. The second part concerns to the gas storages. Different types of facilities are characterized based on their properties. Thesis is interested in relation between gas storages and forward markets with gas, which developed in Europe in last decade. The final part looks into the future of gas storages and their role in import-dependent Europe.

## Keywords

gas storages, European liberalization, gas storage investments, forward markets, gas storage valuation

**Rozsah práce: 68 227 znaků (včetně mezer)**

## Prohlášení

1. Prohlašuji, že jsem předkládanou práci zpracoval samostatně a použil jen uvedené prameny a literaturu.
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## Declaration

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2. I declare that the thesis have not been used for obtaining another title.
3. I agree on making this thesis accessible for study and research purposes.

V Praze dne 10. 5. 2013 Ján Zámečník

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## Institut ekonomických studií

## Projekt bakalářské práce

V této práci se budeme zabývat tématem podzemních zásobníků plynu, neboť nejistota na trzích s plynem způsobená například přerušovanými dodávkami v lednu 2009 zvýšila atraktivnost tohoto odvětví. Zejména v Evropě, kde je pro většinu zemí plyn dovozním artiklem, je toto téma velmi živé. Konkrétně budeme zkoumat, jak se vyvíjela cena skladovacích kapacit v důsledku evropské liberalizace plynárenství. Pokusíme se najít a určit hlavní příčiny tohoto vývoje zkoumáním nabídky a poptávky po skladovacích kapacitách a po plynu a jejich dopad z hlediska problematiky bezpečnosti dodávek. Také se zaměříme na změnu ve způsobu nahlížení na hodnotu podzemních zásobníků plynu způsobenou vznikem spotových a forwardových trhů s plynem. V jedné z kapitol se pak podíváme na situaci v České republice.

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## List of abbreviations

UK – United Kingdom

DG COMP – Directorate General for Competition

NCG – NetConnect Germany

TTF – Title Transfer Facility

GIE – Gas Infrastructure Europe

MWh – Megawatt-Hours

GPL – Gaspool

CEGH – Central European Gas Hub

Bcm – Billion Cubic Metres

SBU – Standard Bundle Units

# Introduction

Recent gas market liberalization introduced significant changes in gas markets. These changes intend to change the structure of national as well as European gas markets. They aim to decrease the market power of former state monopolies and introduce competition to gas markets. This competition should bring lower prices and higher output as well as higher price transparency and stable supply of gas.

This thesis evaluates the impact of liberalization on gas storages. This branch of gas industry is relatively new. Formerly gas storage facilities served as buffers in cases of supply shortages. As a result of liberalization new opportunities emerged and gas storages became attractive business. With development of spot and forward markets and gas hubs gas storages play important role in order to maintain flexibility on these markets.

Gas storages are one of the possible solutions to supply shortages. European Union´s increasing dependence on gas imports requires additional investments in this field in order to prevent energy crisis. This thesis evaluates future development of the gas storage business.

The main objective of this thesis is to bring more attention to gas storages. The liberalization totally changed their nature. This thesis looks for incentives for further investments and necessity of deeper market integration in order to develop fully competitive gas storage market.

# 1. Liberalization

## 1.1. Mechanisms of liberalization

**Liberalization** is the process of removing or loosening the government restrictions on market. Liberalization can take place in many areas such as social or economic policy. The latter is often linked to privatization but it should be noted that privatization and liberalization are not necessarily the same things. The markets which are most often monopolized usually have monopolistic or oligopolistic character with high input costs as these costs were usually paid by government. This work focuses on gas market liberalization in the Europe.

European commission had some objectives for this process it wanted to fulfill. These changes "aim to create internal and external competition based on a competitive unified gas market by integrating traditional and new suppliers (Libya, Nigeria, Qatar, Caspian countries), and by development of spot markets around gas 'hubs', which are being developed. The objective is to secure lower-price supplies for all categories of consumers. Less expensive gas will be obtained by eliminating 'rents' at all levels of the gas supply chain through competitive pressure. Also stability of gas supplies to Europe will be ensured by strengthening technical and trade links between national markets, based on their interdependence." (Finon and Locatelli, 2002, p. 3)

There were several ways European Commission wanted to improve gas market performance. The **third party access (TPA)** was introduced. It is an idea that "in certain circumstances economically independent undertakings operating in the energy sector should have a legally enforceable right to access and use various energy network facilities owned by other companies." (Kotlowski, 2007, p. 1) This law gives the customers the right to choose their own supplier of natural gas. Originally only the big consumers were involved but now the process spread even to the smaller ones.

Every member state could select whether it would **regulate** or **negotiate TPA**. The first one refers to the fact that the access to the storage or transmission and the prices were regulated by an independent office while the second one creates the environment for bargaining between the owner of the facility and the possible supplier. The second approach is more exploitable because it gives the owner an opportunity to set the prices high enough to prevent other market players to enter. Moreover the owner of the facility

can deny the access to other competitors should he be unable to fulfill his own obligations against the customers mainly because of capacity restrictions and take-or-pay obligations. This approach could create significant obstacles in implementing the TPA.

**Take-or-pay contracts** are signed between the owner of natural gas and the buyer who imports and resell the gas. The main idea behind these contracts lies in the diversification of risks. It provides the extractor with some level of security because of the huge up-front investments necessary for gas extraction. The owner specifies the amount of gas buyer can buy for fixed payment with zero marginal costs. When the buyer needs more gas, he can purchase it but with positive marginal costs. This system puts some price risk on the owner while the buyer bears the whole quantity risk. "It is often claimed that vertical integration would be the natural way to ensure the upstream firm to be able to resell the contracted gas in the final market, covering their t.o.p. obligations." (Polo and Scarpa, 2003, p. 4)

**Vertically integrated firm** often enjoys high economies of scope. In context of gas industry it means that the extraction, transportation, distribution and the final sale is done by one firm. In the gas industry, traditional benefits such as lower transaction costs or no double marginalization are strengthened by the burden of long-term investment in transmission and so on. This is covered by above mentioned take-or-pay contracts for example. Vertically integrated firms can and often are strong players on markets usually preventing competition so there are efforts to change it.

One way to do that is **unbundling**. It is a process of breaking apart something into smaller parts[1]. In the context of vertically integrated firms it is a tendency to divide it into smaller companies with each of them taking care of different parts of business. European liberalization focused mainly on the transmission, distribution and storage because these sections could be a barrier for creation of competitiveness. There are several ways in which the unbundling can be presented.

The first one is the ownership unbundling. It is the most radical way and requires that all activities within the vertically integrated firms are separated into independent companies. This implies the highest level of independence but also the highest resistance from companies.

The second one is functional unbundling. According to Gao (2010, p. 33) these "regimes are intended to change the organization and decision-making of gas

[1] According to businessdictionary.com

corporations. Even if a gas structure company remains a subsidiary in a vertically integrated company, it will act more independently and fairly when providing infrastructure service for its market affiliates and other companies." This means that the decisions and organization of this subsidiary should be totally independent of the parent company from other activities not related to the subsidiary.

Legal unbundling for transmission and distribution activities has to be done by separate network which is not required to own the assets it operates with but it has to have the decision making rights in line with the functional unbundling mentioned above. There is not an "obligation to separate the ownership of assets of transmission/distribution system from the vertically integrated undertaking." (Portörő, 2007, p. 2)

The most harmless type of unbundling is the accounting unbundling which requires separate accounts maintenance for transmission and distribution objects. Countries which applied this type of unbundling reported the lowest level of openness of the market. On the other side countries with ownership unbundling showed a better result in openness.

## 1.2.History of liberalization

In 1998 European Commission promoted liberalization in natural gas industry through Directive 98/30/CE. Member states were bounded to implement this first Directive into their own legal system by the end of July 2000. The main issues of the first Directive were market opening and steps towards changing the industry structure. Also network access conditions were changed. Legal unbundling and regulated or negotiated third party access were the main pillars to achieve higher competition and efficiency on natural gas markets.

So far, European natural gas markets were characterized by high degree of market concentration and insufficient unbundling. There were huge differences in prices and tariffs in different member states of European Union. No market based balancing regimes except for United Kingdom were applied and even in the UK the market solution was not totally pure.

After the approval of the first Directive, Commission came with some additional remarks which were really ambitious. Commission asked for liberalized access for business consumers by 2004 and for all consumers by 2005. The gas market regulation should shift from national government´s supervision to an independent regulator.

The process of adoption of the first Directive was slow. Mainly France and Germany were blocking the adoption. Germans were not able to implement the First Directive even by autumn of 2002 despite the fact that the deadline was two years ago. There was also a struggle between France and the Commission about the date of market opening for households. Finally, this dispute ended in a draw and France agreed to the adoption of the Directive.

The Directive 2003/55/EC of June 26, 2003, originally known as the acceleration one, continued in the process of liberalization. The market opening for households was set on July 1, 2007, two years later than commission originally intended. This was the result of the struggle mentioned above. On one hand, France could delay adoption of this Directive. On the other hand, Commission could assert the date of the market opening for business consumers. The obvious fact is that the households were the only ones negatively affected by this struggle.

The second Directive became a poor version of the Commission's ambitious plans. Instead of introducing directly regulated Third Party Access for storage, the Directive did not change anything in this direction and allowed both regulated and negotiated access to storage. The changes in degree of unbundling were postponed; the only introduced innovation was the concept of management unbundling. The Commission's target of establishing independent regulators in member states failed in the way that allows regulatory authorities to share the sector regulation.

As can be seen the obstructions by Germany and France led to limited qualitative progress achieved by the second Directive. „Noteworthy in this context is that the second Directive laces more emphasis on security of supply and other public service obligations." (Haase, 2009, p. 174)

The commission proposed to treat gas storage as a public property in order to transfer part of decision-making power from private to public. This was supposed to secure the gas supply and make European Commission the keeper of the security of supply in Europe. This concept was disapproved by the European Parliament on 22 September 2003 in its plenary session.

The original proposal suggested that „member states should impose minimum storage objectives on undertakings." (Haase, 2009, p. 176) This action would have huge impact on gas sector as the capacity of storages was suddenly decreased. Moreover the Commission not only wanted to intervene in the market but also wanted to control the release timing of the stored gas. These proposals were successfully rejected by the Parliament, the Commission and involved Committees. None of the ambitious aims of Commission about security of gas supply was included in Directive concerning the security. Instead, member states were obligated to report the contract duration of supply arrangements.

The inquiry about natural gas market took place on 13 June 2005. It was enabled due to new regulation for DG COMP which then can control markets if they had suspicion that competition may by restricted within the common market. European Commission needed to justify the inquiry but this was not a problem. The market indicated rising prices, slow integration and high market concentration. There were also high concerns about price development. According to the investigation by DG COMP, Commission deduced that the lack of liquidity on the market leads to price volatility and because of that the prices could be manipulated.

The investigation pointed out the well-known fact of market malfunctions. Commission targeted the main five of them: market concentration, lack of liquidity on the gas market, insufficient market integration indicated by numerous barriers towards cross-border trade, hampering competition due to the lack of transparency and high prices in conjunction with a lack of trust in price formation on wholesale level. Inquiry also showed that the degree of unbundling was still insufficient and a lot of companies did not cancel long-term contracts. This led to vertical foreclosure and prevented creation of competitive market. This inquiry was Commission´s preparation for the next directing of EU energy policy.

From behavior of member states and their statements concerning gas market policy was obvious that the majority was kind of reluctant mainly during the inquiry. Of course some states act pro-actively, for example United Kingdom or Netherlands who asked for earlier implementation of the second Directive.

Another step in the creation of a competitive market was the establishment of the Gas Regional Energy Markets in 2007. This divided the European gas market into three sectors: south, south-east and north-west. As the political will of whole EU was very weak, these institutions were supposed to identify and remove the barriers on regional

level. This scheme seemed promising nevertheless there was a danger of market fractioning.

In the energy package, issued in 2007, „three main dimensions of energy policy were covered. i.e. supply security, the environment and the market, with concrete proposals for all three, underlining the comprehensive character of the package." (de Jong, 2008, p. 5) Energy package is based on three pillars and for this thesis the first one is the most important. „A true Internal Energy Market where the aim is to give real choice to EU energy users, whether households or business, and to trigger the huge investments needed in energy. The single market is good not just for competitiveness, but also for sustainability and security. Analysis shows that further action is required to deliver these aims through a clearer separation of energy production and supply from energy transmission. It also calls for stronger independent regulatory control, taking into account the European market, as well as national measures to deliver on the EU´s target of 10% minimum interconnection levels by identifying key bottlenecks and appointing coordination." (de Jong, 2008, p. 6) The other ones contain the shift to low carbon energy and the objective to save about 20 % of energy consumption.

On 13 July 2009 the third Directive 2009/73/EC was issued as well as Regulation 715/2009. This directive targeted common rules for internal market of natural gas. It included all „old issues" like monitoring of security supply, regional solidarity or public service and customer protection. On the other hand, as a result of the energy package from 2007, it also included the „biogas and gas from biomass or other types of gas in so far as such gases can technically and safely be injected into, and transported through, the natural gas system" (Directive 2009/73/EC, 2009, p. 8). The Regulation kept on previous regulations and established conditions for access to the natural gas transmission networks.

## 1.3. Consequences of liberalization

The gas market in EU was mainly characterized by monopolies (usually state owned) or oligopolies. That had to be taken in consideration while creating Directives to achieve competitive market. This applies also for gas storages.

The main condition for liberalizing markets in such conditions is a third party access to the network. This could be achieved by proprietary unbundling of the incumbent company operating the network if he has some connection in downstream or upstream markets. The unbundling diminishes the incentives to exclude or limit the access of competitors to the network. This can be applied even for gas storages. The problem of sufficient proprietary unbundling appears also in the allocation of transmission rights and appropriate level of access charges.

The gas market characterized by take-or-pay contracts is unique because of these contracts. The retail suppliers have no marginal costs and huge fixed costs under these take-or-pay obligations which strongly modify the cost structure of the market. The suppliers then serve their own part of market and have very little incentives to compete for other customers because this is very unprofitable. As a consequence the competitive environment is difficult to achieve and the monopoly pricing and market segmentation remain. This can be solved by creating wholesale market where suppliers with take-or.pay obligations can sell the gas. The retailers and customers who create demand side would face single pool price determined on the market. In such a situation gas price in the pool reflects the unit cost of gas provision for gas producers and marginal cost for retail suppliers. This allows competition on the market because the marginal cost for retailers includes all the cost components. Moreover if the retailers compete for the same customer the equilibrium price on the wholesale market makes it possible to cover costs and make profits.

Against these wholesale markets there are gas storages. The retail suppliers have an option to use them if needed. In the light of above mentioned situation gas storages may be used for price arbitration. The retailers can buy the gas on the wholesale market when the price is low and store it in the gas storage facilities and withdraw the gas when the price is high. Such possibility can occur during the daily peaks and also during the seasonal ones. Also the difference between price of the gas and electricity has an impact on the arbitration and use of storages. This option does not emerge if the cost of access to storage is too high.

The gas market in the European Union is an international business. The gas flows through Europe and the pipelines cross and create nods. These places are called hubs and the incentives for investment into gas storages are higher in locations close to them. First reason is that these hubs are natural trading places for gas. The second one refers to the

limited capacity of the pipelines which can act as some kind of bottleneck and limit the supply side.

# 2. About gas storages

## 2.1. Gas storage characteristic

Because of the fact that natural gas has to be produced and transported and these actions take some time, it can also be injected in underground storage facilities. Traditional function of gas storage was to decrease the difference between summer and winter demand for gas. Now as gas consumption increases gas storages serve also in summer months as other source of gas, mostly in a short time. Also the security of supply is an important part of having gas storage because of natural disasters, some unexpected accidents or some obstacles during the transmission.

Until the liberalization gas storage served as a buffer between transportation and distribution. Since then gas storage can be used for commercial purposes by any industrial participant. It is used it to cover the demand shifts in summer and winter or to store gas when the price is low and withdraw it when the price is high.

Gas storages can be divided into two types – base load and peak load storage. Storages of the first type are those whose objection is to fulfill seasonal demand requirements, mainly the higher demand during winter months. In the summer months, the gas is injected into them. The injection and withdrawal ale slower in comparison with peak load storages. Base load storages also have higher capacity. Their turnover is about one year.

On the other hand, peak load storages are intended to meet short-term market requirements. They are designed to have high level of deliverability so the injection and withdrawal rate are higher in comparison with base load storages and their turning over is in days or weeks as they have lower capacity.

Natural gas is usually stored underground in three types of storages: depleted gas fields, salt caverns and aquifers. It can also be stored as liquefied natural gas (LNG) which is the most common state the gas is transported via ships. In its natural form it takes much more space.

Any underground facility can be used as gas storage. During gas injection the pressure in the facility increases until there is no more space available. When gas is going to be withdrawn it is easier to do it when the pressure is higher. As the amount of withdrawn gas is increasing the pressure is decreasing and the costs for withdrawal are

higher. It is also impossible to withdraw all the gas. This is called unrecoverable gas. In addition to unrecoverable gas, every facility has something known as „base gas" or „cushion gas". This is the amount of gas you need to withdraw the remaining gas. Base gas creates the required pressure for that. „Working gas" is the amount of gas that could be withdrawn or injected from or in the facility. It is the total capacity of the storage minus the base gas. Storage facilities usually use working gas as a measure of their capacity because this is the amount of gas they can work with.

Let´s have a look at the three types of gas storages. **Depleted gas reservoirs** are the cheapest and easiest way to obtain storage facility. As the name suggests they are abandoned and depleted gas fields. So in order to use them it is not necessary to install additional equipment because former miners left it there. Not every depleted gas field could become gas storage facility and the reasons are both geographical and geological. The field needs to be close enough to the consumption area and also to the transportation pipelines and distribution network. Depleted reservoirs have to have high permeability and porosity which are the geological reasons. The first one refers to the rate at which natural gas flows through the geological formation. This induces the withdrawal and injection rate. The second one means the total capacity the reservoir could hold. About 50% of gas has to be used as cushion gas but the field has already been used so it contains the unrecoverable gas already. Depleted gas fields are example of base load storage.

**Aquifers** are former underground water reservoirs. Facilities of this character could be found in areas without depleted gas fields due to the fact that they are much expensive to develop and maintain. First you need to examine geological characteristics of the formation. The area, the porosity and the composition have to be explored. The capacity is known only after the injection. The aquifers used to be water and not gas reservoirs so it is necessary to develop all the associated infrastructure beginning with wells and extraction equipment through dehydration facilities up to the compression equipment. Another consequence of aquifers' characteristics lies in the possible feature of withdrawn gas which may contain particles of water so it has to be dehydrated before transportation. Because aquifers do not have the same natural gas retention as depleted fields, some gas may escape into other parts of the formation and has to be extracted by "collector" wells. Another disadvantage of aquifers could be the amount of cushion gas which may be up to 80 % of the total capacity and it may be also difficult to withdraw after the facility is shut down. Because of this aquifers were established during the

periods with low prices of gas. Creation such a facility is expensive and time consuming and is also restricted from environmental reasons because it could contaminate fresh water. Aquifers could be used both as a base load or peak load facilities.

**Salt caverns** are last type of gas storage. They are characterized by very strong structural strength so they degrade really slowly. The salt caverns are created from salt deposits which can be divided in two types – domes and beds. The main deference is in the magnitude. The domes are thirty times higher than the beds and also have higher average. If the salt deposit is found it is necessary to start a process called "salt cavern leaching". This means that you need to drill a well into salt cavern and pump water into it in large amounts. The water dissolves the salt within the deposit and leaves an empty space inside. Although the salt cavern leaching can be expensive, gas storage with high deliverability is obtained. Moreover this type of facility requires the lowest amount of cushion gas – approximately 33 %. Because of the high injection and withdrawal rates the salt caverns are used mainly as peak load storages.

Smaller part of peak load storages is formed by **LNG peak shaving** facilities. These facilities are the smallest one of these four and have the highest deliverability rate. They are used for peak shaving, i.e. reducing the peak load during the period of high consumption. The gas stored here is in liquefied form.

According to Gas Infrastructure Europe (GIE), an organization representing interests of storage system operators in arguments with European Commission and the regulators, it "currently gathers 31 Storage System Operators with around 110 storage sites in 15 countries in Europe, representing approximately 85% of EU technical storage capacity"[2] (GIE, 2011). Moreover, there are almost another hundred projects for gas storages. Germany has the highest capacity of storages, approximately six times higher than Czech Republic.

## 2.2. Current position of gas storages

Gas storages have three main purposes. They manage the risk of supply shortages whether it is caused by political or physical reasons. As a market tool they provide necessary flexibility to the market in order to smooth the intraday and seasonal supply-

[2] Source: http://gie.eu.com/index.php/maps-data/gse-storage-map

demand gap. They also play an important part as contributors to the liquidity of markets. This is crucial to enable markets provide robust price signals.

The role of gas storages is increasing nowadays because the import dependence of European Union is increasing. "With growth 1.8% per annum, … [there will still be] gap of more than 7.2 Bcm of working gas volume, even if all currently planned facilities were effectively realized by 2030." (European Federation of Energy Traders, 2009, p. 5) With the development of spot markets throughout Europe such as NCG or TTF, the demand for storage capacities as a trading tool will be even higher.

Every country implements Gas Directives in their legislation on their own and there could be some differences. For example, established gas suppliers in Italy booked large amount of gas storage capacities. In this case it is not clear whether this capacity is fully used. Moreover, any additional capacity is not offered on the secondary market. Owners of gas storage capacities have also an obligation to keep some minimum amount of gas in their facilities at the end of each month in the winter. This regulation should serve as a tool for security of supply but it is not efficient because large quantity of stored gas is sterilized over winter months.

The situation is different in France. Companies that supply certain consumers have reserved the majority of gas storage. This creates an obligation for storage operators who have to allocate capacity to these companies so these companies could hold sufficient amount of gas in order to comply with their contractual obligations. This is a wrong approach because it creates obstructions to free access to storage and therefore prevents the development of market signals and effective capacity allocation.

The uniqueness of gas storage business is of key importance due to the role gas storage plays in the mechanic of gas market and it also enables the access to the market. Liberalization of gas storage facilities and the increase in competition on gas market promote gas storage as a tool for trading and optimization objectives due to the flexibility that gas storage offers. It also provides the companies with a great opportunity to diversify their portfolio and strengthen their stability. This supply flexibility and interconnection capacity between markets increase competition and help markets to find their equilibrium which will consequently reduce the risk of price shocks.

Increasing demand for gas outside of the borders of European Union and decreasing endogenous production of member states, mainly Netherlands and Great Britain, will lead to higher demand for regional and local flexibility in order to meet seasonal consumption patterns. The decrease in endogenous production will limit the

ability of suppliers to deliver gas to their customers in line with their commitments and the increasing distance from sources of gas will stress the risks connected to regularity of supplies. This problem could be diminished by gas storages located close to the market and connected to the important pipelines inside the European Union.

The flexibility gained from the usage of gas storages can also help gas fired power plants to become more competitive in electricity market. Current trends in electricity ask for low carbon power generation and gas fired power plants as well as wind power plants can provide it. The advantage of gas fired power plants lies in their higher responsiveness to sudden peaks in demand and gas storages can provide gas in these situations.

Gas storages are also an essential part of strategic storage problem that is being discussed in Europe. With higher import dependence this problem becomes more and more important. Strategic storage can be defined as some gas stored in facility and be able to used only in case of some supply interruption or other emergency by an administrative instruction. In ongoing discussion on this topic the key point is whether we should use the strategic storage or just rely on the commercial storage. In this situation where the liberalization is still in its process it could be tricky rely just on commercial storage. Nevertheless during the supply crisis in January 2009 it was the gas from commercial storages that helped to solve this situation. It is reasonable to assume that if the market integration will improve even more and the price transparency will be more reliable there will be better response on emergency situations from commercial storages. On the other hand markets with high trading volume have not been established yet. Governments are still concerned about the security of supply. These concerns may lead to the creation of an obligation to ensure supply to customers, especially in peak demand. Should such obligation be imposed, it is important for a proper functioning market that the suppliers have the freedom to choose the source of gas, one that offers the best solution. One solution to cope with this obligation could be the investment in new storage facilities.

If a gas company wants to participate in gas storage business and has enough capital, the best way is to invest and build own facility. In this case the regulation should be very careful with providing third party access to this facility in order to allow new entrants to compete and establish his own trading position. The recommended process is to let the new entrant to develop a new facility without any obligation for third party

access provided that he is able to prove that he will operate in competition with existing storage providers. This solution can improve competition in wider gas market.

The goal of liberalization should be to eliminate restrictions in market access except general competition rules and necessary transparency requests. So the third party access should be temporary solution until a fully liberalized and competitive market is developed. To create such market it is necessary that companies providing storage services are independent and have a free choice to whom their allow access to network based purely on price and market signals. Also enough alternative sources of flexibility with non-discriminatory access provided to network users are essential for creation such market. Finally sufficient infrastructure and network interconnections are needed.

To improve investment decisions and increase investments it is necessary to establish reliable forward price transparency. Only market based mechanisms should be used for allocating capacity to guarantee that there is no discrimination among market players. Also an institution which will monitor prices and transparency obligations is essential mainly to limit market power and simplify decision making for new entrants.

No such a perfect market is in existence nowadays. Most national markets are ruled by monopoly or duopoly so the regulated third party access remains crucial until sufficient competition has been established.

## 2.3. Cost-plus pricing

Building of gas storage is a long-term and financially demanding project with uncertain profit. To prevent losses in such a project, developers used cost-plus pricing in evaluating the price of stored gas.

Cost-plus pricing is a method for evaluation of the final price of product. It is based on the amount of the fixed costs and variable costs. These costs are easily obtained for the firm so the uncertainty about final price is significantly diminished. Nevertheless these costs only represent the total costs of the whole project. The company needs to estimate unit price which could be sometimes difficult and company has to settle for rough estimates.

This is not the case of gas storages. Of course the company does not know the exact volume of its storage but the estimation is quite precise. The formula for the first step of cost-plus pricing is following:

$$P = AVC + AFC,$$

where AVC stands for average variable costs and AFC are average fixed costs. These average costs are obtained in this way:

$$AVC = TVC/Q$$

and

$$AFC = TFC/Q,$$

where TVC are total variable costs and TFC are total fixed costs. Q stands for estimated quantity (it the case of gas storage volume).

The price P evaluates the unit cost of production. The second step is the addition of markup over costs. This markup is set by the company over the desired rate of return and so the profit can be evaluated easily. The formula for final price is extended in this way:

$$P = (AVC + AFC)*(1+m),$$

where m stands for the desired rate of return or in the other words the firm´s margin.

This approach was widely used in gas storage markets before liberalization. It decreases cost of decision-making. As the gas storage development is a financially demanding project, investors need some assurance that the investment will be repaid and this method is a good way to ensure a guaranteed profit.

## 2.4. Cost of storage after liberalization

After the liberalization, gas companies were obliged to offer some unbundled units of their gas storages due to Third Party Access. This service was not for free of

course but there were three main ways how to calculate the amount charged for using of gas storage.

The first one is using fees for services. This approach is used widely throughout the whole European Union. Every company which uses this method of charging sets some basic fee for its services. The primary fee is for storage. Company will publish the price for storage usually in €/MWh. There are also calculators which can be used to obtain the final price of storage. The difference in price is caused by the length of storage or by the time you order the service. In most cases companies have two periods when the storage can be order – winter and summer. The prices differ according to the period. Companies often offer discount for the longer contracts.

Most of the companies also charge a fee for injection and withdrawal. These prices are also stated in €/MWh. The difference is given by the type of facility, the amount of gas withdrawn or injected or by the period of the year.

There was a lot of discussion about this method of charging. In conditions without any regulator there is a great opportunity for companies that own gas storages to set the fees so high that it would be almost unprofitable for other companies to use them. This could prevent development of competition in European Union´s gas market. Fortunately this option was taken into consideration while creating the second and the third Directive. Still there could be a problem to set the nondiscriminatory prices on markets withone powerful company and a few little ones. This could be for example case of France where over 90% of gas market is controlled by Gaz de France.

On the other side companies do not have such freedom when they set fees for their services. For example in Italy, The Regulatory Authority for Electricity and Gas (Aeeg) exists. This authority has been established in November 1995. Its goal and purpose is to protect consumers and users and promote competition on national markets. "Aeeg mission includes defining and maintaining a reliable and transparent tariff system, reconciling the economic goals of operators with general social objectives, and promoting environmental protection and the efficient use of energy. It provides an advisory and reporting service to the government and parliament, and formulates observations and recommendations concerning issues in the regulated sectors of electricity and gas." (Aeeg, 2011)[3] Besides the above mentioned obligations Aeeg sets

[3] Source: http://www.autorita.energia.it/it/inglese/index.htm - official website

up prices for gas storage services. This ensures transparency of gas storage industry and prevents companies to take advantage of their market position.

Aeeg is an example of energy regulatory office. Similiar office is established in every member state of EU and has the same or similar duties, obligations and possibilities as Aeeg. Moreover, since third Regulation from 2009 Agency for the Cooperation of Energy Regulators (ACER) has been created. The official launch of ACER took placein March 2011. The main task of ACER is to facilitate cooperation between national regulatory offices and between regulatory bodies at EU level and also provide some framework within regulators can cooperate. Through ACER National Regulatory Authorities can for example set the same level of prices for whole European Union. This could help with market integration process that should be completed by 2014.

These are some of arguments which should ensure us that using fees for storage service is transparent and competitive-friendly and that this is not just some other way how cost-plus pricing is used in gas storage industry. Of course we cannot be ever 100% sure that prices set by National Regulatory Authorities are the most efficient and closest to equilibrium but this depends on people working there and their judgments. The system is set up quite well based on level of liberalization.

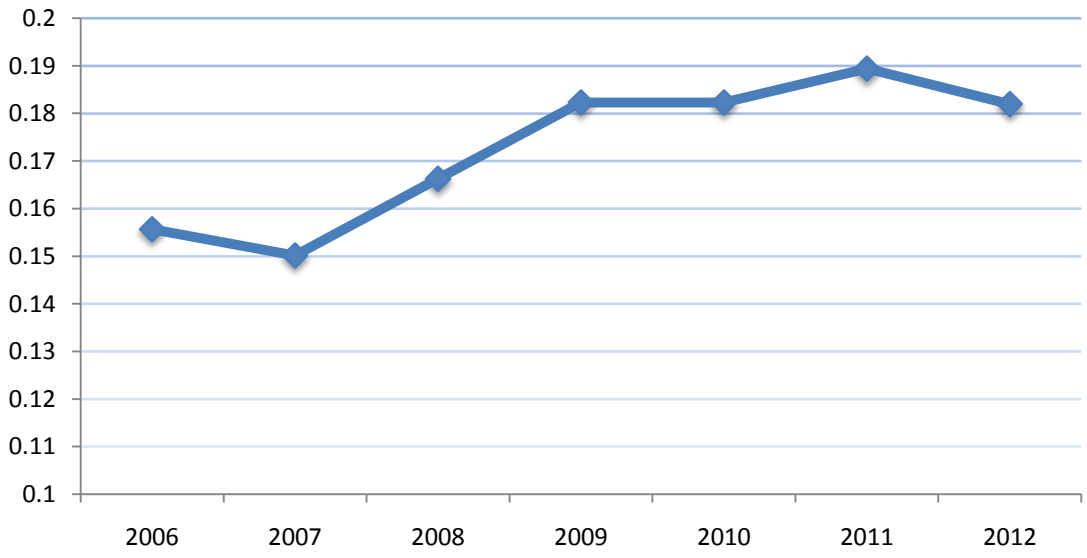



Figure 1 - Development of unit price of space in € / GJ / year in Edison Stoccaggio

The second possibility how to determine the price for storage is negotiation. This option is not used very often because it lacks transparency. Also the informational

asymmetry can highly affect the final price of storage and could really differ from market price.

This method was mainly used after the first gas Directive especially by the countries who disagreed with this Directive and their implementation of this Directive was on the mildest degree possible. As a clear example France could be named but also Greece, Portugal and partially even Germany.

The auctions are the last option of price setting for gas storage. This possibility is the youngest one of these three and it is not so spread in European Union. It is regularly used in Czech Republic, Denmark and United Kingdom. How does such auction work?

The auction takes several rounds. The provider offers the capacity available for the auction and the price for the first round. The applicants react with the amount of storage they want to buy. If the total amount the applicants want to buy is higher than available storage the auction goes to the second round. In the other case when there is some space left, provider can decide whether he wants to offer this remaining capacity in next round for lower price or whether he leaves it unsold.

In the case demand exceeds supply, the same amount of storage is offered in the next round but for higher price. Again the applicants state the amount they want to buy for this price. If the demand is still higher than supply, next round comes. This process lasts up to the state supply is higher than demand.

In this situation the provider proceeds in the following way. The price for the gas storage is taken from the last round where the demand exceeds the supply. The applicants who were willing to pay the higher price offered in last round obtain the amount they requested in that round but for the price of previous round. The residual amount is divided into all applicants according to their requirements from previous round.

Here is an example. The available capacity is 100 million MWh. In $4^{th}$ round the applicants demand 190 million MWh for price X. In $5^{th}$ round they demand 70 million MWh for price Y where $Y > X$. So the residual capacity is 30 million MWh. The applicants from $5^{th}$ round obtain the requested amount for price X. The residual amount 30 million is divided between all applicants form $4^{th}$ round relatively to their unmet requirements. In this example the unmet demand is 120 million MWh. If the applicant asks for 60 million MWh in $4^{th}$ round and 0 MWh in $5^{th}$ round he gets 15 million MWh. This amount was calculated by this formula:

(residual amount/total unmet requirements)*unmet requirements of one applicant = final amount for applicant

This formula is applied for all applicants who have unmet requirements in 4th round which was not satisfied in 5th round. In this case all available capacity, 100 million MWh, was divided into applicants.

## 2.5. Spot markets and hubs

The main purpose of spot markets is to allow producers to effectively allocate their surpluses and offer them to the buyers who need to satisfy the demand of their own clients. The trades are executed immediately. Spot markets exist for a lot of commodities from corn and bean over crude oil and gas to gold and silver.

The first spot market for gas on continental Europe was created in Netherlands in 2003. It is called Title Transfer Facility. It allows to trade short-term gas and gas futures contracts. Another one is in United Kingdom, but this one was created in United Kingdom which started liberalized their gas market even before European Union.

Gas spot markets are created in areas where a significant amount of pipelines crosses. These places are called physical hubs. There are also notional hubs which are characterized as regional or national zone. There are two types of traders in these hubs – pure and physical. Pure traders only trade and never move gas from hub; they try to make profit on price fluctuations. On the other hand physical traders actually deliver or take the gas from hubs. For these traders the gas storages are far more important than for pure traders.

In Europe the gas hubs are now on rise. Besides the Title Transfer Facility in Netherlands and National Balancing Point in United Kingdom, it is possible to trade in Belgium on Zeebrugge Platform, in Germany on Gaspool in the north and Net Connect Germany in south and in northern France on Gas Exchange Point. Five more hubs are emerging – in central Europe, northern Italy and southern France and in Spain. The number of hubs should decrease in the future according to the plan of regulatory authorities. Increasing number of hubs increase complexity of trades and decrease liquidity. In this situation a trader in UKwho wishes to withdraw gas which was bought

in Germany needs to book transmission of gas over more than one border which makes trading more complicated.

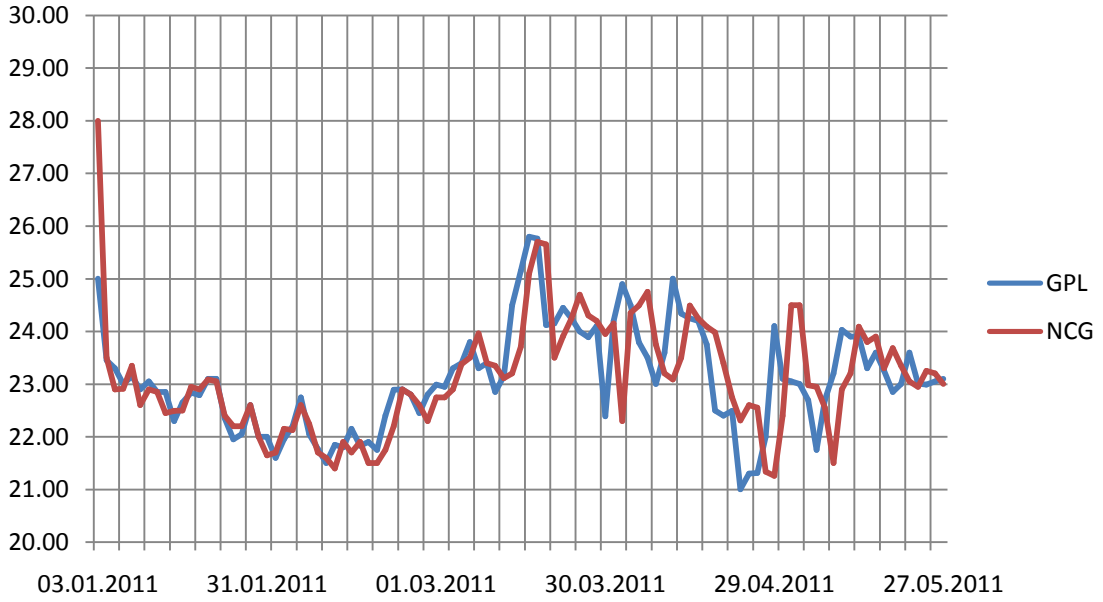



Figure 2 - Prices at GPL and NCG in first half of year 2011

The creation of gas storages is essential for physical traders located close to these hubs. In a situation when the price is too low on the spot market they need to store the gas somewhere until the price rise so they can actually gain some profit. Also these gas storages near the hubs can be used for arbitrage because of daily peaks and seasonal peaks. So there are incentives to create gas storages near the hubs. This is nicely illustrated in central Europe, northern Italy, Netherlands and Belgium where the storages generate very dense network.

# 3. Gas storage as a market tool

## 3.1. Gas storage and forward market

Gas storages are essentially investments into the future. Investors do not know how the price of gas will change or whether or not a new mining spot will be discovered. Nowadays gas storages are used mainly as buffers against peak demand but they can be considered as potential investment opportunity. With the structure and characteristics they are like forward or future contracts.

Forward contract is a cash market transaction in which delivery of the commodity is deferred until after the contract has been made. Although the delivery is made in the future, the price is determined on the initial trade date.[4] Forward contract specifies the size of underlying asset that is going to be exchanged. The main difference between forward contract and spot contract is in the time of delivery which is in case of spot contract made immediately but in case of forward contract it is made in future which is determined by the contract. The price at which the delivery is made is called forward price and this price is also specified by the contract.

Forward price is said to be the most accurate estimation of future spot price. The estimation is not precise and this is the reason investors are using forward contract. The difference between these two prices is called forward premium. With so many opinions on development of commodities or financial instruments investors are willing to buy a forward contract in order to gain some profit or to use them for hedging. This is one of the biggest advantages of forward contract which is their flexibility. Both sides of such contract have plenty of room for bargaining to reach optimal version. One disadvantage stems from this though.

Forward contracts suffer from low liquidity because of their specific requirements. The transfer of obligations from one party to another is complicated and cannot be done easily and the termination of such contract is usually costly.

A closely related contract is the future contract. Future contract is a contractual agreement, generally made on the trading floor of a futures exchange, to buy or sell a particular commodity or financial instrument at a pre-determined price in the future.[5]

[4] According to investopedia.com
[5] According to investopedia.com

Futures contracts can be divided into commodity futures and financial futures depending on the underlying asset. The size of the contract plays crucial role with respect to trading – with bigger size the attractiveness for small investors is decreasing, on the other side lower size increases transaction costs. Also delivery date and minimum price movement have to be specified.

Future contracts are standardized contracts with given specifications which allow them to be traded on specialized exchanges like London International Financial Futures and Option Exchange, Chicago Board of Trade or Eurex. This standardization provides them with high liquidity as well as the possibility to cancel such contract by performing a reversal trade. One can terminate a future contract by waiting until delivery date when cash settlement or physical delivery happen. The second option how to terminate future contract is to buy an offsetting position (seller buys equivalent contract and buyer sells equivalent contract). This must be done before delivery day.

Forward and future contracts have one important thing in common – both contracts enable the investor to buy or sell some underlying asset in the future for a price agreed upon today. Otherwise there are a lot of differences between them. The most significant one is the standardization of future contracts with respect to forward contracts. As mentioned above this fact causes high tradability of futures and its popularity among small investors. On the other side the flexibility of forward contracts allowed them to be large in size so the main players on forward markets are governments, large corporations or big financial institutions. The price between future and forward contract imposed on same underlying asset could differ because price of future contract is dependent on interest rates. On the other hand according to Hull (2008, p. 110) "theoretical differences between forward and future prices that lasts only a few months are in most circumstances sufficiently small to be ignored." Hull (2008, p. 110) continues with statement that "in practice, there are a number of factors not reflected in theoretical models that may cause forward and future price to be different. These include taxes, transaction costs, and the treatment of margins. The risk that the counterparty will default is generally less in the case of futures contract because of the role of exchange clearinghouse. Also, in some instances, future contracts are more liquid and easier to trade than forward contracts. Despite all these points, for most purposes it is reasonable to assume that forward and future prices are the same."

I believe gas storages fit better to the description of forwards. They are usually large in size and they are not tradable on exchange. It is almost impossible to cancel a

contract on gas storage and if you manage to cancel it there is very often a high penalty attached. Gas storage contracts also have high flexibility. Someone could call this flexibility as a space for corruption and market distortions but with ongoing liberalization, the prevention against such practices has increased.

In my analysis I would like to focus on the relationship between gas storage auctions and forward contracts and also between gas storage auctions and winter-summer spread.

It is hard to presume future price of gas in order to buy proper amount of gas storage space to meet consumer requirements and have sufficient supplies with respect to demand peaks. Gas companies can use forward contracts as indicating variable. On the other side, as I mentioned above, forward contracts are not exchange-tradable and are very specific so their price can confuse these gas companies. Based on assumption made by Hull earlier in text I will use future contracts as my proxy variable for forward contracts.

In this part I would like to compare gas storage auctions between winter-summer spread which is difference between winter and summer future. If the difference between winter and summer future is higher then also the spread is higher and vice versa. A higher spread indicates higher prices for winter futures and therefore higher demand for gas in winter. Higher demand for gas could be partly satisfied by gas storages. I assume that higher winter-summer spread leads to higher demand for gas storages and therefore higher prices in auctions. I decided to use futures because their prices are assumed to contain all possible influences and therefore the price of gas storages should also be affected by all these influences. Cold winter, discovery of new gas fields, political trouble or increase or decrease in gas mining in some current gas field could be involved in influences affecting future and also gas storage price. Because future contracts are tradable on exchanges they have higher ability to absorb changes in above mentioned effects and interpret them in their price.

I will use data provided by Thomson Reuters from January 1$^{st}$ 2008 up to December 24$^{th}$ 2010. Dataset includes monthly, quarterly and yearly futures for gas. I will use summer futures and winter future to calculate the difference between these two and use this spread as my explanatory variable. Development of winter-summer spread for examined period is on Figure 3.

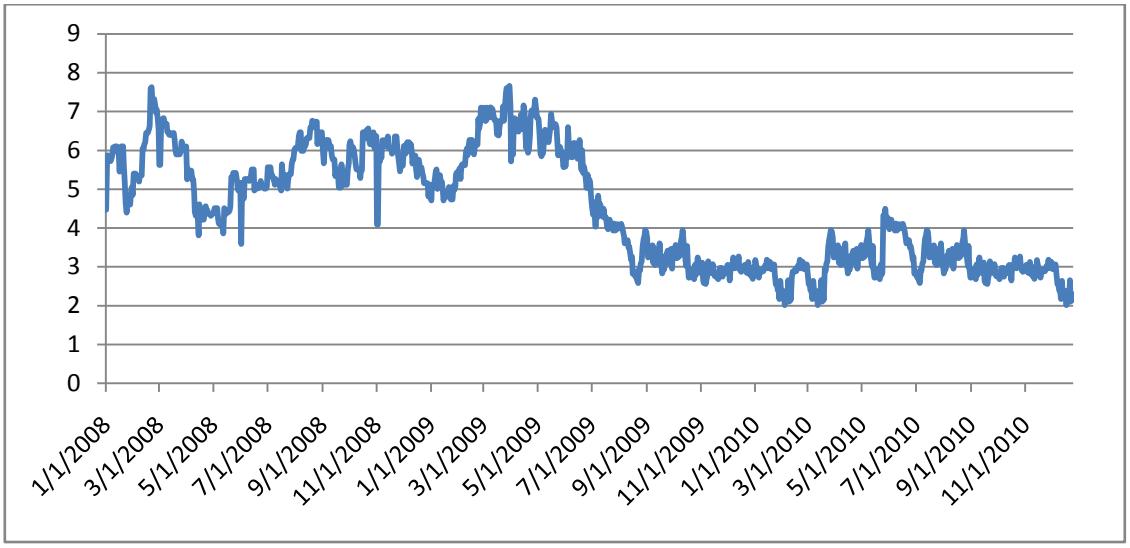



Figure 3: Development of winter-summer spread

I will use gas storage auction prices as my response variable. Third party access to gas storages was provided with second Gas Directive so the data should theoretically be available since 2003. In practice the first auctions of gas storage were held in 2005 in Denmark. Also the data are unevenly distributed through the year with highest density during first three months of the year. This is caused by the fact that most of contracts concerning gas storages start at 1 April. Rarely there are contracts from June or October.

These data come from three different gas storage companies which use auctions as a sale method for their facilities. So far there were 25 auctions held in Czech Republic, 16 of them were successful. In Netherlands 6 auctions were organized and in 5 cases there were buyers. Finally in Denmark there were 18 auctions since 2009 and 12 of them successful. In other countries there are no public auctions of gas storages. Companies offer them for stable fees and tariffs.

This behavior can be explained by the stage of the liberalization. Denmark and Netherlands are countries where the process of liberalization is at higher level in comparison with other European countries. In Czech Republic public auctions are enabled by legislature. RWE Gas Storage and MND Gas Storage offer public auctions in Czech Republic. Here are conditions of RWE Gas Storage:

"Our storage tariffs are **market-based**. RWE Gas Storage offers available firm storage capacity in electronic auctions with the exception of daily firm capacity. This therefore applies to new (1 to 15 years) and existing (1 to 5 years) yearly storage capacity as well as monthly capacity (1 to 12 months). The company announces all

auctions on its website. Storage capacity is offered as a bundle of working gas volume, injection and withdrawal capacity or separately.

A minimum price is set for each auction and published together with the relevant terms and conditions on our website several weeks or months prior to auction, depending on the type of capacity offered." (RWE Gas Storage, 2013)[6]

In my sample, two auctions were held in the same day on six occasions. One of them was a primary auction and significantly higher amount of SBU was sold so I use the price from this bigger auction. This reduces our dataset to 25 observations. In the examined period only 8 auctions were held so my dataset reduced really significantly. Since first auction was held in March 2009 I decided to drop year 2008 from my dataset.

Based on simple observation of Figure 3, I can say that the spread increases over spring months but there are no more patterns in data. Maximum value of spread is 7.658, minimum value is 2.016 and the mean is 3.8936 with standard deviation 1.4166. Data are not normally distributed (Figure A1) with higher density around value 3 even after the drop of year 2008.

I will use a simple regression to determine the relation between winter-summer spread and auction price for gas storage. I will also check if there is at least some correlation between these two variables. My model looks like this:

$$auction_t = \beta_0 + \beta_1 * spread_t + \varepsilon_t$$

where $\beta_1$ is the coefficient I am the most interested in. Using OLS I obtained results written in Table 1.

| | ***Coefficient*** | ***Std. Error*** | ***t-ratio*** | ***p-value*** |
|---|---|---|---|---|
| **const** | 6.04531 | 0.816638 | 7.4027 | 0.00031 |
| **spread** | -0.0446938 | 0.216908 | -0.2060 | 0.84357 |

Table 1: Results of regression

The hypothesis that $\beta_1=0$ cannot be rejected even on 90% significance level. The correlation between spread and auction price is equal to -0.0709 which is almost zero. Based on results I can say that there is no relationship between gas storage auction price and winter-summer spread but there are some limitations to this model that have high effect on the results and my analysis.

[6] Source: http://www.rwe-gasstorage.cz/en/indicative-price/ - official webpager

First of all there is a really small amount of observations on gas storage auctions. This type of sale of gas storages is very young and not so widely spread. Liberalization is trying to improve this situation but this process is slow and takes a lot of time. Also since building of gas storage is expensive the development is not as wild as in other "cheaper" industries. Other reason for low number of observation could be high monopolization of market with gas. There are not so many companies on national markets so there is low level of competition and these companies have strong position for negotiation and it is not in their interest to hold gas storage auctions since they can simply make a deal which is much more efficient for them. One of the goals of liberalization is to diminish such powerful negotiation positions.

There are also some issues with my model. Since the dataset contains only 8 observations on auction prices, over 700 observations are dropped from our model because software used (gretl, Stata) does such a thing in case of simple OLS estimation. Some other model which deals with omitted variable problem should be used but in this case with 8 observations it will have no meaning. Sometimes mean is plugged for missing values but in this case I would have almost constant dataset which would not help in any way. With this small amount of observations it is impossible to test for heteroskedasticity of my model or to check whether the residuals are normally distributed.

In summary I did not find any relationship between winter-summer spread and price for gas storage auctions. On the other side I did not have enough data to support my results.

## 3.2. Gas storage and investments

Gas storages serve mainly as a tool for smoothing peaks on intraday or seasonal basis. In the following text the seasonal gap will be discussed, mainly the volume necessary in the future and amount of new gas storages necessary to cover this gap.

Closing the gap is more a problem of a right framework for investment than a technological problem. When a functioning market is flexible enough, an operational storage gap can be closed by market forces by increase of price. This price peaks will

create the incentives for new investments. On the other hand regulation of storage tends to decrease investment incentives. This is the reason why there is an exemption in Gas Directives presented by European Union.

This seasonal gap is defined as the difference between sum of winter consumption and the sum of summer consumption. Winter consumption is defined from October to March and summer consumption is defined from April to September. The gap ratio is defined as the seasonal gap divided by the total consumption.

This seasonal gap can be basically closed in a three ways. Firstly, you can produce more gas in winter than in summer. This is called flexible production. The second way is through flexibility in import contracts. Using gas storage for storing gas in summer and withdrawing it in winter is the third way.

Each option is costly. Flexible production can be done easily but it has to be recalled that there are huge costs for even starting the production. It is necessary to explore the possible gas deposits and install there production facilities. These are fixed and sunk costs that have to be made in order to produce gas. Because of that the most cost effective method of energy production in these facilities is to use their capacity to the fullest. The same logic could be applied for pipelines, especially for the long ones where the investment costs are huge and it is costly not to use them.

Import contracts are usually long-term so there is little space for negotiation. The best way seems to be usage of gas storages. Since the liberalization there is a clear trend. Storage facilities have become more important. Their part in gap closure has increased. On the other hand, the flexible production has decreased. This is also caused by the exhaustion of gas fields in Europe, mainly in United Kingdom, Netherlands and Germany. Share of import in closing the gap is stable.

Due to almost full extraction of some gas fields in Europe, there will be a shift from indigenous production to imports from North Africa, Russia and Middle East. These imports will eventually come from farther and farther sources so their share in gap will decrease as well as the share of indigenous production due to depletion of gas field. After these adjustments the importance of gas storages will significantly increase.

Speaking of imports, the security of supply has to be mentioned. With increasing dependence of import there are higher risks that some technical problem, political reasons or terrorist attacks may reduce import. This reduction may have negative effect on gap ratio and the governments may have some incentives for obliged gas reserves. Spanish government forces importing companies to diversify their portfolio in order not

to be dependent on one supplier. The companies could receive up to 60% from one supplier. In Italy the government uses different approach. Every gas company which obtains gas from source outside European Union has to have at least 10% of these imports as a gas reserve. As a result, such obligation unfortunately blocks storage facilities that could be used for closing the gap. These two obligations, both Spanish and Italian, are kind of extreme. Usually, the obligations are meant as compulsory reserve in case of really cold winter. Source of supply does not matter. Nevertheless after applying these ideas into process of closing the gap the importance of gas storages increases even more.

Every gas storage has its working gas volume. But this volume can be taken as the operational gas volume. It is frequently observed that only small fraction of working gas volume is used. This can be explained by obligation to hold some stocks in case of extreme weather conditions. On the other side gas suppliers on their own hold more provisions for cold winters so the working gas volume decreases even more.

Let´s create an example and use the consideration above to show how important is to invest in gas storages in the future. Some country faces the gap of 100 bcm. It has gas storages with total working gas volume 80 bcm and fully competitive market. The gap is covered from 50% by indigenous production, from 30% by imports and remaining 20% is obtained from gas storages. After 20 years the home production will decrease and the import will come from distant sources.

Ability to cover the gap will decrease by 50% both for import and indigenous production so gas storages importance will increase. Assume that gas storage has some passive volume because of the obligation to hold some stocks, approximately 20% of their capacity, the situations looks like this. Gas storages have to cover 60% of the gap that is 60 bcm. Total working gas volume is 80 bcm but after reduction the available capacity is 62 bcm. This is not too much positive for the future but it could be worse.

Now assume that gas storages have to hold 10% of their imports from non European Union´s countries and that they import 200 bcm. Such obligation will decrease available working gas volume by 20 bcm so there is 18 bcm of gas which are not covered. Usually the situation is worse because most of countries in European Union imports exclusively from Russia, Middle East or North Africa and they do not have so much working gas volume. This is clear incentive for investment in new facilities.

In reality gas storage market is not fully competitive. Ongoing liberalization already regulates access to storage facilities. Strategic considerations become more

important and some storage operators may have incentives to hold some capacity from the market so not all reported working gas volume could be actually available.

Additional restriction could be imposed by technical parameters of gas storage, especially by its injection and withdrawal rate. These rates can be low so the facility would not be able to meet peak demand in winter. It is hard to quantify the effects of liberalization and technical parameters of storages but it is clear that this will even more increase the shortage on the market during winter.

In the beginning three ways of how to close the gap were proposed. The third one, gas storages, seems to be the most prospective. Additional investment in new facilities is necessary.

The gap could be also closed by market mechanism. In the example price adjustments were not considered but they are likely to happen. Gas storages will become scarce, the price will rise and as a reaction the incentive to invest in storage will significantly increase. Also as a result of price increase other methods how to reduce the gap could arise or become more perspective.

In order to enable market close the gap, well functioning market for flexibility is necessary. This is also goal of liberalization. Investment into gas storages are significantly affected recent regulation so it is important to ensure access to gas storages for new entrants. Fear that storage business could become natural monopoly is despite the huge sunk costs unfounded. In Germany there are 14 companies working as storage operators.

"The European Union has accounted for this: the Gas Directive in Article 22 allows for the exemption of new storage facilities from TPA regulation under the condition that "the investment must enhance competition in gas supply and enhance security of supply". Given the predicted future scarcity of storage amounts, such an exemption seems to make sense. However, it highlights that there is a trade-off between establishing short-term competition in the downstream market and investment incentives in storage facilities." (Höffler and Kübler, 2007)

Gas storages were originally built by state monopoly so they are often part of company´s networks. It is essential to integrate storage facilities into European transport system and establish conditions for competition in this area and also to avoid high transport fees that could deform market development. Gas Directives also provide obligation to unbundle storage operations from transport operations.

# Conclusion

Europe is trying to be more integrated in many areas including energy industry. Since the beginning of liberalization we can observe some changes towards more integrated markets and higher level of interconnection between member countries.

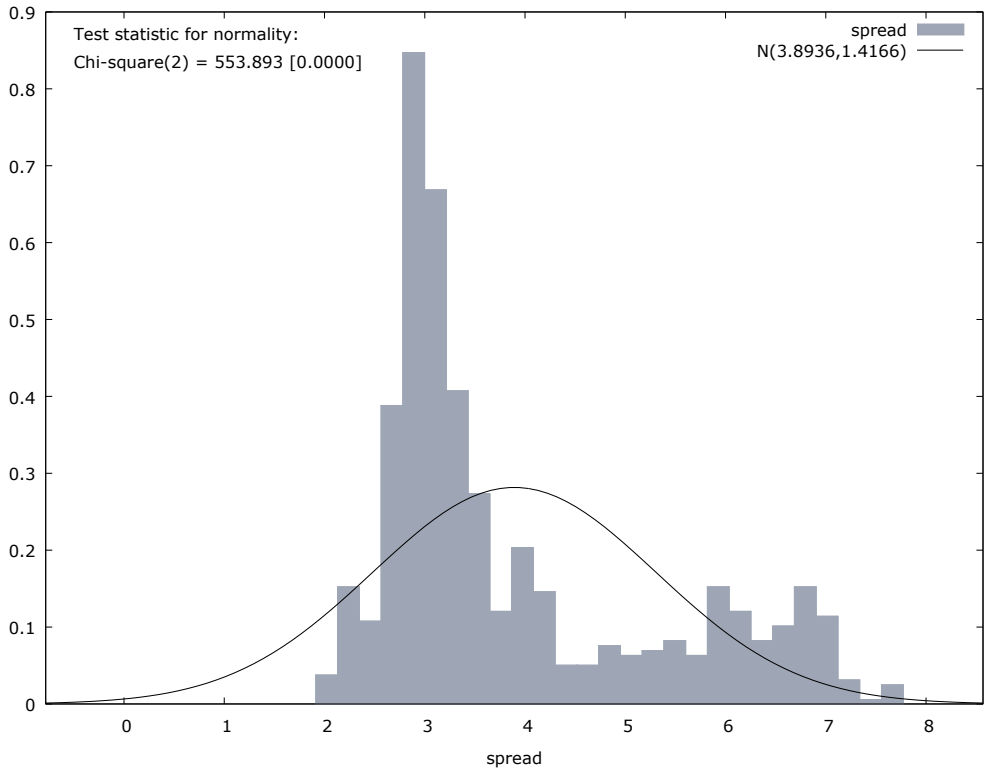
This development is not so fast in gas storage industry. The facilities are expensive to build and dependence on gas is underestimated by many states. Nevertheless some development could be observed. In my work I tried to find out whether the liberalization already took effect on the market with gas storage. Based on my model I can say that there is not enough evidence to confirm or reject such hypothesis.

I expect increase of investments into storage facilities in future mainly because of growing import dependence. European Union will have to react and adjust its steps in legislation. Liberalization of gas markets has to be enforced much more in future in order to prevent delays.

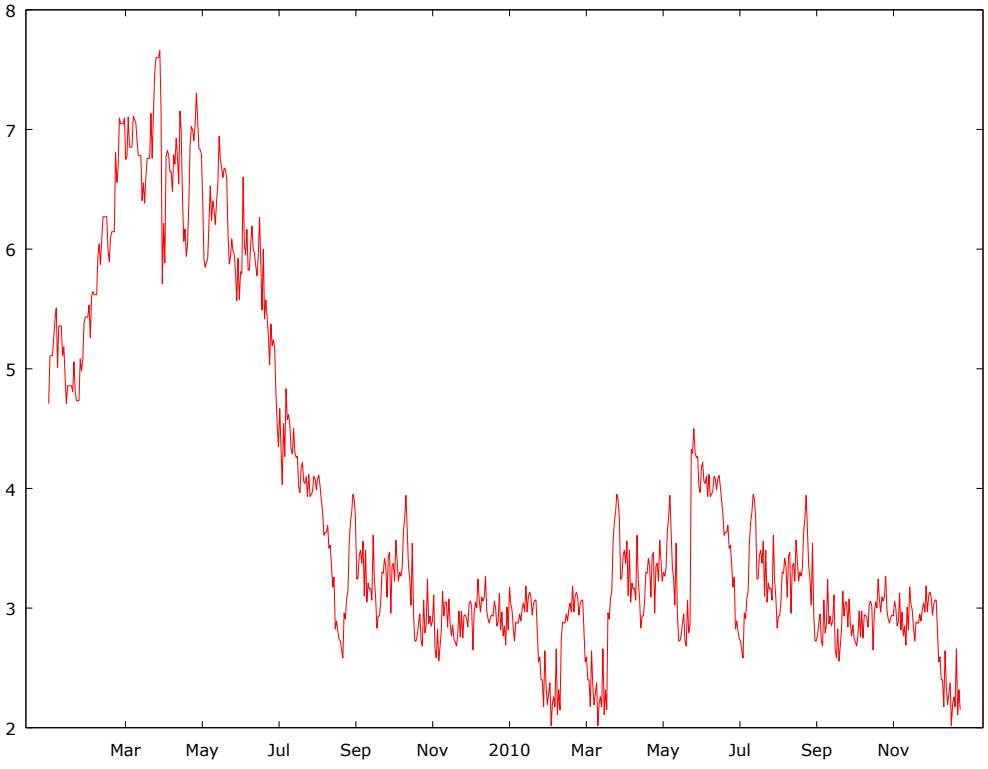
I believe that using auctions as market tool for gas storages is the best way with respect to transparency and competition. Unfortunately very few companies use this way. European Union should focus on this issue and introduce new legislation forcing companies to use this method at least on some part of their free storage units.

## List of appendices

# Appendix




Appendix 1: Frequency distribution of spread variable tested against normal distribution without year 2008 (figure)




Appendix 2: Time series plot of spread after drop of 2008 (figure)

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