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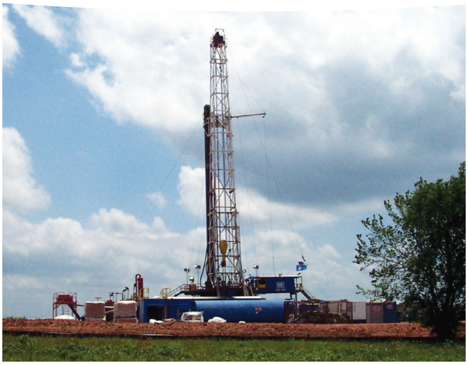

Natural Gas Storage Market Analysis in the Danube Region

NEW SZÉCHENYI PLAN

PREPARED BY

REKK

**The market analysis was commissioned
by the Sustainable Energy Priority Area of the Danube Region Strategy.**

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March 2013

Ministry of
Foreign Affairs
of Hungary

The market analysis was supported by the VOP-1.1.1-11-2011-0001 project
of the Ministry of Foreign Affairs of Hungary.

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1 EXECUTIVE SUMMARY

The present study addresses the need in the Danube Region for new underground natural gas storage (UGS) facilities. There are several UGS investment proposals on the table and there is some uncertainty on how to evaluate their regional impact and how to rank them in the European Project of Common Interest (PCI) selection process. This study aims to focus on the added value of these new storage facilities for the region and for the national markets. From our previous study[1] on the ranking of gas infrastructure projects of the Danube Region we learned that individual storage investment does not have significant regional wholesale gas price impacts. This study examines whether storage investments are essential for the security of supply of their host countries and/or whether they have the potential to increase the economic welfare of the region.

The most important role of storage under normal market conditions is to cover seasonal swings in demand. The Danube Region has predominantly depleted field storage facilities that are technically suitable to provide this seasonal flexibility. The seasonal volatility in consumption depends on the weather conditions of the country (moderate climate countries use more gas for heating), the sectorial distribution of gas consumption (gas used for power generation is driven by the price spread between gas and electricity). The need for storage capacity is also influenced by the interconnectivity of the country, as flexibility can be provided by gas purchase contracts through interconnectors as well. These are the main determinants of storage demand and their composite outcome can be simulated by the forthcoming market modelling exercise.

In the first part of the study, we give a short overview of the natural gas storage markets of the Danube region. We found that the Danube Region as a whole has sufficient storage capacities but with uneven distribution across countries. While some have spare capacities (e.g. Hungary) others do not have storage facilities at all (Bosnia and Herzegovina, Moldova and Slovenia). In case of Slovenia the necessary flexibility is provided by Austrian storages. For Moldova and Bosnia, historically the long term gas supply contract provides the necessary flexibility. A few new types of infrastructure have already been commissioned which will change this situation fundamentally; Serbian storage was commissioned in 2012 and the Romanian-Moldovan interconnector is to be commissioned in 2013. The Bosnian need for flexibility can be accommodated by storage from neighbouring countries, while Moldova has its own storage investment plans and it can use the Romanian storage facilities in the future. According to our model simulations even without further expanding the gas storage capacity, these new infrastructure investments end isolation and will enhance security of supply in the region.

The most important characteristics of the storage market are market and ownership structure, price determination, and the rules for third party access. The storage market in the Danube region is dominated by vertically integrated companies. In five countries it is a monopoly (Bulgaria, Croatia, Poland, Serbia and Ukraine), and in the rest of the countries the market share of the largest player is around 80%, with the exception of Austria (36%). Unfortunately, despite this low concentration, the storage market in Austria is not competitive but characterized by long term capacity contracts, making it difficult for new entrants to access the facilities.

Our storage tariff benchmarking analysis highlighted the lack of competition on the storage market: tariffs vary greatly within the region. Whereas Austrian, Slovakian and Hungarian tariffs are among the highest,

[1] The Danube Region Gas Market Model and its application to identifying natural gas infrastructure priorities for the Region, available at: http://www.rekk.eu/index.php?lang=en

Ukrainian, Bulgarian, Croatian tariffs are much cheaper. The difference between the highest and lowest tariff (excluding Ukraine) is almost six-fold (7 €/MWh). As a response to the concentrated market structure, tariffs are regulated in the region. Czech Republic is the exception, where new capacities are auctioned and provide a good estimate of the value of storage capacities in a competitive environment (around 3.5 €/MWh). Third party access to storage is the default regulation, however there are a few exceptions: e.g. Serbian storage does not have third party access.

We understand that storage demand is driven by many factors, and as the markets become more interconnected and competitive storage can be partially substituted by other means of flexibility, which can be best simulated with market models. However as a first assessment without market modelling, we developed a rule of thumb based on historical data of mature gas markets to see, where additional investment into storage might be needed. For seasonal flexibility need, we use a proxy for the ratio of total working gas capacity of a country and annual gas consumption. A ratio above 25% is considered to be sufficient, between 20-25% questionable, while below 20% insufficient storage capacity.

*According to our rule of thumb **Bosnia and Herzegovina, Bulgaria, Croatia, Moldova, Poland and Slovenia** lack the required working gas capacity. **Romania and Serbia are in an uncertain position, and thus require further analysis.** Austria, the Czech Republic, Hungary and Slovakia seem to have sufficient infrastructure.*

As we received comments to refine the above rule of thumb with the daily flexibility need, we defined a second proxy of withdrawal capacity/ peak day consumption ratio, calibrated on the same historical data from mature markets. The second proxy confirmed our previous findings.

In the second part of our study we run our Danube Region Gas Market Model to evaluate the necessity of further storage investment. We consider 2015 as our reference case, when new interconnectors already under construction in the region will be in place. In the reference case South Stream is delivering 10 bcm to Italy with 1.5 bcm trading possibility along its route. Compared to 2011 we found that despite the growing regional annual gas consumption (from 2011 to 2015 regional consumption grows by 21 bcm), regional storage demand drops from 16 to 14 bcm. The reasons behind are twofold:

(i) New interconnectors strengthen interconnectivity in the region providing additional flexibility that competes with storage facilities.

(ii) In a more integrated market cheaper storage attracts demand from other markets. This leads to a new distribution of storage gas injection where Hungary, Serbia and to a lesser extent Croatia gains storage stock, and Slovakia and Austria loses some (assuming unchanged storage pricing policies).

If no further investment takes place, 9 bcm existing spare working gas storage capacity cannot be utilised due to the lack of interconnection or high transmission costs. At the same time several markets utilize their storage at the technical maximum, indicating that investment is needed.

In the next step we analysed the effect of a 5 bcm package of proposed new UGS infrastructure package for the countries facing storage capacity shortages (BG, HR, MV, PL, RO, SB) on the Danube Region storage market and on social welfare.

Results show that this 5 bcm new working gas capacity investment is too much for the region. Unused spare capacities grow from 9 to 13 bcm and less than 20% of the new storage infrastructure is utilized. The reasons for this result are:

(i) new capacities are expensive (tariffs should cover investment costs) and not competitive with other flexibility mechanisms

(ii) old storages of neighbouring countries are cheaper even with the added cost of transmission charges.

(iii) Social welfare analysis justifies the Polish and the Moldavian storage investments.

To measure the security of supply benefits of a storage investment, we simulated a supply crisis. We assumed a supply disruption to occur in January caused by a 30% supply cut of Russian gas transits through Ukraine. In our 2015 base case we assume a certain level of "strategic" gas stock to be kept for security of supply purposes (30 days winter consumption of the household sector of the given country). We found that keeping this stock in storage prevents the countries from dramatic consequences in case of a supply shock, and only a modest price increase in the Eastern Balkans is foreseen. By adding the 5 bcm new storage infrastructure to the region, even this modest reaction is eliminated. We simulated what would happen without the "strategic stock" and the model suggests that a similar crisis as of the one in 2009 would occur. From the modelling exercise our policy recommendations to the Danube Region policy makers are the followings:

- The 994/2009 Security of Supply Regulation aims to ensure continuous supply through the most cost-efficient measures. Hence a better use of existing infrastructure should be encouraged instead of building new capacities. New interconnectors open up new possibilities to provide flexibility to the market. The region's spare gas storage capacities should be used in the first place instead of building new facilities. Regional policy cooperation to facilitate the use of neighbouring countries' storage facilities shall be encouraged.

- A certain level of obligatory "strategic stock" to be kept in storage increases the security of the whole region significantly. We understand that other flexibility tools are competing with storage under normal conditions (supply contracts, demand side measures, spot markets), but in a supply crisis situation the storage facilities play a crucial role in maintaining the integrity of the market and the continuity of supply. The strategic stock should not necessarily been stored in a physically separate or otherwise dedicated storage facility.

- In a security of supply situation the physical reverse flow possibilities are of utmost importance. The exemption from the obligation to allow physical bi-directional gas flows on pipelines – besides decreasing the effectiveness of market integration – is undermining the efforts to ensure continuous supply in crisis situations.

- Investment in new storage facilities does not necessarily increase the total social welfare for the region. Regional investment proposals are excessive and would result in an increase of unused spare capacities. The benefits of new facilities under supply crisis situations can barely out weight the losses on these investments for the region as a whole. A cost benefit analysis of the individual storage investment projects shall be carried out, taking into account the competing flexibility possibilities and the externalities on other market participants.

- In the Danube Region the Polish and the Moldovan storage investment proposals seem to be justified on the basis of our welfare analysis. The Bulgarian storage investment results in positive social welfare change only under the supply interruption scenario, but not in normal conditions.

It is understood that a certain level of mistrust exist when security of supply is ensured by facilities outside of the territory of the given Member State. To overcome this problem, it is important to encourage the conclusion of arrangements between natural gas companies. Governments or regulatory agencies should identify incentives or provide the necessary political and economic guarantee for the parties that ensures regional cooperation will not be undermined in a crisis situation, which includes a contractual provision for reliable delivery.

2 INTRODUCTION

Natural gas storage plays various roles in the national and regional gas markets, namely balancing seasonal demand, providing daily flexibility, and helping inter-temporal price arbitrage. Natural gas storage also contributes to ensuring supply security and can be considered as a separate sub-sector of a regional gas market. In our previous study[2] conducted for the Danube Region (Danube Region Gas Market Model), we found that adding new storage infrastructures to the region's existing infrastructure had no measurable impact on wholesale gas price convergence of national markets.[3] The effect of new LNG infrastructures and certain interconnectors was much more relevant for market integration and wholesale price convergence, which was in line with our expectations. However, to better understand the role of storage and the effect of storage infrastructure investments on regional prices and consumer welfare, we need to first analyse the regional storage market. In the course of the present study DRGMM inputs were updated with actual storage data from the market.

In the first part of the study, we give a short overview of the natural gas storage markets of the Danube region. Storage facilities, annual demand, access regimes and strategic storage obligations are discussed and compared on the regional level. In the second part, the DRGMM is used to provide a better understanding of the possible future utilization of storage facilities under various assumptions.

[2] The Danube Region Gas Market Model and its application to identifying natural gas infrastructure priorities for the Region, available at: http://www.rekk.eu/index.php?lang=en

[3] In the first modelling runs, storage fees were considered 0.

3 REGIONAL STORAGE MARKET OUTLOOK

3.1 Role of storage in the region

In the Danube region, gas storage facilities are predominantly used for seasonal demand balancing and for protecting against supply disruption.

Seasonal demand can be supplied from a number of sources that include domestic production, imports, and storage. The annual demand is a sum of domestic production, imports and net withdrawal from storages. The net withdrawal is injection into storage minus the withdrawal from storage. To illustrate how storage is used to cover winter consumption by the withdrawal of gas injected during summer, we use the example of the Czech Republic (Figure 1).

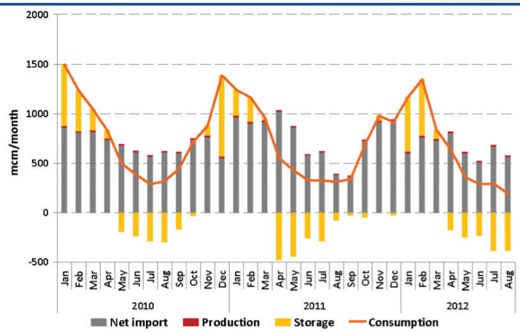

Figure 1: Sources of supply and seasonal gas demand in the Czech Republic

source: IEA, Eurostat

Seasonal consumption determines the need for storage, which can be characterised by the ratio of heating season consumption divided by annual consumption. The table below shortly summarizes the annual consumption of the Danube Region countries for 2010 and its sources (import, production, storage).

	consumption 2010, mcm	net imports	domestic production	net storage withdrawal	heating season / annual consumption
AT	10 284	7 860	1 715	709	65%
BA	247	n.a.	n.a.	n.a.	54%
BG	2 698	2 485	78	135	72%
CZ	9 520	8 291	213	1 016	71%
HR	3 486	989	2 563	-66*	58%
HU	12 387	9 724	2 881	-218*	72%
MD	1 893	1 893	0	0	64%
PL	16 781	10 788	5 721	272	63%
RO	13 858	2 374	11 359	125	60%
SB	2 297	n.a.	n.a.	n.a.	58%
SI	1 069	1 069	0	0	64%
SK	4 753	4 767	101	-115*	57%
UA	68 465	n.a.	n.a.	n.a.	71%

Table 1: Consumption structure in the DRGMM countries

source: Eurostat, IEA

*the net storage withdrawal can be negative if in a given year more gas was injected into storage in summer than withdrawn in winter; this amount is part of the storage stock

The ratio of heating season consumption and annual consumption (last column of Table 1) is a good indicator of the countries' consumption patterns: the different consumer groups (household consumers, power generation and industry) have different consumption patterns. The ratio is higher for countries that use gas for heating compared to those that use gas mostly for industrial purposes. The geographical position of the countries (e.g. winter temperatures) has also a significant impact on consumption. Consumption patterns define the demand for storage: where winter season consumption has a higher ratio compared to the annual consumption, storage is an essential facility to cover the seasonal demand peaks. The ratio of Bulgaria, the Czech Republic, Hungary and the Ukraine are above 70% meaning that consumption is highly seasonal in these countries.

Countries with a high heating season/annual consumption ratio and with limited source diversity introduce security of supply standards and measures to reduce the risk of supply disruption towards protected final consumers.

Article 8 of the 994/2010 regulation sets a minimum supply standard to be ensured for the protected (mainly for household) consumers. These standards are to cover extreme temperature cases and supply disruption of the single largest infrastructure[4]. As the region has experienced the 2006 and 2009 January supply crises, the latest case is a highly relevant issue.

One of the measures to ensure these security standards is to have an obligatory stock in the underground storage for crisis situation.[5]

[4] Art 8 sets the following 3 supply standards to be ensured for protected consumers: (a) extreme temperatures during a 7-day peak period occurring with a statistical probability of once in 20 years; (b) any period of at least 30 days of exceptionally high gas demand, occurring with a statistical probability of once in 20 years; and (c) for a period of at least 30 days in the case of the disruption of the single largest gas infrastructure under average winter conditions.
[5] 994/2010 Regulation of the European Parliament and Council concerning measures to safeguard security of gas supply and repealing Council Directive 2004/67/EC lists some other measures that can contribute to the fulfilment of the supply standard, e.g. "linepack, supply contracts, interruptible contracts or any other measures that have a similar effect, as well as the necessary technical measures to ensure the safety of gas supply". In this study we do not focus on these measures, since in this region they can only serve as complementary measures for storage to ensure supply security.

Types of storage facilities

Underground gas storage facilities have three important characteristics: 1) working gas capacity, which denotes the amount of gas which can be injected into storage; 2) injection capacity, which refers the daily/hourly rate of injection; 3) withdrawal capacity, which indicates to the speed at which stocks can be accessed.

In the EU around 69% of working gas capacities are in depleted fields, 19% in aquifers, 10% in salt cavities, and 2% in above-ground storage and each have different flexibility attributes. Generally speaking, depleted fields reach their maximum withdrawal capacity slower than salt cavity or aquifers, and run one cycle in a year: filled in summer and withdrawn in winter. This cycle cannot be reversed many times within a single year, so they are less capable to react to short term market price signals.

Storage units in the Danube Region are mostly depleted fields. There is only one salt cavity (crystalline structures) storage (Háje 72 mcm) in the Czech Republic and there are some small aquifers in the Czech Republic and two in the Ukraine (Mryn 310 mcm, Olysevka 1500 mcm).

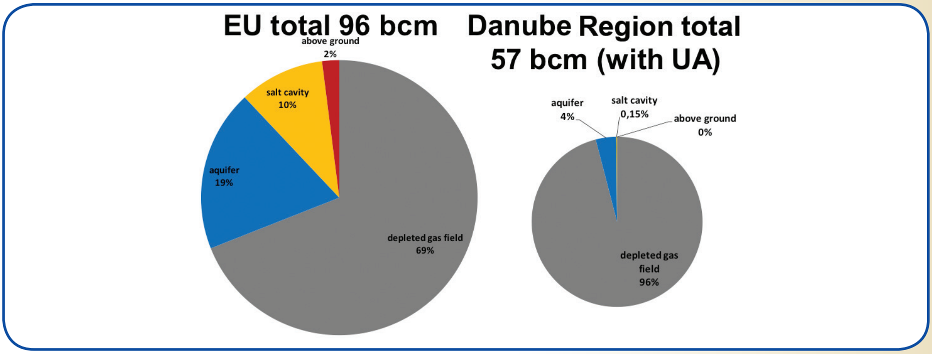

Figure 2: Types of storage in the European Union and in the Danube Region and their working gas volume (bcm)

source: GSE 2012

3.2 Need for storage development

Storage facilities have two main important parameters. First, working gas capacity to provide seasonal flexibility,(i.e. the amount of gas that can be stored). The other is the daily withdrawal capacity (i.e. the amount of gas that can be delivered to the consumers on a winter day) to provide daily flexibility. In this chapter we analyse both the availability of storage working gas capacity and storage withdrawal capacity of the Danube Region.

3.2.1 Seasonal flexibility analysis

On the whole, the Danube Region has ample working gas capacity to balance its winter consumption (working gas values total at about 39% of annual consumption, excluding Ukraine). This value is much higher than the 18% characterising the European Union as a whole (Figure 3).

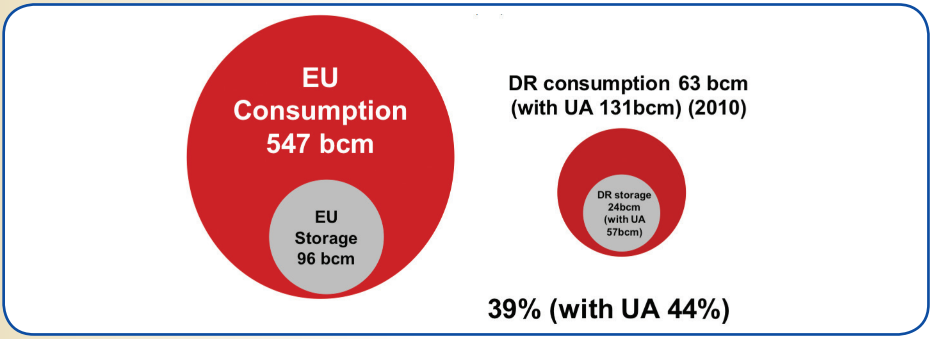

Figure 3: Annual consumption and storage working gas capacity of the EU and the Danube Region in 2010 (bcm)

source: GSE 2012

However, some countries have no or insufficient storage.

Based on monthly historical natural gas consumption data for 2010 and 2011, we have examined the role of storage in two consecutive heating seasons. Countries possessing storage facilities covered roughly 35-40% of their heating season consumption from underground storage facilities. Since annual data are more easily available, we estimated that 35-40% heating season consumption makes up 20-25% of the annual consumption.

We define a proxy for storage need: the ratio of working gas storage capacity and annual gas consumption of each country. To avoid the yearly variation caused by the weather dependency of annual consumption, we used a range[6]. As a rule of thumb, we considered 25% working gas/annual gas consumption ratio as a minimum level of sufficient storage[7]. Storage infrastructure is deemed to be insufficient given a ratio less than 20%. Between 20% and 25% further analysis of the specific country is needed in order to assess other forms of flexibility and the relative importance of natural gas. Other factors to be taken into account are i.e. domestic production and a flexible TOP contract that may serve as a substitute for storage. It might also happen that natural gas consumption is insignificant in the energy balance of the country, because residential consumers heat with other fuels).

Figure 4: Rule of thumb for first evaluation of actual storage capacity of countries based on working gas capacity/annual consumption ratio

[6] In colder winters the ratio proved to be 1-2% smaller.
[7] Storage operators confirmed that about 30% storage use is calculated for the region for portfolio optimization. This is in line with our calculations, and would not change the outcome of our analysis.

	Working gas	Working gas/annual consumption 2010	Working gas/annual consumption 2011
AT	7451	73%	80%
BA	0	0%	0%
BG	450	16%	14%
CZ	3432	37%	42%
HR	550	17%	16%
HU	6330	52%	52%
MD	0	0%	0%
PL	1822	11%	11%
RO	2701	20%	19%
SB	450	20%	19%
SI	0	0%	0%
SK	2905	47%	45%
UA	32130	47%	n.a.

Table 2: Working gas and storage need indicator

source: Eurostat, GSE, REKK calculation

According to our rule of thumb **Bosnia and Herzegovina, Bulgaria, Croatia, Moldova, Poland and Slovenia** lack the required working gas (red background in Table 2) while **Romania and Serbia need further analysis** (orange background).

3.2.2 Daily flexibility need analysis

Besides supplying working gas for seasonal needs, the natural gas system must be able to adjust to daily imbalances. This so-called flexibility refers to the daily adjustment capacity of the different sources of supply.

Apart from storage, daily flexibility can be met by the flexible operation of a pipeline, production, or the curtailment of certain natural gas consuming industries. Thus the competition of storage services is not confined to the various storage facilities but also other means of supply or curtailed demand. The table below summarizes the flexibility of existing gas storages. Withdrawal rates/peak consumption gives an indicator on the extent storage can contribute to the gas supply in peak consumption days.

	Withdrawal, mcm/day	Peak demand mcm/dav	Withdrawal capacity/ peak demand
AT	88	57.6*	153%
BA	0	1.7**	0%
BG	3	17.5*	17%
CZ	55	63.8*	86%
HR	6	12.0**	50%
HU	80	78.8*	102%
MD	0	n.a.	0%
PL	36	75.8**	47%
RO	31	69*	45%
SB	5	12.7***	39.3%
SI	0	5.6**	0%
SK	38	47.1***	80.7%
UA	301	n.a.	n.a.

Table 3: Withdrawal capacity and daily storage need indicator

source: GSE 2012 May

*REKK data collection for 2012, based on daily actual consumption data,
** Entsog TYDP 2013 high demand scenario

In Austria and Hungary storage alone could supply the domestic market even on peak consumption days. In the case of Romania, Croatia, and Poland the flexibility requirement can also be served by domestic production. However the Bulgarian consumption (with high seasonal demand) would justify much higher storage withdrawal capacity than is presently available. Countries with no storage facility have to be supplied by flexible gas contracts (Bosnia Herczegovina, Macedonia and Moldova) or use the storage facilities of neighbouring countries, e.g. Slovenia is using Austrian storage.

Besides capacity values, we examined the actual flow data for the year 2012 on a daily basis to get a better valuation of the operating storages. Daily flow data by entry-exit points were collected for the year 2012. Note that in 2012 there was an extreme cold spell in February. We selected 10 days with the highest gas consumption and calculated the share of flows from storage to the consumers on these days, which was then averaged. Three countries with considerable storage and gas consumption - Czech Republic, Hungary and Slovakia – were chosen to formulate a rule of thumb.

We define the second proxy for storage need as the ratio of daily storage withdrawal and peak day consumption for each country. As a rule of thumb, we considered 60% daily withdrawal /peak day gas consumption ratio as a minimum level of sufficient storage. Below 35%, storage infrastructure is deemed insufficient. Between 35% and 60% further analysis of the specific country is needed, including an evaluation of other forms flexibility and the relative importance of natural gas (i.e. demand side management, interruptible consumer contracts, indigenous production or a flexible TOP contract that may serve as a substitute of storage; residential consumers heat with other fuels than gas).

	Withdrawal / Peak consumption
CZ	63%
HU	57%
SK	71%

Table 4: Share of flows from gas storage in 10 days peak consumption, 2012

source: IEA, Eurostat

Sufficient over 60%	To be further analyzed 60-35%	Insufficient Below 35%

Figure 5: Rule of thumb for first evaluation of actual storage capacity of countries based on withdrawal capacity/peak day consumption ratio

3.3 Unbundling and access regime

So far we have shown that sufficient physical capacities are available on a regional level but some countries lack domestic storage. The question is whether regional spare capacities are accessible for third parties and under what conditions? This chapter will analyse the ownership structure of the storage facilities (the role of unbundling), the market concentration on national markets, and the access regimes.

3.3.1 Unbundling and ownership of storage sites

EU legislation does not demand the legal unbundling of storage system operation, only accounting unbundling applies from the Third Energy Package. According to the definitions set out by the European Commission, a company is vertically integrated if it performs one of the following functions: transmission, distribution, LNG transport, or gas storage and at the same time is involved in production or supply of natural gas.[8]

In 2008 Ramboll Oil & Gas carried out extensive research on European storage infrastructure and found that about 53% of European storage operators are involved in extraction and production of gas, which classifies them as vertically integrated according to the above definition.[9] In 2011, all storage owners in the Danube Region are found to be vertically integrated companies.

3.3.2 Storage access regimes in the Danube Region

The EU third package allows for three main forms of access to storage: regulated, negotiated, and, in certain cases, exemption from third party access.

Regulated storage access is the most prevalent form of access regime in the Danube Region; in this case, a national regulatory authority sets the storage tariffs. Since nearly each regulatory agency uses its own methodology, tariffs are quite diverse and hard to compare. The main reason for having regulated access is the relatively high market concentration in the storage markets. In the absence of a regulated tariff, the monopolistic or oligopolistic actors would easily abuse their market power by raising the price for third parties.

[8] Directive 2003/55/EC Article 2 count 20
[9] Natural Gas Storage in the Region http://ec.europa.eu/energy/gas_electricity/studies/gas_en.htm

Negotiated access is used in some countries, for only a limited quantity of working gas. In this case, the owner of the facility organises an open auction to sell its capacities. We must stress that negotiated access does not allow the owner to sell its capacities to a designated buyer for a non-transparent price. The transaction must be made public and the owner must, at a minimum, disclose the results of the auction, the quantity of products sold, and an average price.

In some cases, member states may opt for exemption from third party access (TPA). Strategic storage inventories for instance do not need to be offered for TPA.

The dominant access regime in the Danube region is regulated third party access. Negotiated access is used in the Czech Republic where new storage capacities are auctioned. The other extreme is Serbia, where the storage facility is declared to be the first facility of South Stream and no third party access is applied. This is why there is no tariff published for the Serbian storage.

Since storage markets are usually concentrated, negotiated access regimes jeopardize third party access because storage operators can easily exert rent from users. The table below sums up the HHI indices[10] of the Danube Region countries, the number of storage operators, and the access regime in force.

On a regional scale, with an HHI index is above 6000 in all countries except for Austria, the storage market is very concentrated. The Austrian regulator has conducted a storage market analysis in 2010 and concluded that both supply and demand are too concentrated to introduce negotiated third party access.[11] An important phenomenon in Austria is that capacities are contracted for long term, so new entrants have no access to storage facilities. Without access to storage they cannot serve their clients, because storage is an essential facility on the Austrian flexibility market.[12]

	HHI	Number of storage operators	TPA	Market share of the biggest player
AT	2 696	5	R	36%
BA	n.a.	n.a.	n.a.	n.a.
BG	10 000	1	R	100%
CZ	6 389	3	N	78%
HR	10 000	1	R	100%
HU	6 662	2	R	80%
MD	n.a.	n.a.	n.a.	n.a.
PL	10 000	1	R	100%
RO	7 703	3	R	87%
SB	10 000	1	NO TPA	100%
SI	n.a.	n.a.	n.a.	n.a.
SK	6 643	2	R	79%
UA	9 400	2	R	97%

Table 5: Market concentration and access regimes in the DR

source: GSE 2012 May, REKK calculation

3.3 Utilisation of storages

So far we have only considered the physically available storage capacities. The actual utilisation of these capacities (i.e. the volume of gas molecules in the facilities) further elaborates the working of storage markets.

[10] Herfindahl-Hirshmann index (HHI) is calculated as the sum of squares of the relative market shares. Higher values indicate a more concentrated market.
[11] E-Control GmbH (2010): Diskussionspapier Konsultation der Marktteilnehmer zum Thema „Vorschlag für eine Wettbewerbsanalyse des österreichischen Speichermarktes anhand der nach Artikel 33 RL 2009/73/EG zu definierenden Kriterien" http://www.e-control.at/portal/page/portal/medienbibliothek/gas/dokumente/pdfs/positions-papier-ecg-gasspeichermarkt-06-09-2010.pdf
[12] Underground storage is only part of the flexibility market needed to serve final consumers, it can be provided by other tools as well: in a well-functioning gas market with liquid wholesale markets the spot trade can offer daily flexibility, or supply contracts can offer flexibility, or the consumers can offer interruptible services.

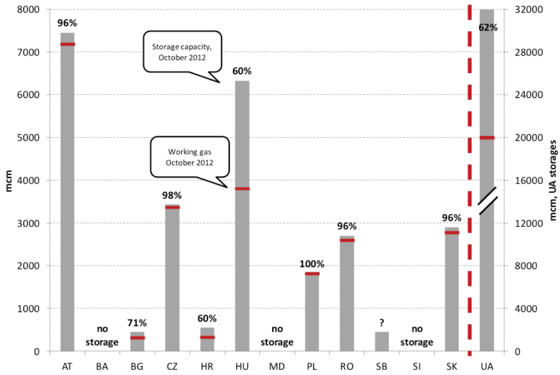

Figure 6: Utilisation rate of regional storages in October 2012 in the DR countries

source: GSE AGSI, storage operator's websites

Note: no available utilisation data for Serbia (SB)

Before winter, the storage capacities are usually full in Austria (booked for long term), in the Czech Republic, in Poland, in Romania, and in Slovakia. There are spare capacities in Hungary, Croatia, in Bulgaria and in the Ukraine. These capacities could be utilized for regional purposes. However instead of using already existing capacities, there are extensive national investment plans to build new facilities.

3.4 Investment plans

Currently, storage investment plans amount to 9 bcm working gas capacity in the region. Countries which were indicated to have insufficient storage in the previous chapter seem to be planning new facilities.

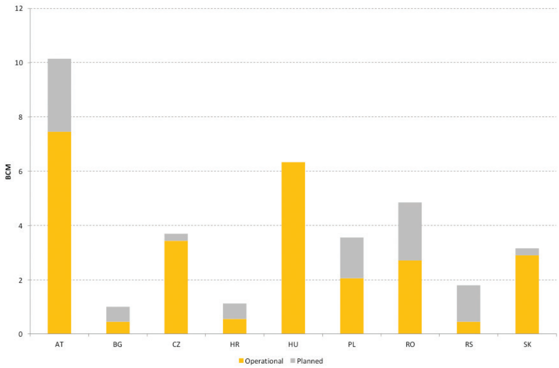

Figure 7: Existing and planned capacities in the DR

source: GSE 2012 May

3.5 Possibilities of a regional storage market

Even if the region has ample free storage capacity and relatively clear TPA rules, storing natural gas in another country is not typical. Security considerations, the lack of physical interconnection, potential distortions in cross border capacity access (if they exist), the variability of storage fees, and high transmission costs are perhaps the most important impediments to closer storage market integration. Next we have a closer look at the latter two factors: storage and transmission fees.

To compare storage fees, we calculated each to a common €/MWh unit. Storage products are sold in three forms: i) capacity-based fees, where users pay for working gas capacity, injection and withdrawal capacities; ii) capacity + usage fee type tariffs, in this case users pay for a working gas capacity and a usage fee for the gas injected and withdrawn; iii) bundled products, where users may buy predefined bundles of working gas capacity, injection and withdrawal. The different storage fees were defined in a variety of units, ranging from gigajoules to cubic meters. For countries using national currency other than Euro, 2011 exchange rates of the ECB were used. For the conversion of these various data, we used a hypothetical booking of 100 mcm, and heating values of the EIA 2011 Natural Gas Information.

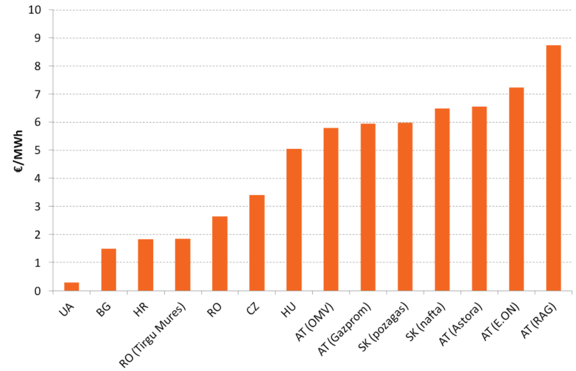

Figure 8: Storage fees in the DR countries (tariffs applicable for 2012)

source: storage operators and regulatory authorities, IEA, REKK calculation

Storage fees vary in the Danube Region on a large scale. Astoundingly high tariffs characterise Austria and Slovakia, while in the Czech Republic, where new capacities were auctioned, the price is much more moderate. In the Czech Republic case it seems that storage facilities have to compete on the flexibility market with the spread of spot and long term contract (LTC) prices. However we can conclude that the wide range of storage tariffs proves that competition is limited on the storage market in the region. This might change with the new regulation on Capacity Allocation. More transparent and efficiently used transmission infrastructure will create more competition on the storage market as well. It is however important to note, that storage service price competition is strongly dependent on the transmission tariffs. Traders consider the combined cost of storage and transmission when optimizing their portfolio. The next chapter will focus on the transmission tariff differences of the region.

3.6 Transmission tariff benchmarking of the Danube Region

The use of foreign storage capacities requires transmission tariffs payment as well. Since these are calculated according to entry-exit points, comparison becomes even more complex due to the existence of alternative routes.

In this section we describe a benchmark analysis for transmission tariffs in the region. The original idea was to calculate alternative routes for the storage option for each country. Following the November 2012 presentation, we asked the DR Task Force members to define their typical import routes and an alternative route involving storage. Unfortunately, we have not received any responses, so we were unable to model scenarios based on DR country experiences.

Nevertheless, to illustrate the possibilities and give a brief overview to the problem, we compare three possible scenarios for a gas supply and storage product with a supply delivery in Austria: first, storage in Hungary that is transmitted to Austria; second, transmission through Slovakia and storage in Austria; and third, storage in Slovakia and transmission to Austria.

	First route UA border → HU storage → AT border		Second route UA border → SK transit → AT border → AT storage		Third route UA border → SK storage → AT border	
Transmission	UA-HU entry	1.49	UA-SK entry	0.44	UA-SK entry	0.44
	Storage entry (exit)	0.00	SK-AT exit	0.50	Storage entry	0.22
	Usage fee (storage entry)	0.44	SK-AT entry	0.10	Storage exit	0.04
	Storage exit (entry)	0.89	Storage entry	0.05	SK-AT exit	0.50
	HU-AU exit (backhaul)	0.17	Storage exit	0.00		
	Usage fee	0.44				
	Transmission total	3.43		*1.07*		*1.18*
Storage	Storage usage fee*	5.05	Storage usage fee	7.05	Storage usage fee	6.38
Total tariff		**8.48**		**8.13**		**7.56**

Table 6: Storage and transmission fees for three different routes, €/MWh

source: storage and transmision operators and regulatory authorities, IEA, REKK calculations

Notes: In case of storage tariffs, capacity fees were accounted for. In case of Austria and Slovakia, we used a working-gas weighted average to calculate the storage fee.

For the basic calculation, we used the 2011 average of 280 HUF/€.

The second route delivers the cheapest transmission tariffs through Slovakia with storage in Austria. For the route through Hungary, the transmission fee is about three times higher than on the other routes, while the storage tariff is the cheapest in Hungary and the highest in Austria.

In total the combined storage and transmission fee for one MWh is highest for the first route, through Hungary, although storage in Hungary is cheaper than in Slovakia or in Austria. We can conclude that being situated in a country with lower transmission tariffs is a competitive advantage for storage operators.

It must be noted that the storage fee is highly sensitive to the HUF/€ exchange rate. With an exchange rate of 290 HUF/€ the first route becomes cheaper than the second, and above 310 HUF/€ it becomes cheaper than the third storage route.

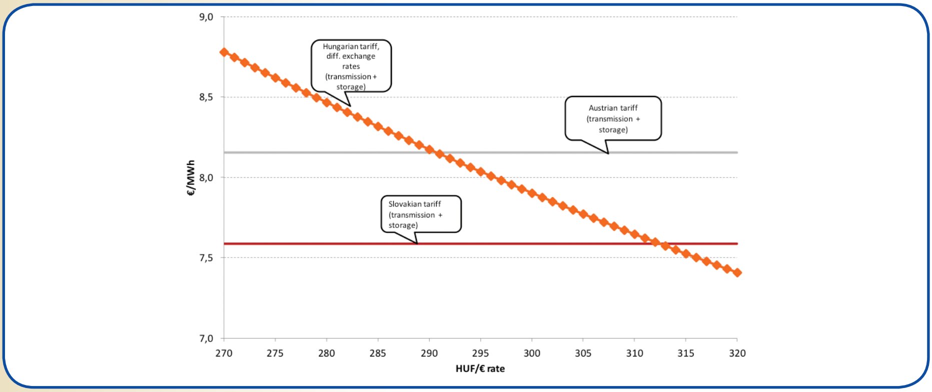

Figure 9: Sensitivity analysis of storage fees

source: REKK calculations

Without information from the Danube Region country representatives on the possible transit routes, we decided to incorporate the transmission tariffs into our Danube Region Gas Market Model and to use modelling for the evaluation of storage utilization of the region for 2015. The results of the modelling will be presented in the second part of the study.

3.7 Transmission tariff analysis

In order to incorporate gas transportation costs into the model, we collected the transmission tariff rates effective in the region. Not only do tariff systems vary across countries, unit tariff calculation methodologies also differ considerably. There are differences in the measurement units as well as in the basic reference gas conditions that tariff rates are associated with. The consistent use of transmission charges in model calculations require that fees are expressed in a common measurement unit, and refer to the same type of transportation service. Therefore, we performed our tariff rate calculations based on the following assumptions:

- The duration of transmission contracts is one year.
- Contracts refer to firm (not interruptible) transportation services (except for a few cases in which backhaul transportation was possible only on an interruptible basis).
- The booked maximum hourly capacity is 10,000,000 kWh (/h/y).
- Shippers are able to pool the demands of final consumers, enabling them to better utilize booked capacities. The load factor (i.e. the average rate of capacity utilization) is 80%.
- Tariff rates are expressed in €/MWh/year.

In making our assumptions we relied on previous tariff benchmarking studies, expert opinions, and our own calculations to confirm the effect of different capacity reservation levels and load factors on per unit charges.[13] We carried out calculations for 15 different "transportation profiles", including the combinations

[13] See for example the ERGEG Benchmarking Report of 18 July 2007 at http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Gas/2007/C06-GWG-31-05_BM-Gas%20Tariffs%20Report_0.pdf, or the latest ADL West European Gas Transmission Comparisons at http://www.gasunietransport-services.nl/en/downloads-en-forms

of 5 hourly capacity reservation levels (10,000,000; 1,000,000; 200,000; 10,000 and 1,000 kWh per hour) and 3 different load factors (100%, 80% and 50%). For countries using an entry-exit system, we calculated an average transportation charge, taking into account the average of all border entry tariffs and the average of all border exit tariffs, and adding the volume-based tariff components where applicable. Other fees (e.g. system administration fees) were also included. Our results led to similar conclusions to those of the above mentioned benchmarking studies. While the amount of reserved capacity has almost no effect on tariff rates, load factors can have considerable impact according to the relative share of capacity and commodity based components in the tariff structure, as Figure 1 shows.

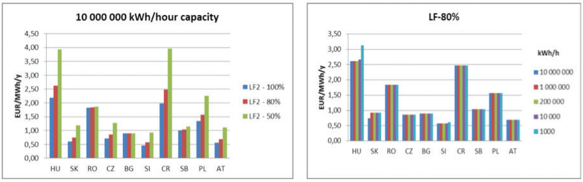

Figure 10: Average transmission charges at different load factor (LF) (left) and capacity reservation (right) levels

source: REKK collection from TSO fees

Tariff differentiation by consumer groups (i.e. according to the level of booked capacity) is practiced only in few countries (e.g. in Slovakia and in Slovenia for domestic exit points), while imposing both capacity and volume related charges is typical of most systems. In countries with only capacity based tariff elements the load factor is irrelevant (e.g. in Slovakia and Austria). We assumed that the majority of inter-country transmission activities are carried out by shippers who can pool the demand of several consumers and smooth out the actual transported volumes to an extent, in an effort to utilize capacities close to the reserved value. Thus, we used a high load factor of 80% in our calculations.

Using the assumed capacity reservation level of 10,000,000 kWh/h and the 80% load factor for the selected one year transmission service contract, we calculated the overall transportation fee (in €) that would be incurred by a shipper in each of the countries, with all of the necessary gas reference condition and currency unit conversions. For entry-exit regimes, we determined the relevant fees for each entry and exit point respectively and a calculation of commodity charges for all applicable countries.[14] Once we determined the total fee related to the above mentioned hourly capacity value and load factor, we could determine tariffs on a per MWh (/year) basis, dividing the total payments by the yearly transported volume expressed in megawatt-hours.

From the results above we can conclude that transmission tariff levels (for 80% load factor, firm yearly capacity product of 10,000,000 kWh/h) vary in the region between 0.5 and 2.5 €/MWh. The cheapest countries are the common transit countries: Austria, Slovakia, Czech Republic, and Hungary, which reflects the extensive investments into the network over the past decade (interconnector capacity grew by 72% between 2008-2010).

[14] Countries with entry-exit regimes in the region are the following: HU, SK, CZ, SI, PL, AT.

3.8 Modelling the Danube Region gas market

In this chapter, we will use the DRGMM to evaluate the future need for storage facilities. First, we develop a 2015 base scenario to model future demand for storage services, to which all other scenarios will be compared. Then three different scenarios will be developed: the "SOS scenario," which assumes the disruption of Ukrainian imports, where it is expect that regional prices skyrocket and storages are utilised at a higher level; the "investment scenario," which assumes that all planned storage facilities in countries with insufficient storage supply are realised; and the "investment+ scenario," built on the assumption that all planned storages are built in the region.

The DRGMM simulates the operation of an international wholesale natural gas market in the Central and South-East European (CSEE) region.[15] Given the input data, the model calculates a dynamic competitive market equilibrium, subject to constraints represented by the physical gas infrastructure and contractual arrangements specific to the region. The main inputs and outputs of the model are represented in Figure 11.

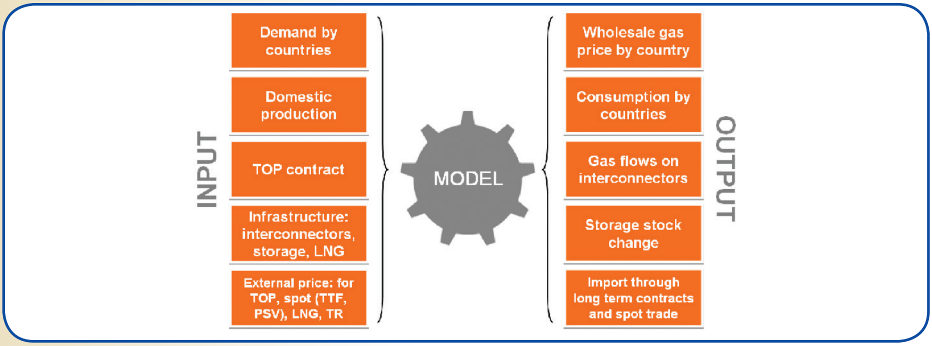

Figure 11: The structure of the DRGMM

Model calculations refer to 12 consecutive months, with a default setting of April to March. Dynamic connection between months is secured by storage operation and each local market can contain any number of storage units (companies or fields). Gas storage can move from one period to another, arbitraging away large market price differences across periods and taking into account a real interest rate for discounting. The model's constraints on storage operation are the following: in each month, there are upper limits on total injections and total withdrawals; injections and withdrawals must be such that during the year working gas capacity is never exceeded; intra-year inventory levels never drop below zero; starting and year-end inventory levels must be met.

Among the key drivers of the value of storage capacity monthly swing in gas demand is explicitly represented in the model through monthly demand input data. Our model is able to examine monthly arbitrage opportunities, but not able to model the effect of daily price volatility. We take into account security of supply concerns as we consider the strategic stock for the model input.

[15] The modelled countries are: Albania, Austria, Bosnia and Herzegovina, Bulgaria, Czech Republic, Croatia, FYR of Macedonia, Greece, Hungary, Moldova, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia and Ukraine.

3.9 Modelling assumptions

This section provides an overview of the various assumptions used in the modelling exercise.

3.9.1 Infrastructure assumptions

We assume that HU-SK and MV-RO bidirectional interconnectors will be built and all existing interconnectors on EU-EU borders will be bi-directional by 2015. We also assume that South Stream will be used by 2015 with TR-BG, BG-SB, SB-HU, HU-SI, SI-IT pipelines, and 10 bcm gas will be shipped to Italy under a TOP regime with allowing backhaul up to 1.5 bcm.

On the Yamal transit pipeline we allow virtual reverse flow (backhaul) transactions.

3.9.2 Price assumption for the markets external to the model

Our price assumptions are the same for 2011 and 2015. For the German market we use TTF[16] spot price (24.6 €/MWh on average), for Italy the PSV[17] price. Russian spot contracts are traded at a premium to TTF/PSV contracts as well as to Russian TOP contracts which is calculated by 80% oil price and 20% spot price indexation (32.2 €/MWh uniformly for all countries). TOP contracts expiring between 2011 and 2015 (HU, BG, HR) are assumed to be renewed with a reduced rate of annual contracted capacity (80% of the former contract).

It is worth noting however that for storage operators, the relative prices (seasonal spread, TOP/spot spread etc.) are of consequence, and absolute price values do not significantly impact the modelling results. Concerning Western-European markets we assume 4.4 €/MWh seasonal (winter-summer) spread, while average spread between oil- indexed and TTF spot gas prices is 10 €/MWh. Price assumptions for outside markets are shown in Figure 12.

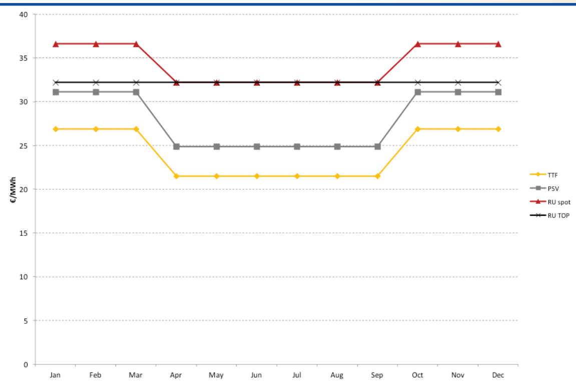

Figure 12: Monthly price assumptions in external markets for the period of 2011-2015

source: REKK calculation

3.9.3 Transmission tariff assumptions

In the model we use transmission fees effective in 2013. In order to use them consistently in model calculations, fees are expressed in a common measurement unit, and are based on the same transportation service. Tariffs are calculated based on the following assumptions:

[16] Dutch gas hub, the most liquid gas hub on the continent, the second in Europe after NBP, the British gas hub
[17] Italian virtual gas hub

– The duration of transmission contracts is one year.

– Contracts refer to firm transportation services (except for a few cases in which backhaul transportation was possible only on an interruptible basis).

– The booked maximum hourly capacity is 10,000,000 kWh (/h/y).

– Shippers are able to pool the demands of final consumers, enabling them to better utilize booked capacities. The load factor (i.e. the average rate of capacity utilization) is 80%.

source: REKK calculation based on TSO tariffs

3.9.4 Storage fee assumptions

As a starting point, we use the 2013 storage tariffs introduced by Figure 8 for modelling purposes. However, the actual tariffs in Austria, Slovakia and Poland are too high compared to the seasonal gas price spread assumed in Germany, which would result in their underutilization during modelling. To produce more realistic injection figures by the model, these tariffs are capped at the level of 5.30 €/MWh, which is in line with international benchmarks for long term storage cost. This solution ensures that storages in the abovementioned countries will be used at a realistic level.

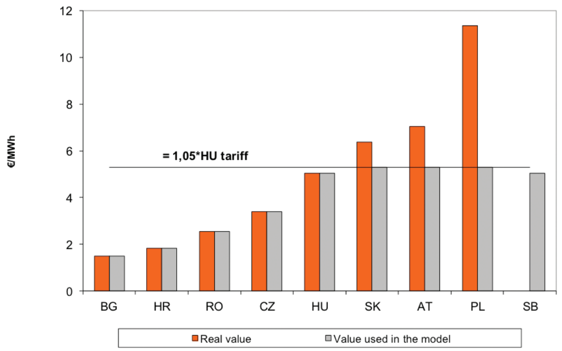

Figure 13: Average storage fees by market, €/MWh

source: REKK calculation

Storage tariffs used in the model can be interpreted as average total cost of storage operation, including not only the injection and withdrawal unit fee but also the capacity fee calculated for a unit of storage usage.

3.9.5 Strategic storage assumptions

Strategic storage in Hungary (Szőreg) is modelled with 815 mcm strategic stock[18] and we assume that all of the withdrawal capacity (25 mcm/day) is used as commercial capacity. In the case of Austria, Slovakia, Czech Republic, Romania, Bulgaria, Serbia and Poland we also assume a minimum level of 'strategic' storage to serve 30 days of residential consumption (in line with the requirement of EU Regulation 994/2010). For Ukraine, in the absence of available data we assumed a strategic stock quantity which could satisfy the country's gas consumption for 30 days.

[18] Decree 13/2011, NFM.

Figure 14 shows the assumed strategic storage capacities in the modelled countries.

Figure 14: Strategic gas stocks

source: Eurostat, IEA, national statistics

For the region (without UA) 2534 mcm total strategic stock was assumed.

3.10 The modelling exercise

3.10.1 The starting point 2011

First we run the DRGMM on 2011 data to compare its results to our findings in the first part of the study on storage utilization. Our rule of thumb identified Poland, Bulgaria and Croatia to have insufficient storage capacity along with the countries that do not have storage facilities at all - Bosnia Herczegovina, Moldova and Slovenia. Countries between our sufficient and insufficient range , such a Romania and Serbia, are also included the modelling exercise. The 2011 results on storage injection (in million m^3) are presented below.

Figure 15: Yearly injection into storage in the Danube Region in 2011 modelled (mcm)

The dark green boxes indicate that storage is fully utilized in a given country.[19] According to these results storage investment would be needed in the Czech Republic, Slovakia, Poland Romania and Bulgaria. The reason why the model output differs from the actual data presented in Figure 6 is that our model is a one year competitive equilibrium model that cannot handle long term capacity booking (Austria) and strategic behaviour of vertically integrated undertakings. We may conclude that Austrian storage units at their present tariffs would not be fully utilized in a competitive environment and note that the Serbian gas storage facility was only in pilot operation in 2011. Our modelled total regional storage utilization in 2011 was 16169 mcm. For the rest of the study it is important to keep in mind that the model results do not indicate the extent to which countries without storage utilize foreign storage facilities. Flows are directed only by the available transmission and storage capacities and their price, and the option of using foreign infrastructure is not limited by any other factors.

3.10.2 2015 reference scenario

To analyse the effect of future storage investments first we created a 2015 reference scenario, in which we assume the present storage capacity but with the uncompleted interconnector projects finished and operational.

Figure 16: Price forecast in the 2015 base case (with the current storage infrastructure)

Note: Figures in the boxes represent marginal (yearly average) wholesale gas prices (€/MWh) calculated by our model. Figures in grey boxes are exogenous market prices. Arrows show the gas flows, with their size indicating the amount transmitted. Grey arrows indicate congested transmission capacities; bold arrows imply that they ought to be at least five times larger (transmitted amount is so high that it cannot be represented proportionally). Orange circles indicate new infrastructure assumed to be realized by 2015.

By 2015 the current price patterns will more or less remain. In Austria, Czech Republic and Slovakia the Western-European price level prevails, while in the other countries prices are relatively higher. Average price in the region (excluding Ukraine) is 31.8 €/MWh.

Figure 17 shows our yearly storage injection forecast in 2015 with the present storage facilities.

[19] For modelling purposes we had to limit the availability of Ukrainian storage facilities because the low tariffs (on transmission and storage) would lead to unrealistic results.

Figure 17: Yearly injection forecast in the 2015 base case (mcm)

Note: Figures in the boxes represent the yearly storage injection quantities of the countries (mcm). Dark green boxes indicate the full utilization of capacities.

Storage facilities in five countries (PL, CZ, HR, RO, BG) operate at full capacity, while Austria, Hungary and Slovakia have significant spare capacities. Countries without storage (SI, MK, MV, BA) use foreign storage facilities. In this base case scenario regional injection quantity (excl. UA) is 14 260 mcm, while the quantity of spare capacities (excluding UA) is 8 965 mcm. Interestingly storage utilization is less in 2015 than it was in 2011 (on a regional level 844 mcm less), however regional consumption grew by 21 bcm (from 82 bcm in 2011 to 103 bcm in 2015). This is in line with our expectations since new interconnectors have strengthened interconnectivity of the region, hence more flexibility can be provided by these new pipelines. This flexibility is competing with the flexibility provided by the storage facilities, and the cheaper solution will prevail.

Interconnectivity make the storage market more competitive, putting downward pressure on prices to attract demand from foreign markets. This leads to a new distribution of storage gas injection, whereby Hungary, Serbia and, to a lesser extent, Croatia gain storage stock, and Slovakia and Austria lose. This is a consequence of the new Hungarian-Slovakian interconnector.

3.10.3 “Investment in shortage capacity countries” scenario

The next modelling step was to analyse the effect of new storage investments. From the list of planned storage investments we excluded those projects that were proposed in countries with already sufficient storage working gas capacity according to our rule of thumb in the first part of the study: Austria, Hungary, Slovakia, Czech Republic. The following table lists the proposed investments included in our analysis as a package.

Storage	Market	Injection Capacity mcm/day	Withdrawal Capacity mcm/day	Working gas mcm
Chiren (Bulgartransgaz)2	BG	7.0	6.7	550
UGS Benicanci	HR	8.3	8.3	550
Grubisno Polje	HR	4.0	6.2	25
Cazaclia	MV	1.9	1.8	74.1
Kosakowo	PL	2.4	9.6	250
Husow (PGNiG) - expansion	PL	5.7	5.7	150
Brzeznica (PGNiG) - expansion	PL	0.3	0.4	35
Wierzchowice (PGNiG)2	PL	7.0	10.8	625
Mogilno (PGNiG)2	PL	20.6	20.6	438
Roman-Margineni	RO	15.0	15.0	1 600
Tirgu-Mures (Depomures)2	RO	2.0	2.0	300
Nades-Prod-Seleus (AMGAZ)2	RO	1.7	1.7	250
Banatski Dvor2	SB	6.5	5.0	350

Table 7: New storage investment plans investigated by the DRGMM as a package

source:GSE 2012

The total working gas capacity added by these projects is 5197 mcm i.e. a 20% increase. As these new investment projects would require a return on investment, we use the long term cost of storage as a uniform price in case of all new investments. This 5.3 €/MWh is a relatively high price in the region and coincides with the capped storage price used for modelling (see Figure 8).

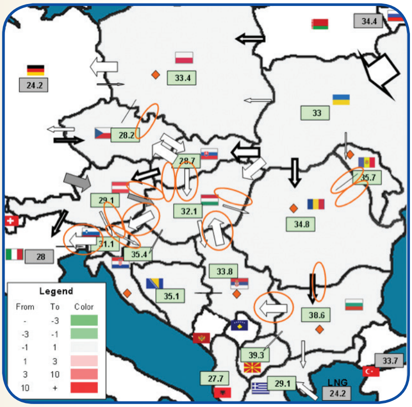

Figure 18: Price forecast for 2015 with new storage investments

Note: Figures in the boxes represent marginal (yearly average) wholesale gas prices (€/MWh) calculated by our model. Figures in grey boxes are exogenous market prices. Arrows show the gas flows, their size indicating the amount transmitted. Grey arrows indicate congested transmission capacities; bold arrows imply that they ought to be at least five times larger (transmitted amount is so high that it cannot be represented proportionally). Orange circles indicate new infrastructure assumed to be realized by 2015.

In line with our previous findings and expectations, new storage investment does not have significant price convergence effect. National wholesale prices however change in the range of -1 and 1 €/MWh.

Minor price reductions are experienced in some national markets (RO, BG, SB) as a result of storage investment due to the ability of storing a higher volume of cheaper gas in the summer.

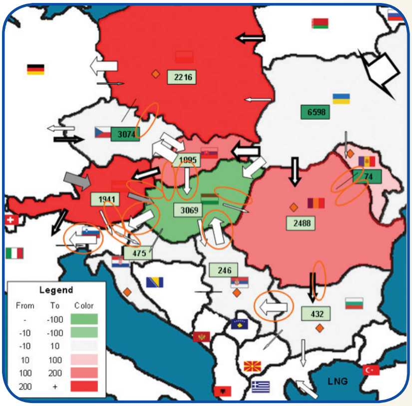

Figure 19: Yearly injection forecast for 2015 with new storage investments (mcm)

Note: The colour of each country indicates the change in the yearly injected quantity compared to the reference case, according to the legend expressed in mcm.

As expected, new investments increase storage injection on a regional level. This increase, however, is relatively small: 844 mcm/year. A significant fraction of new working gas capacity (5197 mcm) remains unused. The existence of 13.5 bcm/year excess working gas capacities in the region indicates that there is no need for the assumed volume of storage investments. An interesting finding is that even in countries where storage capacities were fully utilized (such as Bulgaria and Croatia) new storage capacities are not utilized due to the higher price assumed. Despite the growing regional gas demand, the new Croatian storage facilities are hardly used as they are substituted for by older and cheaper cheaper storage in Austria. Austrian storage capacities remain uncongested. In contrast Czech storages remain congested (similar to the base case scenario). New storage infrastructure in Poland, Romania and Slovakia are partly used, but compared to the reference scenario they are far from full utilization. The new Moldovan storage, however, is congested which indicates that further investment is needed.

In the following we analyse the impact of new storage investments on social welfare. Changes in different social welfare measures are summarized in Table 8. Change in consumer surplus shows how the consumers' welfare varies due to the change in price and purchased quantity. Change in producer surplus is the produced quantity multiplied by the change in wholesale gas prices. Storage operation profit derives from the exploitation of arbitrage possibilities between seasons when price differences are larger than the cost of storage. Net profit from long term supply contracts in a country, is the purchased

TOP quantity multiplied by the difference between wholesale gas price and contracted TOP price. TSO auction revenues which occur when cross border capacities are scarce are also the part of social welfare.

	Change in consumer surplus	Change in producer surplus	Change in storage operation profit	Change in net profit from long-term contracts	Change in TSO auction revenues	Change in total social welfare
All modeled countries	-714	400	-423	692	62	17
Danube Region*	-835	401	-384	730	55	-33
Energy Community	-548	346	-212	557	-11	133
Host countries	122	55	-193	-13	-24	-54
BG	22	1	-25	1	-7	-8
HR	-35	17	0	6	1	-12
MV	1	0	5	5	-2	8
PL	148	-1	-39	-50	1	59
RO	12	34	-132	2	-15	-100
SB	-27	3	0	23	-2	-2

Table 8: Welfare change compared to the base case scenario, 2015, million €

** AT, BA, BG,CZ, HR, HU, MV, RO, SB, SI, SK, UA*

Due to the reduction in the number of congested storages, storage operators suffer profit loss on the regional level. New projects increase the social welfare of Poland and Moldova, while other countries do not benefit from the regional storage development. Local gas producers usually benefit from higher wholesale prices. Assuming that the investment cost of 1 bcm storage capacity is 400 million €, the payback period to recover investment would be 23 years based on monetized social benefits for the modelled countries summarized above.

3.10.4 Contribution of existing and new storage investment to security of supply

Next we analyse the following scenarios in order to evaluate the welfare impacts of strategic storage as well as the proposed new storage capacities under a reference gas crisis situation that assumes a 30% reduction in January Russian gas transits through Ukraine:

- the reference crisis scenario assumes present storage assets and strategic stocks
- the reference crisis scenario assumes present storage assets without strategic stocks
- investment scenario: crisis scenario assumes expanded storage assets and strategic stocks

4 SOS reference: crisis scenario assuming present storage assets and strategic stocks

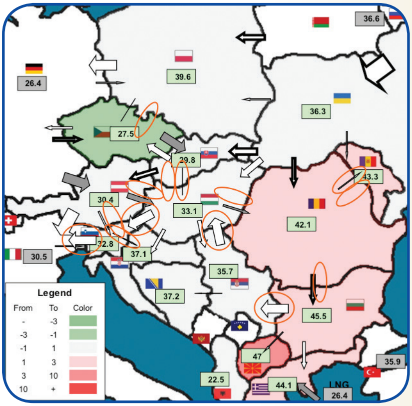

Figure 20: Wholesale January gas price (€/MWh) in January 2015, SOS reference case

Note: Figures in the boxes represent marginal (January average) wholesale gas prices (€/MWh) calculated by our model. Figures in grey boxes are exogenous market prices. Arrows show the gas flows, their size indicating the amount transmitted. Grey arrows indicate congested transmission capacities; bold arrows imply that they ought to be at least five times larger (transmitted amount is so high that it cannot be represented proportionally). Orange circles indicate new infrastructure assumed to be realized by 2015.

To analyse the effect of new storage investment on security of supply we carried out intra-year modelling that assumes a supply disruption in January whereby Russian gas transits through Ukraine decrease with 30%. The effect of the crisis is reflected in the January gas prices: the difference between the January prices under normal circumstances (without disruption) and under the security of supply run is reflected in the colouring of the countries in Figure 20. In extreme cases where the modelled price increase in January is 10€/MWh or higher compared to the results in Figure 18 (these are the dark red countries), serious security of supply problems would likely lead to the curtailment for certain consumer groups. There are no countries in that range resulting from the simulation. A moderate price increase between 1 and 3 €/MWh is expected only in FYROM, which would probably be solved without significant consumption cuts. As Figure 20 shows in Bulgaria, Romania, Greece and Moldova the modelled price increase in January is below 3 €, meaning that such a supply cut do not cause serious problems in the region. This moderate effect is due to the strategic stocks already established. As described above, we assumed that the 994/2010 regulation is followed and there is a release of the UGS stock in this crisis. The next scenario underlines the importance of regional emergency plans and regulatory cooperation for the inter-regional use of storages.[20]

5 SOS without reserves: crisis scenario assuming present storage assets without strategic stocks

To check for the importance of strategic stock reserved in underground storages, in this scenario we assumed that the same crisis situation (30% supply cut in January on all pipelines from Ukraine) with the present infrastructure but without any storage obligation. In this scenario the traders inject gas into storage on a commercial basis only. They try to optimize their costs and use other means of flexibility assuming average winter supply conditions. An unexpected supply cut in January in this case illustrates the vulnerability of the region, highlighting its dependence on a dominant supplier and a single supply route.

[20] Directive 994/2009/EC

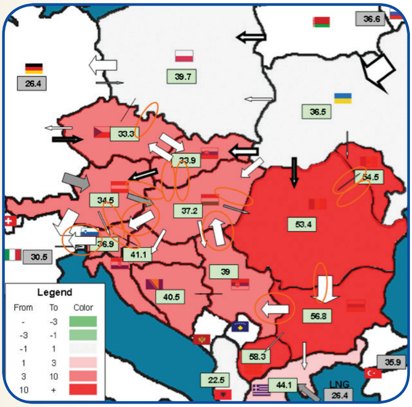

Figure 21: Wholesale January gas price (€/MWh)- SOS scenario without strategic stocks

Note: Figures in the boxes represent marginal (January average) wholesale gas prices (€/MWh) calculated by our model. Figures in grey boxes are exogenous market prices. Arrows show the gas flows, their size indicating the amount transmitted. Grey arrows indicate congested transmission capacities; bold arrows imply that they ought to be at least five times larger (transmitted amount is so high that it cannot be represented proportionally). Orange circles indicate new infrastructure assumed to be realized by 2015.

Figure 21 clearly shows that strategic stocks play an important role in downscaling the effect of major supply interruptions. In their absence prices rise significantly (by more than 10 €/MWh) and supply shock occurs in Moldova, Romania, Bulgaria and Macedonia. The whole of the Western Balkans and Central Europe is affected. This implies that there is a need to incentivise storage utilization to prepare for security of supply problems and to enhance regional cooperation.

6 SOS Investment scenario: crisis scenario assuming with expanded storage assets and strategic stocks

The first scenario (present infrastructure with strategic stock in the underground storage) proved to be a successful tool to prevent the supply crisis shock. Now the storage investment projects proposed in Table 7 are investigated under SOS scenario as well, assuming that all the planned storage projects are implemented.

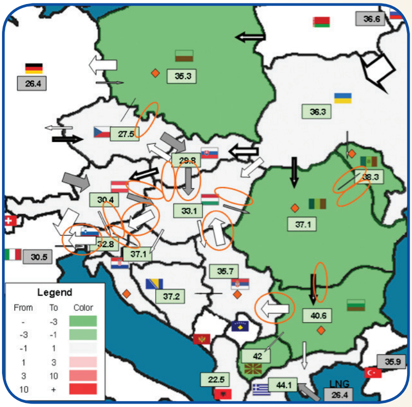

Figure 22: Wholesale January gas price €/MWh SOS scenario with strategic stocks and the new storages

Note: Figures in the boxes represent marginal (yearly average) wholesale gas prices (€/MWh) calculated by our model. Figures in grey boxes are exogenous market prices. Arrows show the gas flows, their size indicating the amount transmitted. Grey arrows indicate congested transmission capacities; bold arrows imply that they ought to be at least five times larger (transmitted amount is so high that it cannot be represented proportionally). Orange circles indicate new infrastructure assumed to be realized by 2015.

As Figure 22 shows, once strategic stocks are in place and new storage investments are operating even a major supply cut leaves the region virtually unaffected. Even the minor price increase experienced in the reference case without new storage investment (9) disappears. Moreover, as a consequence of the storage investment, wholesale gas price decreases in Poland.

In the followings we carry out the welfare analysis of the SOS scenario. Changes in different welfare measures due to new storage investments with strategic stocks in the case of 30% supply cut are shown in Table 9.

	Change in consumer surplus	Change in producer surplus	Change in storage operation profit	Change in net profit from long-term contracts	Change in TSO auction revenues	Change in total social welfare
All modelled countries	-477	368	-511	615	54	49
Danube Region	-633	374	-444	672	40	9
Energy Community	-521	341	-213	545	-6	146
Host countries	230	27	-252	-44	-17	-55
BG	38	0	-28	-1	-7	3
HR	-25	13	-1	4	1	-8
MV	5	0	5	3	0	12
PL	180	-6	-67	-66	6	47
RO	52	18	-160	-2	-15	-107
SB	-19	3	-1	18	-2	-2

Table 9: Welfare change under the SOS scenario, 2015, million €

**AT, BA, BG,CZ, HR, HU, MV, RO, SB, SI, SK, UA*

Most long term contract buyers make gains on new storage investment in the case of a supply cut. They suffer huge losses on their contracts in base case, but the losses diminish with the expansion of storage capacities. Meanwhile, local producers gain from increased prices. Storage operators' profit remains positive, but their net benefit decreases as new investments abolish congestion rents.

7 Social welfare analysis of the storage investment scenario

To arrive to a full evaluation of the benefits of the storage investments analysed, we have to summarize the benefits of new storage infrastructure investments under normal circumstances (Table 8) and in the crisis situation (Table 9). With a simplified assumption that a crisis situation similar to the modelled 30% supply cut occurs once every 10 years, the benefits under normal circumstances can be weighted at 90% and 10% in a crisis situation. With this weighted probability, the results are presented in Table 10.

	Change in consumer surplus	Change in producer surplus	Change in storage operation profit	Change in net profit from long-term contracts	Change in TSO auction revenues	Change in total social welfare
All modelled countries	-691	397	-432	685	61	20
Danube Region	-815	398	-390	724	53	-29
Energy Community	-545	346	-212	555	-10	134
Host countries	132	52	-198	-17	-24	-54
BG	24	1	-26	1	-7	-7
HR	-34	17	0	6	1	-12
MV	1	0	5	4	-2	9
PL	151	-1	-42	-51	1	58
RO	16	33	-135	1	-15	-100
SB	-26	3	0	23	-2	-2

Table 10: The expected welfare change due to new storage investments, million €

*AT, BA, BG,CZ, HR, HU, MV, RO, SB, SI, SK, UA

The welfare losses under the normal scenario cannot be outweighed by the supply cut scenario's welfare gains. For the Danube Region as a whole the benefit of new storages do not outweigh the high losses to consumers and storage operators.

Total welfare change for the Danube region would turn positive if 20% probability for a SOS situation and 80% probability of a normal situation would be assumed.

There are only two countries that experience positive total social welfare change due to their investments, which are Poland and Moldova, where investment into storage is justified. Serbia and Bulgaria experience small negative welfare changes overall, but the underlying allocation of costs and benefits are much different. In Serbia long term contract holders make gains while consumers loose, and in Bulgaria consumers win while storage operators (and traders using that storage) loose.

Notes

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The project is supported by the European Union.