BACKGROUND

The objective of the study was to analyse and assess the natural gas storage situation in the Member States in terms of availability of storage capacity and to present a set of recommendations on security of gas supply and possibly strategic stock as a mitigation tool in a gas market that is becoming increasingly dependent on imported gas from non-Member States.

This executive summary summarizes the analyses that was conveyed and presents the main findings, observations, conclusions and recommendations. The executive summary is structured in the following parts:

PART I THE EU GAS STORAGE MARKET
Description of the past, current and future developments on the gas storage market within the EU and correlation with market parameters. An assessment of future demand and supply of gas storage capacity.

PART II REGULATORY FRAMEWORK
Brief discussion on the present regulatory environment, with particular attention on access regimes and possible entry barriers to storage markets.

PART III COST OF STORAGES
Overview of costs of building different types of gas storages, and sensibility of the overall costs to component price change.

PART IV NECESSITY FOR COMMON APPROACH TO SECURITY OF SUPPLY ON EU LEVEL
Overview of the existing national provisions on security of supply and related use of storage across EU. An analyses whether a common EU gas strategic stock scheme should be established and analyses of few options for the scheme:

- Experiences from the regulation and use of strategic oil stocks. Evaluation whether the scheme could be transposed into a strategic gas scheme.
- Increased corporation through solidarity agreements. The study examines the possibilities in sharing risks across borders.
- Imposing minimum standards on commercial operators, and the consequences.
- The possibility to create 3-4 dedicated strategic storages in key points of the network.
- The potential of fuel switching as an alternative tool for security of supply
- The potential of supplying cushion gas based on a voluntary tender scheme

1.1 Definitions

Definitions adopted in order to ensure consistent and comparable results.

Security of Supply

Security of gas supply is risk management of gas supply. It indicates the probability of supplying gas to end-consumers in spite of technical, political and economic risks and extreme weather conditions.

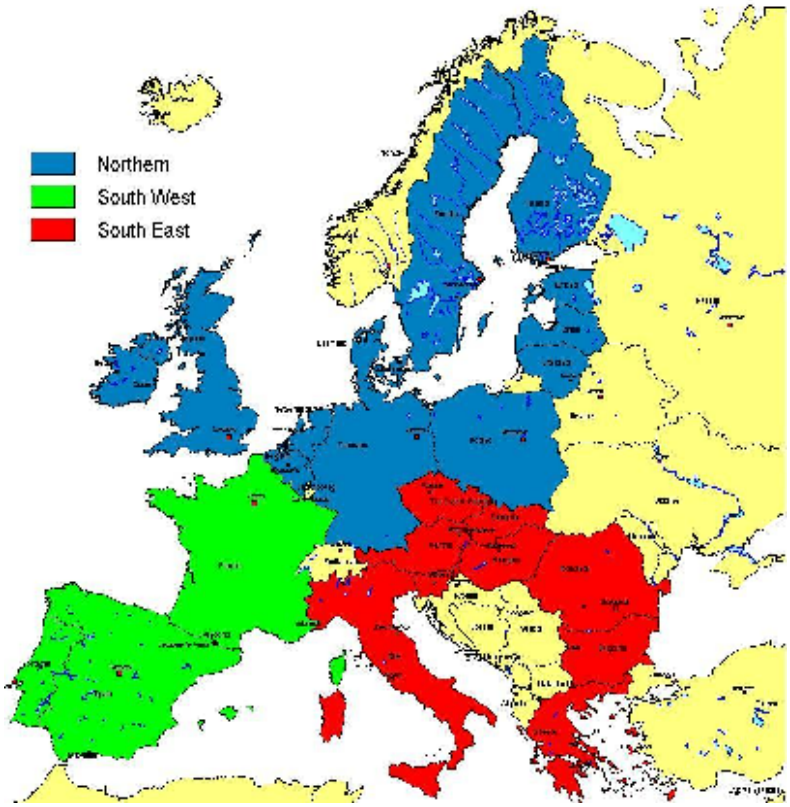
Strategic Storage

For the purpose of this study the Consultant would like to adopt the definition of strategic stock according to the International Association of Oil and Gas Producers (OGP):

"Strategic gas storage is the physical stockpiling of gas for use only as an emergency measure, released by a decision of the related Member State i.e. not available for use during normal market conditions. It will be used when non-market events have moved demand or supply outside of the supply standard, for example, a winter worse than the coldest one in twenty years, serious damage to infrastructure or political conflict"**.**

Regions

This study refers to the regions as defined by the study "TEN-Energy Priority Corridors", these are shown in the figure below



The purpose of these regions is to allow the evaluation of storage demand and supply on an appropriate level, and the definition of the regions is based on the following main considerations:

- The gas storage market in EU is an integrated market, where storage services can be bought across country borders. Benchmarking a single country's storage demand with the available capacity within that country's national borders will only distort the picture of availability of storage capacity in the EU.
- The defined regions are based on the level of market integration and the level of interconnection between countries that can be expected to be in place in 2020.

The chosen regions do not affect the results or the conclusions of the report; rather they are used merely in order to evaluate the storage demand/supply situation at a more detailed level than the overall EU level, which will also be used in the report.

PART I THE EU GAS STORAGE MARKET

This section presents an overview of the gas storages in the European Union with regard to both its present and future composition and assesses the impact of selected key market parameters on the development of storage capacity.

It was found that the development of gas storage capacities in all the three defined regions has been increasing since 1990. The largest development has taken place in the Northern region in form of significant increase in investment in salt cavities. Investments in the South-East region have mainly been in depleted fields. The South-West region has retained a relatively stationary level of storage capacity throughout the observed period.

The situation today is that approximately 78bcm of storage capacity (working volume) is available in the EU, 42.6% in the Northern region, 19.6% in the South-West and 37.8% in the South-East. Of these approximately 69% is in depleted fields, 19% in aquifers, 10% in salt cavities, and 2% in LNG peak shaving facilities.

We examined how key market parameters, such as different types of consumption, indigenous production, and net import, were related to the development in storage capacity. It was found that a 1% increase in household consumption on average was related to a 0.82% increase in storage capacity, making increase in household gas consumption the strongest drive for investment in storage capacity; industrial consumption and gas used for transformational purposes had a much smaller effect on storage capacity with elasticities amounting to almost half of the households' (around 0.40). Indigenous production was found to be negatively correlated with changes in capacity, implying that a 1% increase in indigenous production was asso-

ciated with a 0.32% decrease in storage capacity, thus the development of these parameters play an important role in terms of the overall development in the supply and demand for natural gas storage in the future.

Supply and demand for gas storage capacity for seasonal balancing
The method used for estimating the future demand for storage involved usage of natural gas consumption, production data and swing ratios for each region, from which it was possible to extrapolate the demand for natural gas storage for seasonal balancing for each region.

To account for uncertainties on the demand side we evaluated four different demand scenarios in our model, data on these demand scenarios were taken from the PRIMES reports.

The same approach was used on the supply side were we with background in Gas Storage Europe's classification of the status of investment projects, created two different supply scenarios, a short-term covering only already commenced or committed investments, and a long-term scenario taking into consideration all planned investments listed in the latest GSE database.

In the short term, new capacity of approximately 19bcm (an increase of nearly 25%) would be installed before 2015. The 19bcm is approximately equally distributed on each of the three regions.

Based on the consumption and production levels in the Baseline 2007 scenario, demand for gas storage will grow from 82 bcm in 2005, to 86 bcm in 2015, 91 bcm in 2020 and 100 bcm in 2030 in total within the EU. For the Northern region the growth projections in gas storage demand in 2015, 2020 and 2030 are 35 bcm, 38 bcm, 44 bcm i.e. a total increase of approximately 50% (15 bcm) compared to the 2005 level. In the South-West region the demand projections is much more subtle from 15 bcm in 2005 to 17 bcm in 2030. In the South-East region, we have a projection of growth in storage demand from 28 bcm in 2005 to 34 bcm in 2015, 36 bcm in 2020 to 39 bcm in 2030. Comparing demand to supply, we find that seasonal storage demand is covered in all three regions, with an "excess" supply of 15%, 33%, and 7% for the North, South-West, and South-East region respectively in 2015.

If all investment were taken for certain (the long-term scenario) and compared to the most recent demand update available, the 2007 baseline, supply would exceed demand in all scenarios ranging from an oversupply of 55% in the Northern region, 33% in the South-West region, and 19% in the South-East region in 2030.

We conclude that market responds to demand, and accommodates for decrease in indigenous production within the EU and thus the increased reliance on less flexible gas imports. The planned investments correspond to the most optimistic scenarios for gas consumption on long-term and are being adjusted to the more realistic situation on short-term.

Sensitivity of results
Under the assumption that import from Norway is more flexible we changed the import swing for the northern region from 7.5% to 10% as an analyses of the sensitivity of the results. The implication of this exercise was that the demand for storage decreased by 13%.

A second source of uncertainty is the demand for gas. In 2015 gas storage demand varies by 10 bcm between the 2007 Baseline Scenario and the High Renewables Scenario (16 bcm of variation between the 2005 Baseline and the High Renewables Scenario). In 2030 demand for natural gas storage varies by more than 25 bcm in the four scenarios analysed, which is a considerable level of uncertainty.
Uncertainty in the demand for gas increases the risk of storage investments significantly, and will inevitably have an impact on the investment decisions made by the market players. A high level of uncertainty may postpone the investment decisions and lead to supply of storage not meeting the demand in the short run.

We investigate the performance of the supply and demand, in a situation where demand for gas across EU increased with 8%, an 8% increase is the estimated demand response to a very cold winter. It was found that such a surge in gas demand implied an increase in demand for storage by 6.2bcm. An equivalent surge in gas demand, in the years 2015, 2020, and 2030, implied increases in demand for gas storage of 6.9bcm, 7.3bcm, and 8.1bcm respectively.

Peak day analysis
Supply and demand on peak days is investigated, such an analysis gives an idea of how adequate the supply capacities, for indigenous production, LNG, import, and storage are on days with very high demand. It was found, that in the daily operations peak demand could just be satisfied by the prevailing supply sources. However, the security margin is not large. In the event of a supply disruption, today, storages would be able to cover between 34% and 44% of the total daily gas demand if the supply interruption depending on the demand scenario.

Furthermore, investigating the peak supply and demand relationship in 2015, taking growth in consumption and the committed investments in gas storage into account, we have that in days with extreme demand, a supply interruption could potentially imply shortage of supply.

PART II REGULATORY FRAMEWORK

This section gives an overview of the structure and the ownership types within the gas storage industry through an analysis of the market shares of the gas storage companies today and in the future and summarised in the Herfindahl concentration index.

The analyses reveals that one big player, with the exception of Germany, Spain, and to some degree the UK, is dominant in most national markets today. Taking ongoing and future storage projects into account showed that the concentration in, especially the UK, would decrease considerably, illustrated by Centrica's market share falling from about 70% today to 15% in the long term scenario. Though some countries experience investments from many new operators the general tendency in the rest of the countries, is that the incumbent firms carry out most of the proposed investments.

The proposed changes to regulation in relation to the storage side the Third Legislative Package seek to enhance transparency and improve upon competition by among other things suggesting, that storages are legally and functionally unbundled from the parent company and that the GGPSSO are promoted to regulation. This study does neither recommend nor reject unbundling of storages, as this lies outside the scope of this study.

The "Third Package" is proposing that Guidelines for Good Practice for Gas Storage System Operators (GGPSSO) are included in the directive on gas. We agree with the notion of converting the guidelines into actual requirements. However, we would like to raise attention in terms of the issue of standard bundle units (SBU).
SBU's could possible serve as a barrier to entry, if they are adopted without evaluating the actual markets needs. SBU's have in many countries originally been shaped to meet the former incumbent's needs i.e. technical restrictions are to some extent based on the flexibility needs of the former national incumbent.
The market is today already offering flexible products, however we believe that it is important to ensure that the supply of flexibility does not constitute a possible market hindrance and thus a new Gas directive should promote that the correct level of flexibility is offered and adjusted to any new flexibility requirements in the market.

PART III COST OF STORAGES

The capital costs of gas storages are shown to have escalated considerably in recent years and being sensitive to commodity price increases.

The noted escalation in cost has been primarily driven by rising costs for raw materials and a shortage of essential equipment. Each form of storage is shown to be dependent on alternate investment components in its overall cost. The capital intensive process used in the initial creation of salt cavities, which necessitates a considerable subsurface cost, means that the effects of such recent cost inflation is likely to be most profoundly felt in this form of storage. Gas prices have also shown considerable volatility in recent years, this implies an increased uncertainty with regards to the costs of storages, because they are reliant on significant volumes of cushion gas, comparatively more so for depleted and aquifers because then have a relative higher share of cushion gas compared to salt caverns. Subsequently, the present developments in costs are likely to have an effect on the planning of companies, where higher costs of raw materials and high gas prices potentially could lead to delays or even possible cancellation of projects and consequently possible underinvestment in the market.

The cost of storages was evaluated and it was evident that salt cavities remain the most expensive form of storage, both in their initial creation and in their maintenance, whilst depleted fields provide the lowest costs, in both their creation and their operation. Investments in salt cavities, although considerably more expensive provide the investor with greater withdrawal and injection rates and subsequently the high costs associated with this form of storage, should be considered with their increased ability to provide gas and capture short term price oscillation for profits. Costs of storages are largely also dependent on a number of factors, such as the depth of the storage, porosity and geology meaning that even storages of the same form that contain similar volumes of working gas may have considerably different costs.

PART IV NECESSITY FOR COMMON APPROACH TO SECURITY OF SUPPLY ON EU LEVEL

Overview if existing provisions

The majority of the Member States have transposed the security standards defined in the Security Directive into national legislation through provisions of PSO placed on one or more market players.

The overview of the national provisions on storage for security of supply within the EU shows that the majority of the countries do have provisions obligating at least one market player to stockpile gas to be used in case of supply disruption only, which is de facto the definition of strategic storage.

Selected examples show that individual definitions of strategic stocks that may be optimal for the security of supply of the individual country may not necessarily be optimal seen from a common EU viewpoint. In fact, different national provisions may even be counterproductive, when evaluated at the European level, in that they may only raise the security of supply in the short run and at the expense of the future or may raise the national level security of supply at the expense of neighbouring countries.

Options for a scheme for strategic gas stocks on EU level

We look into few options of possible schemes for establishing gas strategic stock on EU level.

1. Experiences from the EU system of strategic oil stocks
In order to investigate whether some of the experience related to the existence of the scheme for strategic oil stocks can be used as background for a possible implementation of regulation on strategic gas stocks, we have analysed some of the main issues defining the scheme, such as:

- Definition of emergency events/triggering event of oil stock release – how is the event defined and can it be relevant for gas strategic stocks;
- Minimum levels of oil stocks – what is the level of security of supply provided by the strategic stocks and can it be directly or indirectly transposed for gas strategic stocks;
- Responsibility for maintaining strategic stocks/financial scheme – who is maintaining (and paying for) the strategic stock
- Monitoring the strategic stocks – who is ensuring that the strategic stocks actually are in place.
- Stock release mechanism/coordinated action – what is the actual procedure for releasing the strategic stocks

The general conclusion is that the Consultant is not of opinion that the scheme of oil strategic stocks can be transposed into a scheme of strategic gas stocks neither completely nor partially.

The experience from the IEA Response Measures can be used as a background in establishing a common EU Emergency Supply Plan for common EU action in case of a supply disruption.

Each Member State shall be able to announce idiosyncratic emergency supply situation and apply for common response by Member States. However, common response

by Member States can be triggered upon approval by the Gas Coordination Group only.

Limited number of strategic stocks located at key points of the network
An investigation is undertaken into the possibility of providing a number of strategic storages at key points in the network.

Whilst a number of countries are found to have the geological potential to accommodate such storages ultimately the option of creating such dedicated storages remained unfeasible for the majority of countries evaluated. This unfeasibility is primarily due to poor existing networks in potential countries and subsequently an inability to be realistically envisaged as viable storage points.

The North Sea offshore fields and the Ukraine showed to be most appropriate regions to accommodate storage out of the options investigated. The Ukraine is chosen as it has a key location, underutilised existing storage, and a decent existing network, whereas the North Sea offshore fields were seen to have vast potential volumes available, excellent existing networks, and potential existing infrastructure already in place.

Establishing limited number of strategic stocks at key points of the network is a very theoretical possibility and is not recommended pursued further. The location of the strategic stocks is pre-determined by geological potential and not selection of key points on the network. This implies that transmission infrastructure is not or is only partially in place to facilitate the use of these strategic stocks. Also an intense cooperation between related parties would be required to enable the operation of the system in case of supply disruption.

However, if decision is taken to establish a strategic gas stock on EU level, an offshore storage facility in the North Sea would be the most suitable option.

Increased corporation through solidarity agreements
Can countries respond in a rapid, efficient and flexible manner to come to the aid of partner country, in the event of supply disruption by using strategic stock across borders? Corporation through solidarity agreements can be an option insofar that the countries cooperating have mutual benefits, thus incentives, in doing so.

The benefits of engaging in solidarity agreements are to a high extent related to the correlation of risks. If countries are sharing risks of supply disruption the scope for corporation is limited. In a case of perfect (100%) risk correlation, the marginal consumer supplied in each country will be identical and there is no scope for cooperation.

An analyses of the correlation of consumption showed that the Iberian Peninsula is less correlated in its gas consumption with the rest of Europe, whereas most other

European countries have a closely correlated seasonal and overall consumption pattern. In this sense the integration of the Iberian Peninsula with France in a single unit was used as a case study.

We quantify the benefits by comparing the total surplus in a situation with risk sharing, to a situation where were no risk sharing occurs, this analysis shows, that the total surplus is larger in a setting were risk is shared than when each country is by itself.The difference in total surplus (the gain) amounted to approximately 2%. This gain depends positively on the magnitude of the supply disruption and the number of countries sharing the risk.

Based on our analysis, following can be concluded:

Withdrawal from storage across borders (not necessarily strategic stock) is the best tool for security of supply between two countries that share the risks of supply disruption.

For countries that do not share the risks of supply, interconnection is a better tool for security of supply than withdrawal from storage across borders.

Imposing minimum standards on commercial operators
We model a storage of natural gas that replicates the behaviour of stocks and flows and then simulate implementation of a policy for obligatory stockpiling by making part of the capacity in the commercial storage inactive for seasonal arbitrage. We investigate how implementation of this policy affects the profit of the storage operator. We compare two types of policies that appear in the EU – a flat policy and a time varying policy through the examples and analyses of actual stock flows data from Italy and Denmark respectively.

Following observations were made:

- The probability of the emergency event decreases the loss of profit; this effect is visible but is however relatively small, almost marginal.

- The parameter having significant impact is the minimum standard (expressed through the level of obligatory stock) imposed. The more storage capacity is available for seasonal arbitrage to the storage operator the higher the value of the firm.

- The flat rate policy gives less security of supply compared to the time varying policy. The time varying policy ensures gas enough for (in this case) 60 day ahead gas consumption. This means that there is no risk for the storage to be empty for seasonal balancing after the strategic stock has been used to mitigate supply disruption emergency event.

We then examine the requirement to the Danish and Italian policies in terms of how much extra capacity would be needed in order for these two policies to be implemented on EU level. The results for 60 days of coverage of either the Italian policy

(average household consumption) or the Danish policy (maximal consumption) showed that depending on the policy implemented, substantial investments must be carried out.

Imposing minimum standards in a form of imposing to market players an obligation for stockpiling of strategic stock in commercially operated facilities is not recommended, due to:

- Crowding-out effect, which might eventually result in lack of storage capacity for security of supply

- Immobilizing storage capacity that was planned for other purposes (seasonal balancing), which might eventually result in lack of storage capacity for seasonal balancing

If a common security of supply level is desired for customers across EU, a minimum standard on coverage can be imposed i.e minimum number of days of consumption of specific or all customers to be ensured, leaving the market players to choose between the tools available on the market of the specific Member State in fulfilling this obligation.

The potential of fuel switching

The share of countries with a realistic fuel switching options is very dependent on the extent to which gas is used for electricity generation purposes. It is shown, that since 1996 there has been an increase of 70% of gas used for electricity generation within EU, from around 85 bcm in 1996 to approximately 147 bcm in 2006.

However, only a handful of countries in the EU use more than 10 bcm of natural gas for electricity generation. The UK, Italy, Germany, The Netherlands and Spain used approximately 21 % of total annual gas consumption in the EU for electricity generation in 2005. Thus these large countries have a large potential for installing fuel switching capacity, whereas Bulgaria, Latvia, Luxembourg, Sweden, Estonia and Slovenia only consumed 3 bcm combined in their electricity sector in 2005. On an overall EU level these countries will thus not be able to provide a significant level security of supply by installing fuel switching capacity.

In evaluating the costs of installing fuel switching, we find that fuel switching costs are very fuel cost sensitive. Estimation of costs show, that depending on the fuel price, the total costs could amount to more 35 billion € in order to install capacity equivalent to strategic storage in the amount of 38 and 50 bcm. This equals a cost of between 424 and 736 million EUR per bcm of strategic storage equivalent.

The potential of supplying cushion gas based on a voluntary tender scheme

We here evaluate the potential of extracting some parts of the cushion gas in a predefined emergency situation of supply disruption could be an alternative solution to strategic storage; an alternative that could have a number of advantages and should therefore be further investigated.

Empirical evidence from the US indicates that cushion gas is being used, withdrawing sometimes as much as 10%.

We investigate the scope for the EU, in doing so we assume usage rates of 20-33% of the cushion gas. Given this assumption, it was found that usage of the cushion gas could potentially provide up to 19bcm of strategic storage. This would be enough to cover approximately 15-16 days of average winter consumption.

It is our recommendation that the usage of cushion gas, as a strategic stock to be supplied on a voluntary and case by case basis is investigated further. Such an investigation should be carried out in corporation with storage operators and should among other things include:

- An assessment of the costs in terms of damage to the different types of storages.
- The actual potential of using cushion gas based on storage types.
- Evaluation of the cushion gas potential on a regional level.
- The overall development in the potential for utilisation of cushion gas.
- How improvements in technology may enhance the possibility of extracting cushion gas.
- Potential impacts of cushion gas in the commercial gas storage market
- The value of utilising cushion in the event of a supply interruption.

CONCLUSION

Strategic gas stock is gas and corresponding storage capacity reserved and immobilized to be used in a pre-defined emergency event of gas supply disruption, a non-market event.

Even a well functioning market cannot be expected to provide security of supply in non-market events. If gas customers are to be supplied with gas in non-market events, this can only be obtained by use of non-market measures, such as strategic stock.

The overview and the analysis of the gas storage market within EU shows that the market is receiving investment signals and is responding to them. Correlation of storage capacity to market parameters shows that the main investment drive for storage capacity is the demand for storage for seasonal balancing, which is directly linked to seasonal gas consumption. However, not much of the existing and planned storage capacity can be immobilized as strategic before the capacity available for seasonal balancing will be less than the demand. The market is not and cannot be expected to receive signals to invest in strategic storage.

Is the market receiving signals for security of supply in market events? The picture indicates a lack of overview of the actual security of supply on EU level. The difficulty

EU to have a clear perception at any time of the actual level of security of gas supply in the separate EU Member States and in the EU as a whole is perhaps one of the immediate weaknesses with the existing regulation, and possibly the strongest argument for reviewing the existing approach to security of gas supply.

Furthermore gas supply disruption can be a form of force major or can be caused by one, and as such should be tackled by coordinated common EU action.

We are therefore of opinion that there is a need for more specified common approach towards the security of gas supply on EU level. Common approach related to storage for security of supply is not necessarily a common regulation on direct obligation for stockpiling of gas to be released in case of a gas supply disruption.

In order to strengthen the common approach to security of gas supply, the existing regulation could be modified by following:

- Unify the security standards
- Define the PSO on EU level instead of national level
- Place PSO on suppliers
- Place monitoring role on TSO/ENTSOG
- Enhance regional cooperation by forming Regional security of supply forums within the Gas Coordination Group
- Prepare an EU Emergency Supply Plan for common action in case of a gas supply disruption