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**THE INTEGRATED APPROACH TO DEVELOPMENT OF THE UGS  
EUROPEAN SYSTEM IN CONTEMPORARY CONDITIONS**

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## **1. ABSTRACT**

Contemporary conditions of gas market development result in more strict requirements for gas supply system parameters.

Today a number of various measures, which can serve interests of both natural gas suppliers and consumers, is being developed and adopted to fulfill requirements of energy safety regulations of EU member states. One of such measures is the integration of national gas supply systems in a unified transnational network that would cover EU states.

One of the main tasks is to ensure security of natural gas supplies to Europe. Underground gas storages maintain the status of the most effective solution of this task during the whole period of gas industry development. Increase in global gas consumption opens up new opportunities, methods and means to balance natural gas flows along the whole process chain: production-transmission-storage-marketing. This set of measures together with regional specifics of the power industry development exerts significant impact on development of the European UGS sector. However on the other hand elaboration of UGS development and expansion plans must take into account process specifics and conditions of UGS construction and operation. We must bear in mind that UGS first of all is a hazardous process facility and its construction and operation are strictly controlled by regulating bodies. It first of all means creation and introduction of the methodology of estimation of the required gas reserves in UGS, according to it's multi-purpose use, based on sound scientific basis.

The paper details the basic provisions of strategizing for UGS development in Europe based on the integrated approach.

## **2. TEXT OF THE PAPER**

Apart from analysis of economic, political, climatic and geological factors, evaluation of the actual prospects of European UGS industry requires taking into account technological specifics of UGS operation during creation and management of UGS reserves.

Thus, an integrated method of strategizing for UGS system development includes:

1. Top-down approach. Study of external factors that impact development of UGS industry representing a subsystem of Pan-European gas supply system. Identification of optimality criteria for substantiation of UGS construction and development.
2. Down-top approach. Estimation of annual and peak daily demand for UGS reserves by regions and with reference to its multifunctional application, process parameters of UGS and GTS and use of replaceable power sources.

### **EXTERNAL IMPACT FACTORS OF UGS DEVELOPMENT**

Different European countries have achieved different progress in UGS development depending on regional specifics. Advancement in this area is determined by common development trends in the global power industry.

The list below provides the main factors that impact development of UGS system in Europe:

- 1.1. Energy policy of the European Union is aimed at tackling two top-priority problems in gas industry: integration of EU gas markets into Pan-European and its liberalization. The future reforms will be based on the Third Energy Package approved by the European Parliament on 03 March 2011. It regulates rights, responsibilities and opportunities of national regulators and companies operating on natural gas markets.
- 1.2. Development of EU gas markets is accompanied by decrease in regional gas production. According to average estimates of the international analytical agencies, production volumes will decrease by 40 %, as compared to today's rates, and will amount to 250-320 BCM (together with Norway). With 800-820 BCM forecast demand by 2030 this factor will drive development of energy-saving technologies and search for new natural gas sources or substituting power sources.
- 1.3. Geopolitical instability contributes into uncertainty and increases risks during planning and forecast of natural gas market development indicators. Russian-Ukrainian gas conflict in January 2009 (transit volumes through Ukraine amount to about 20% of the total export to Europe), political conflicts in North Africa and Middle East (30% of the total export to Europe) are the most remarkable examples. Political risks can be mitigated by consideration of gas flow diversification options and thus development of different scenarios (highest to lowest) according to optimality criteria.
- 1.4. Gas infrastructure development plans, including expansion and integration of gas transmission systems, construction of reverse flow pipelines, trading platforms (gas "hubs"), construction of offshore gas pipelines (Nord Stream, South Stream, Blue Stream, Nabucco, etc.), construction of LNG terminals. This set of measures must be taken into account in development of possible gas flow patterns for each specific region/country.
- 1.5. Development of alternative power sources. Interchangeable approach that consists in flattening of operation modes of electric power stations. For example, gas-powered stations contain back-up capacities for windmills operated in extremely irregular conditions. That is why development of wind power industry requires the possibility of quick gas injection/withdrawal.

Above factors are taken into account when making forecasts of the UGS reserve capacity demand. This facilitates elaboration of quick-response plans for development of underground gas storage system in Europe. It means that the situation is analyzed by top-down approach, whereas estimation of the actual UGS development prospects should be done down-top. The last approach takes into account strong regional and geotechnical specifics of UGS operation.

### **ESTIMATION OF THE REQUIRED VOLUME OF UGS RESERVES WITH REFERENCE TO ITS MULTIFUNCTIONAL APPLICATION**

The central issue that arises during creation of the integrated gas supply system is to reduce risks associated with short-term supply of significant gas volumes into the network in case of sharp decrease of the air temperature or contingency situations in gas supply system related to operation failure of separate components of the system.

For timely response of gas supply system facilities to certain changes in natural gas supplies, gas storage facilities should be in the best way integrated into the unified gas supply network and together with

GTS should be able to provide required volumes of gas supplies as soon as possible. Regulatory documents of the Economic Commission for Europe (UNECE) should ensure the best regulation of inland gas supply systems, which should be efficient both at the level of companies and pan-European level.

At present key decisions of main gas market players are taken on the national level. Such a situation leads to the increase of the number of operations in the secondary gas market. The experience of the USA in the establishment of the liberal natural gas market shows that the effect of excess of UGS reserve capacities on the market and discrepancies in regulating documents of different states can be controversial.

Lack of methodologically substantiated identification of the share of each gas reserves component in UGS and managing of gas reserves volume may lead to the situation that the least solvent and flexible consumer (for example, the household sector) will be unprotected in the critical situation. The illustrative example is the situation caused by the Russian-Ukrainian gas conflict, when certain budget organizations of East Europe did not get gas for heating in cold winter of 2008, though there were gas reserves in UGS of this or adjacent region.

As experience shows, excess of reserve capacities is not able to fully compensate energy risks and to balance the gas supplies to end consumers and even leads to increase of gas price due to UGS operational expenditures. On the other hand, insufficient volume of UGS reserves along the main gas transmission routes and in major gas consumption points causes imbalance in gas supply system operation.

Thus, further development of the European UGS system under liberalization of isolated gas markets, third parties access and spot market development requires reliable substantiation of gas reserves demand of the region in order to evaluate actual prospects of underground gas storage in Europe and take a grounded decision on the feasibility of investment in UGS construction.

The methodology of drawing up the UGS development strategy is based on the integrated analysis of various factors that have an impact on the economic development of the region in general and gas consumption in particular.

Figure 1 shows main stages of UGS development strategy elaboration.

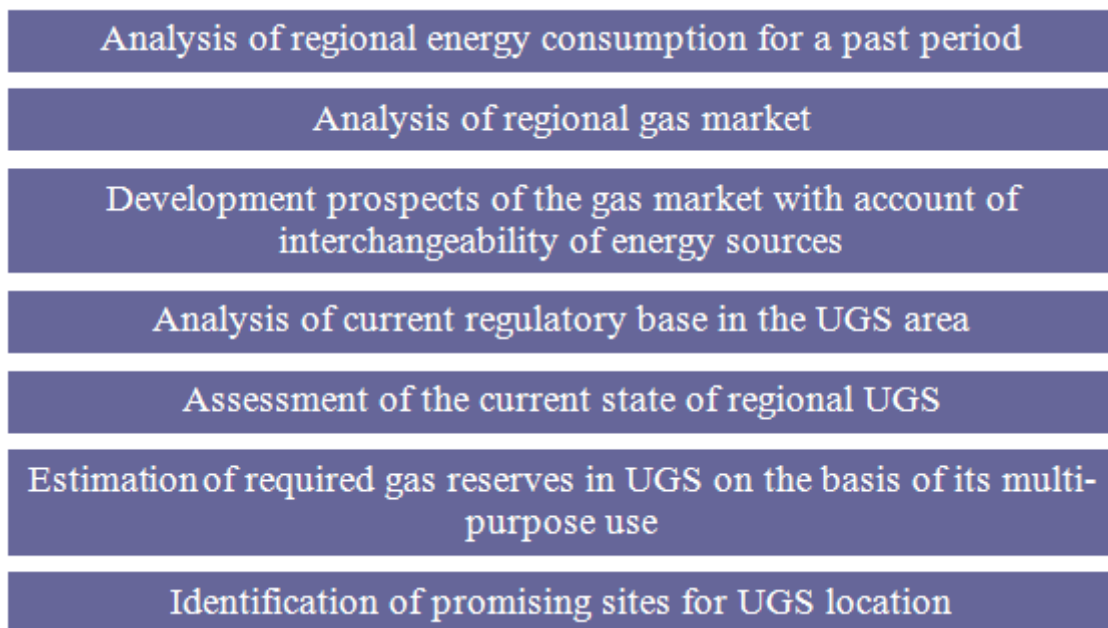


Figure 1 - Main stages of working out the UGS development strategy

To determine required volumes of gas reserves aimed at mitigation of operation risks, Gazprom VNIIGAZ developed a procedure that takes into account many functions of UGS gas reserves. According to this procedure, gas reserves in UGS are classified in the following way (Figure 2):

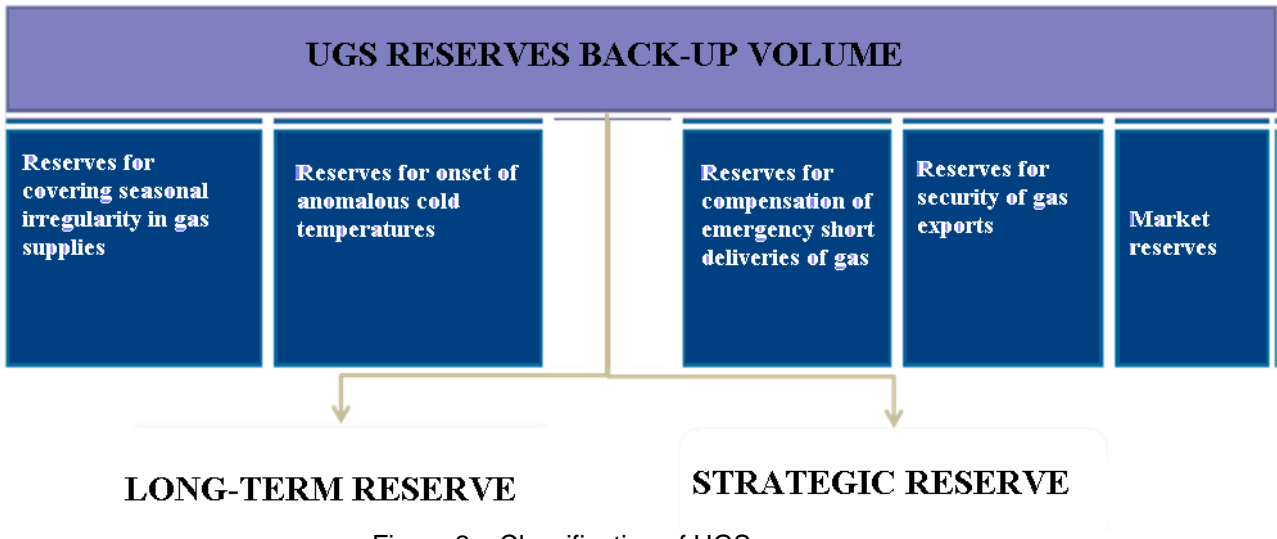
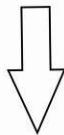
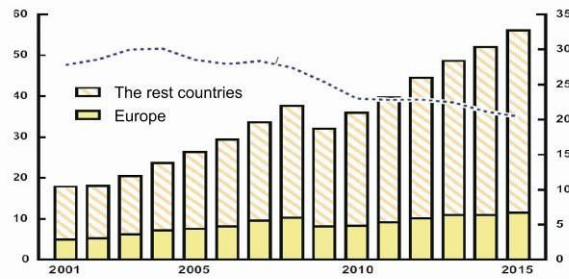


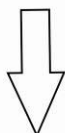
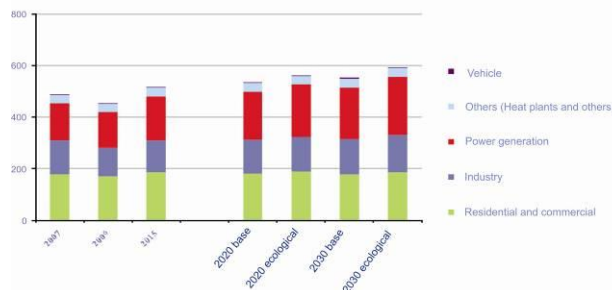
Figure 2 – Classification of UGS gas reserves

Estimation of the necessary reserve capacities in the region requires the analysis and calculation of climatic, economic and technological parameters that have an impact on forecast supply and demand trends in the gas market (Figure 3).

### Forecast indicators of the socio-economic development



### Natural gas demand outlook (by sector and by region)



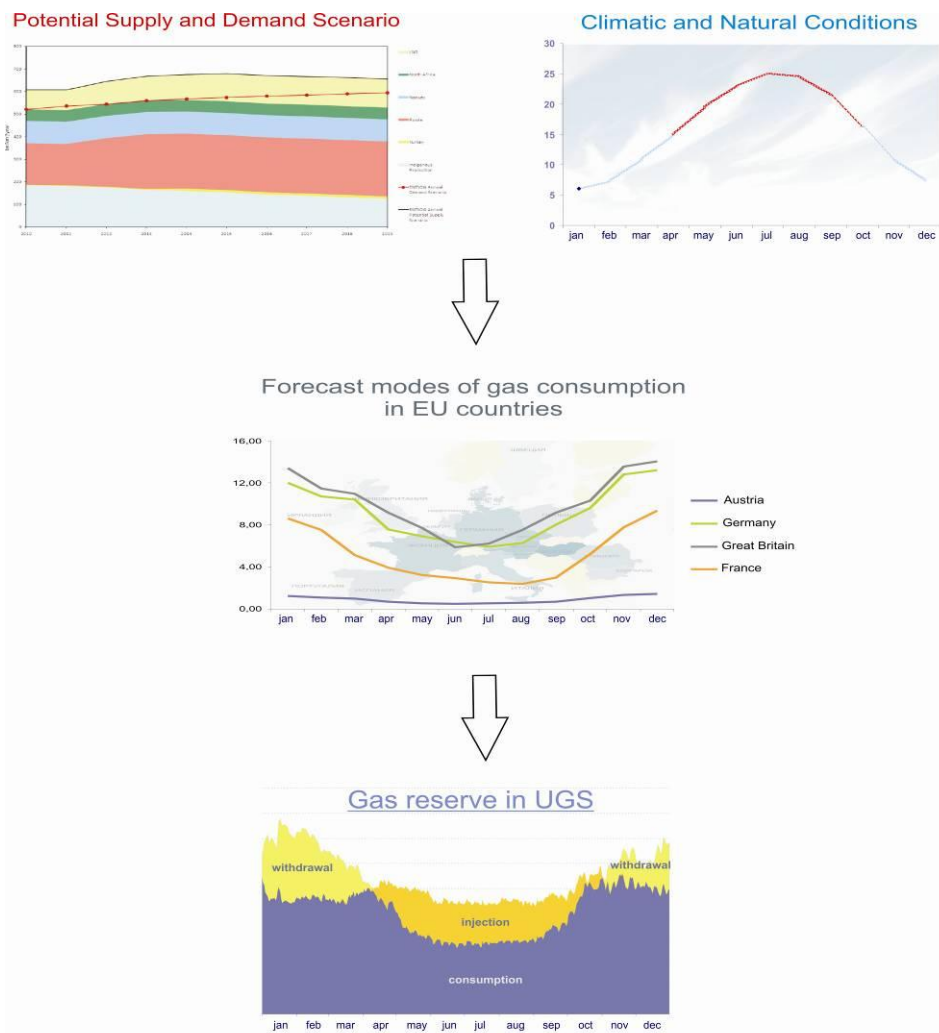


Figure 3 - Parameters used for estimation of necessary gas reserves in UGS

The volume of gas reserves in UGS for a specific region have been forming based on the following parameters:

- the role of UGS in the gas supply system,
- current and planned GTS capacity in the UGS area,
- UGS location (remoteness from production facilities, major consumers, territorial borders, hubs),
- consumer structure,
- development of LNG capacities;
- interchangeability of energy sources.

The mentioned above analysis and calculations determine the various scenarios of the necessary gas reserves volume and long-term maximum daily UGS capacity for the region (Figures 4, 5).

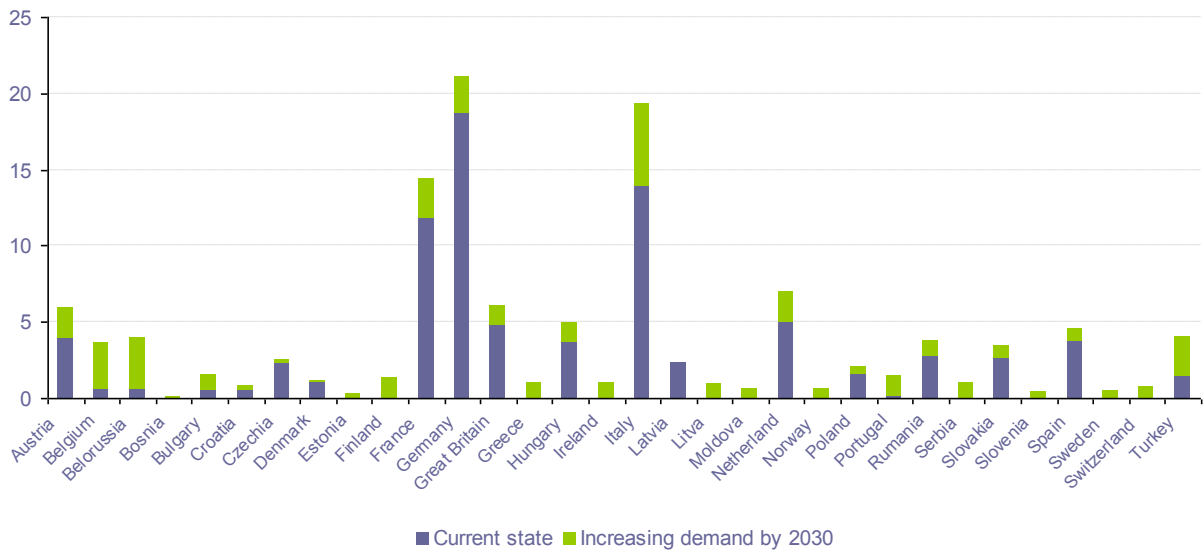


Figure 4 - Demand for UGS back-up capacities of European countries by 2030, BCM

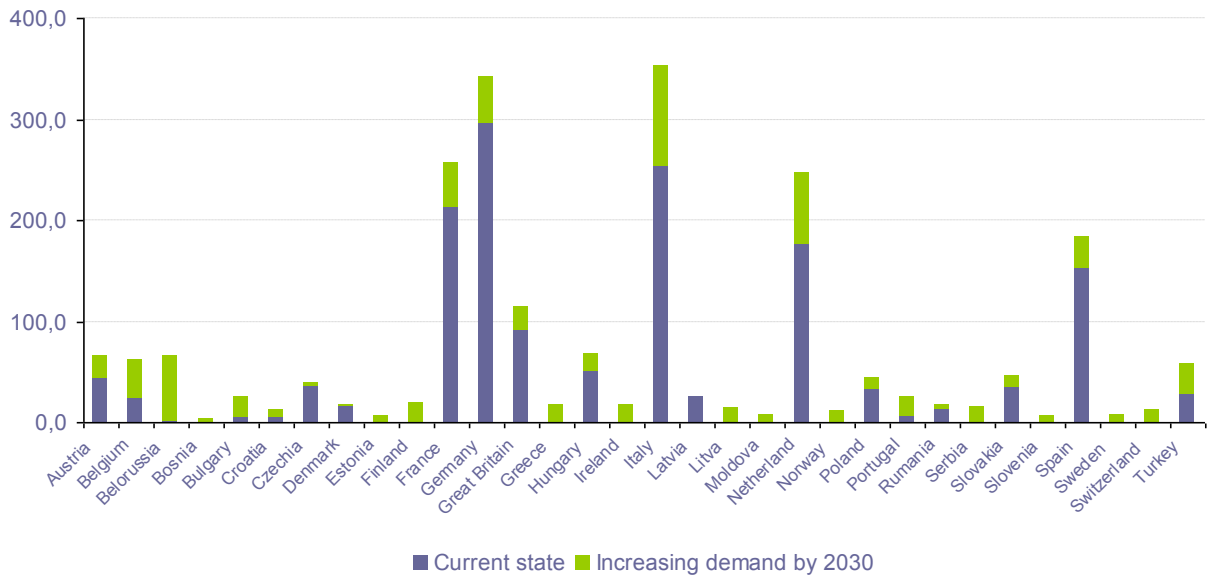


Figure 5 – Demand for daily capacity of UGS in European countries by 2030, mln m³/day



## CONCLUSION

The strategy of UGS system development in Europe should become a foundation for drawing up a single regulating procedure and management for UGS gas reserves with reference to its multipurpose functions. It must also facilitate introduction of methods and technologies aimed at improvement of performance parameters of UGS, which is a complex geotechnological facility.

As it has been many times stated, the last several years of UGS operation were accompanied by increased uncertainty of the environmental conditions, which has an adverse effect not only on equipment operation, but also on the state and operation of UGS reservoir system.

Management of UGS reserves that must be regulated by the corresponding bodies and be based on the developed methodology is also an important factor.

Such set of measures will help to formulate the concept of development of the single GTS and UGS system in Europe to optimize transmission flows, gas production and storage.

The use of results of performed studies in real practice imposes stringent requirements for UGS operation, namely:

- flexibility of the operation modes;
- optimization of the UGS processes,
- increasing safety level,
- reliability of the control system.

### **3. LIST OF FIGURES**

Figure 1 – Main stages of working out the UGS development strategy

Figure 2 – Classification of UGS gas reserves

Figure 3 – Parameters used for estimation of necessary gas reserves in UGS

Figure 4 – Demand for UGS back-up capacities of European countries by 2030, BCM

Figure 5 – Demand for daily capacity of UGS in European countries by 2030, mln m<sup>3</sup>/day