The development of underground natural gas storage facilities should be considered in association with the possibility to integrate with the new natural gas transmission and network interconnection projects. These projects aim to increase the natural gas supply from Russia to Europe and to integrate the Baltic States’ natural gas market into the common EU natural gas market. The purpose of the facilities would be to ensure natural gas supply regulation and storage of emergency stocks for Central, Western and Eastern European countries. The planned Northern European gas pipeline project (Nord Stream) is one of the projects that could benefit from underground gas storage facilities, which would increase the security of gas supply to the EU.

The integration of the Baltic States’ natural gas network into European networks could lead to further exploration of the potential role of Latvia’s natural underground gas storage capabilities to ensure emergency stocks. A proposal for a directive on emergency natural gas stocks is under discussion in Brussels. See also Geological Structures for the Establishment of Underground Gas Storages – www.liaa.gov.lv –> Publications –> “Geological Structures…”

Latvia is characterised by fast economic growth. In the time period from 2000 to 2006 the GDP has grown by an average 8.2% each year. From 2005 to 2006 the GDP showed an increase of 11.9% - the highest growth among the Member States of the European Union. (Source: Central Statistical Bureau)

Latvia has also seen a steady year on year growth in investment. In 2006, investment exceeded 1 billion EUR – a two fold increase compared to 2005. (Source: Central Statistical Bureau)
Entrepreneurship and commercial activities in the Republic of Latvia are monitored by various regulations, the most important of which are:

- **Commercial Law** defines of merchant and commercial companies, specifying the procedure for registration of these various types of merchants, and sets regulations for their operation.

- **Law on Taxes and Fees** – the “umbrella” system of law for taxes and fees, regulating all issues concerning the tax system, tax collection and administration.

- **Law on Environmental Impact Assessment** and associated regulations define activities which are subject to environmental impact assessment and the procedure for conducting such assessment. According to the law, initial environmental impact assessment shall be conducted in cases where:
  - Over ground and underground natural gas storage facilities are created,
  - Gas, steam and hot water pipelines, or high-voltage network are installed, surpassing 5 km;
  - Pipelines are installed allowing for transportation of oil, gas, chemical substances and chemical products, if the diameter of such piping exceeds 500 mm and their length is over 40 km.

- As laid down in **Civil Law**, subsoil in Latvia is the property of the landowner. The main requirements concerning use of subsoil have been defined in the **Law on Subsoil** and the associated regulations of the Cabinet of Ministers.

- **Subsoil is not subject to property tax.**

### Main taxes relating to entrepreneurship in Latvia

<table>
<thead>
<tr>
<th>Tax</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise income tax</td>
<td>15%</td>
</tr>
<tr>
<td>Value added tax</td>
<td>18% (in some cases 0% or 5% are applied)</td>
</tr>
<tr>
<td>Immovable property tax</td>
<td>1.5% of the cadastral value of the immovable property</td>
</tr>
<tr>
<td>Natural resources tax</td>
<td>Individual rates</td>
</tr>
<tr>
<td>Tax burden</td>
<td>29.7% of GDP</td>
</tr>
</tbody>
</table>

In cases where useful properties of the subsoil need to be used for the interests of the society and country, the state can impose restrictions to ownership rights on subsoil applicable to the territory defined by the Cabinet of Ministers as **area of subsoil of national importance**. Such status also will be given to geological structures that are potentially aligned to creating underground gas storages.

- **Subsoil can be used by:**
  - Landowners,
  - Legal entities or physical persons, having signed an agreement of lease with the landowner, indicating the type of use of the subsoil. This agreement is an obligatory precondition for obtaining a licence for the use of the subsoil.

- **Subsoil can only be used** (including also geological exploration, and use of useful properties of subsoil) after obtaining the relevant licence, which shall be issued by the Latvian Environment, Geology and Meteorology Agency (LEGMA) in accordance with the procedure laid down by the Cabinet of Ministers:
  - For geological exploration purposes – time period up to 5 years,
  - For geological exploration purposes, followed by extraction of minerals or use of useful properties of subsoil – time period up to 30 years.

- **Licence for use of subsoil of national-importance area shall be issued through a tender procedure.**

- **Natural gas merchants in Latvia shall abide by the provisions of Energy Law**, the law on **Regulators of Public Services** and the associated regulations. As part of the unified public utilities process, the energy industry is regulated by the Public Utilities Commission. As laid down in **Energy Law**, the licence allowing for production, transmission, distribution and storage of natural gas is issued by the Public Utilities Commission for a time period of 20 years, and the licence for sales of natural gas for a period of 5 years. Based on the procedure laid down by the Cabinet of Ministers, the energy supply merchant shall compensate the owner of immovable property if losses are incurred relating directly to the installation of new objects of the energy supply merchant or ensuring the operation and repair of the existing objects, and for land alienation or restricted usage rights, if:
  - the property is utilised for the installation of a new object of the energy supply merchant or the reconstruction of an existing object,
  - the area where the energy supply merchant’s site is located or the protection area running around or surrounding the site, is increased.
The consumption of natural gas in Latvia has decreased from nearly 3 billion m³ in 1991 to 1.7 billion m³ in 2006. Regardless of this decline, natural gas still remains one of the leading fuel types in Latvia, making up ~30% of the total energy mix.\(^1\)

### Gas supply

The natural gas supply in Latvia is provided by vertically integrated JSC "Latvijas Gaze" that is licensed to cover the whole process of gas supply, including also storage:

- Exclusive rights allowing for transmission and distribution of natural gas within the territory of Latvia, and storing natural gas at the Inčukalns Underground Gas Storage until 10.02.2017. The licence shall not apply to underground gas storage in areas where such storage facilities do not yet exist,
- Sales of natural gas within the territory of Latvia (the licence is not exclusive, and is in force until 10.02.2012.).

The existing capacity of the Inčukalns Underground Gas Storage, which is currently reported to be one of the largest underground gas storage facilities in the region, can be increased to the actual capacity of 3.2 billion m³ (appropriate to the survey conducted by OAO "Gazprom" subsidiary “Giprosgaz”).

### Gas supply infrastructure

#### Transmission and distribution

The natural gas network in Latvia consists of the following:\(^2\):

- transmission network - total length 1'281 km,
- distribution network - total length more than 4'591 km.

#### Storage

The Inčukalns local high is situated in the central part of Latvia (Riga District), approximately 40 km to the north-east from the capital (Fig. 7). The structure is of great practical importance, because it has served as storage of natural gas since 1968.

The natural gas system in Latvia is season specific, where during the heating season (October – April) natural gas is fully supplied, using the large underground gas storage in Inčukalns:

- Total capacity - 4.47 billion m³,
- Active capacity – 2.32 billion m³.

Inčukalns Underground Gas Storage of JSC “Latvijas Gaze” bears a high strategic importance, allowing for gas supply to the Baltic States and north-west of Russia with the main purpose of balancing seasonal fluctuations in gas supply. During winter Inčukalns Underground Gas Storage allows for gas supply throughout Latvia (fully), Estonia, the Russian Federation, and in smaller amount also to Lithuania. In the future, the amount of natural gas stored for the needs of the existing users can be increased, linking also the distribution systems of Estonia and Finland over the sea, thereby allowing for storage of natural gas for Finland’s needs.

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\(^1\) Latvia’s energy in numbers, Investment and Development Agency of Latvia (LIAA)
\(^2\) JSC Latvijas Gaze non-audited financial report for 2006
\(^3\) The non-audited annual report of JSC Latvijas Gaze for 2006
Latvia’s geological situation is favourable for creating underground natural gas storage systems with the total capacity of exceed 64 billion m³ which will equal roughly the total actual underground gas storage capacity currently used by all EU Member States. In the future, by integrating Latvia’s underground gas storage system into the common gas network, Latvia might become a significant seasonal regulator of natural gas in Europe.

The total gas storage capacity in 130 existing gas storage facilities within the European Union is estimated at 70 billion m³. Additionally there are 37 projects (28 underground reservoirs) with a total capacity of around 20 billion m³. The European Commission is concerned that adequate stocks (80...85 billion m³) need to be built up to ensure supplies in time of disruption. This will contribute to improving the internal market by increasing the possibilities for transfer between Members States, and by securing the gas deliveries in case of supply crises.

The government’s position is to support activities undertaken by any gas company, or investor with respect to development of the potential of Latvia’s underground gas storage facilities.

**Characterisation of the reservoir and caprock**

Deposits of the Cambrian system (the Deimena Formation and the Cirma Strata) can be used as reservoirs for the storage of natural gas in Latvia; they occur all over the Latvian territory. The reservoir rocks consist of a rather uniform sandstone layer with good filtering and capacity properties. They also have an optimum location in relation to rocks that are impermeable for gas, since they lie directly under the Ordovician caprock (Fig. 6).

In most of the Latvian territory, the average effective porosity of sandstone varies from 20 to 25%, the permeability reaches several hundred and thousands of milli Darcy (mD). Such reservoir properties of rocks are very favourable for pumping gas in and out. The capacity and filtering parameters of the Cambrian sandstone worsen in the south-western part of Latvia, since its effective porosity does not exceed 10-15%. The effective thickness of the used reservoir in the western and central parts of the country is 30-70 m, varying from 5 to 30 m in the rest of the territory. The reservoir depth increases from 700 m MSL in central Latvia to 1,700 m MSL in the south-west. The shallowest reservoir (not deeper than 300-350 m MSL) is situated in the north-east and south-east. In the areas where the best prospects for gas storage – local highs (structures) are situated, the reservoir surface lies at the optimum depth – 700-1,100 m MSL. The reservoir contains highly mineralised groundwater. The salinity exceeds 100 g/l, the temperature is over 20°C there. The hydrostatic pressure in the aquifer reaches 70-110 at (atmospheres).

The Cambrian reservoir is overlain by a tight clayey-carbonaceous succession of Ordovician and Silurian deposits, the thickness of which varies considerably – from 40 m in north-eastern Latvia to 600 m in the south-west. Besides, in the western and central Latvia, the reservoir is overlain by a 15-40 m thick Lower Ordovician clayey layer of the Zebrus Formation, forming a safe and impermeable to fluids caprock, which prevents gas from entering into the overlying deposits. The properties of caprock worsen towards the north-east and east, since lower Ordovician clayey deposits are replaced by terrigenous-carbonate ones, with the thickness reducing to 5-10 m.
Geological structures suitable for the exploitation of useful properties of subsoil

Geological objects, which are suitable for the establishment of underground storage of natural gas, are one of the most important subsoil resources in Latvia. Geological investigations, carried out predominantly during the 1960s and 1970s, have demonstrated that there are geological structures in Latvia, which could be suitable for the establishment of underground storages of natural gas. Besides the existence of structures, other geological preconditions exist as well: deposits suitable for the storage of gas – Cambrian sandstone, caprock, which is not permeable to gas, favourable hydrogeological conditions and optimum depth of objects. In one of such geological structures, an underground storage of natural gas was established already in 1968 – the Inčukalns Gas Storage. According to the existing level of exploration, there are 15 structures in Latvia, which could be suitable for the establishment of underground storages of natural gas, since their structural geological conditions are similar to those of the Inčukalns high.

The main criteria for the determination of prospective objects are as follows: the existence of a local high identified based on the seismic data, the size and depth of the trap, reservoir properties and existence of reliable caprock, as well as the level of exploration and proximity of the infrastructure. Based on those criteria, the prospective structures suitable for the establishment of underground storages of natural gas are as follows (in the order of priority): Dobele, Snēpele, North Blīdene, Degole, Kalvene, Vērgale, Usma, Edole, North Kuldīga, Liepāja, North Ligatne, Lūku-Dūku, Aizpute, South Kandava and Viesatu (Fig. 7). At all the above prospective structures suitable for the establishment of gas storages (except the Dobele structure, which has been partially explored) detailed prospecting/exploration operations must be conducted in order to confirm their suitability for the establishment of gas storages. New seismic operations must be carried out in order to map the extent of the structures and the adjacent fault zones, which could cause gas seepage. The prospecting results must be checked up and made more accurate by drilling wells, in order to determine more accurately the geological structure and reservoir properties of rocks. Experimental studies are also necessary, since the possibilities of pumping gas in and out must be determined. The Dobele, Kalvene, Lūku-Dūku, N. Blīdene and N. Ligatne local highs are situated within a tectonically dislocated zone – within the Saldus-Sloka-Inčukalns high. The Inčukalns local high is situated in the NE part of that regional high, where an underground gas storage in the Cambrian rocks already exists. The local highs are near-fault brachianticline folds. Their area is 15-50 km², the amplitude – 55-80 m, the effective thickness of the reservoir exceeds 30 m. The top of the reservoir at the Dobele, Kalvene, Lūku-Dūku and N. Blīdene structures is situated at the depth 950-1,050 m MSL, while that at the Inčukalns and N. Ligatne local highs – at the depth 650-750 m MSL. The Dobele structure is the best explored of that group of highs; 20 wells have been drilled there. The Kalvene, Lūku-Dūku and N. Blīdene structures were identified based on the seismic data, because only 2–3 wells had been drilled at each high. The N. Ligatne structure has been explored quite insufficiently. The surface of the crystalline basement was identified there, as a result of analysing seismic reflection profiling data of 1963. Besides, no wells have been drilled at that high. The prospectivity of that structure is determined by its proximity to the Inčukalns underground gas storage.

The second group of prospective objects – the Snēpele, Vērgale, N. Kuldīga, Edole and Usma structures, which are situated in western Latvia, are a part of the Liepāja-Kuldīga-Talsi High. Those structures, mapped based on seismic reflection data, are near-fault brachianticline folds as well. Their area varies from 10 km² to 26 km², the amplitude varies from 25 m to 60 m, the effective thickness of the reservoir exceeds 30 m. The structure of the Vērgale, N. Kuldīga and Edole highs was investigated in several wells, but at the Snēpele and Usma local highs, only a few wells were drilled. The reservoir of the structures is situated at the depth 950-1,050 m MSL.

As regards other prospective structures of central Latvia – Degole, S. Kandava and Viesatu, they have been mapped based on seismic reflection seismic data. The wells drilled there confirmed the existence of the structures. The Degole and Viesatu structures are asymmetrical brachianticline folds that are not faulted. In turn, the southern and northern flanks of the S. Kandava brachianticline fold are bounded by faults. The area of those structures is 15-20 km², the amplitude – 50-70 m, the thickness of the reservoir to be used varies from 25 m at the S. Kandava high to 50-55 m at the Viesatu and Degole highs. The reservoir rocks lie at the depth of 1,000-1,050 m MSL.

The central and western parts of Latvia are most prospective for the establishment of underground storages of natural gas, since large local highs exist there, as well as a reservoir with favourable properties, which is overlain by caprock, which is impermeable to gas. The hydrogeological conditions are favourable, and the reservoir lies at an optimum depth. At the moment, taking into consideration the level of exploration and theoretically calculated (forecast) volume of the gas storages, the best prospects for exploration are the Dobele, North Blīdene, Snēpele and Degole local highs. The Dobele structure is the best prospect for the establishment of new underground gas storage; it was partially explored for that purpose already. According to preliminary evaluations, in the best prospective structures (Dobele, North Blīdene, Snēpele, Degole), the total gas volume would comprise 64 billion m³, active gas volume – 32 billion m³.
Dobele structure - most prospective local high for underground gas storage

The Dobele structure or local high is prospective for the establishment of an underground gas storage; it is situated in central Latvia, 12 km to the west of the town of Dobele, in the territory of the Annenieki, Biksti, Zebrene, Èle and Auri parishes. A high in the surface relief of the crystalline basement was identified already in 1969, during regional magnetotelluric profiling. Seismic reflection investigations in the area of the structure were carried out in 1970-1971 (the total length of seismic lines comprised approximately 200 km). As a result, based on a reflector in top Ordovician, a large near-fault local high was identified, which was recommended for oil exploration. Two structural wells were drilled at the structure in 1971-1972: Dobele-91 – at the dome of the high, and Dobele-92 – in a subsided block; both wells reached the rocks of the crystalline basement. The drilling results confirmed the existence of the high and a large-amplitude fault in the crystalline basement and Lower Palaeozoic deposits. No traces of hydrocarbons were discovered in the wells, but good capacity-filtering properties of the Cambrian deposits were identified, which allowed to recognise the structure as suitable for the storage of natural gas in the Cambrian deposits. During 1987-1990, the Production Association “Sojuzburgaz” conducted investigations at the Dobele structure, the purpose of which was to determine whether the geological conditions at the object are suitable for the establishment on an underground gas storage. 18 prospecting and exploration wells were drilled in the area until 1990, all of which reached the reservoir. A comprehensive set of investigations was conducted in all the wells, including the analyses of cores from the Cambrian reservoir rocks, Ordovician and Silurian caprock, comprehensive geophysical investigations (logging), hydrogeological studies and hydrodynamic investigations of the reservoir. The results of those investigations have demonstrated that the Dobele structure is suitable for the storage of natural gas. The Dobele local high is a well-expressed brachianticlinal fold of the Caledonian structural complex, the southern flank of which is adjacent to a fault with the amplitude 300 m (Fig. 8). The Cambrian reservoir is shielded by the clayey-carbonate Silurian deposits in the fault zone. The Silurian deposits are quite tight and would ensure the impermeability of the reservoir within the structural trap. The hypsometrically closed area of the structure for the top of the Cambrian reservoir within the 1,070 m MSL contour line comprises 67 km², the height (amplitude) – almost 120 m. The top part of the Cambrian succession (the Deimena Formation) is considered a potential storage. Compared to the rest (Lower) Cambrian, it is characterised by a more uniform, predominantly sandstone, composition and better capacity-filtering properties. The top of the reservoir of the Dobele local high lies at the depth of 950 m MSL in the dome of the structure, and at up to 1,070 m MSL – at the periphery of the flanks. Taking into account the existing level of exploration, the maximum contour of the underground gas storage could be assumed within the 1,020 m MSL contour line. Correspondingly, the total height of the artificial gas accumulation would comprise 67 m, the area - 18 km². The effective thickness of the reservoir is 52 m, the effective porosity – 22%, the permeability varies from a few tens to hundreds mD, reaching 1-1.5 Darcy in some cores. If this structure is filled with gas (the level of gas-water contact – 1,020 m MSL), the total capacity of the gas storage is evaluated at 12 billion m³. Correspondingly, the volume of active gas would comprise approximately 6 billion m³.

For information about other prospective local highs for underground gas storage see Geological Structures for the Establishment of Underground Gas Storages - www.liaa.gov.lv -> Publications -> “Geological Structures...”.
Figure 7. Locations of local highs prospective for underground gas storage