THE BLEYZER FOUNDATION

LNG and Natural Gas Supplies to Ukraine:

New Business Opportunities

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TABLE OF CONTENTS

LNG AND NATURAL GAS SUPPLIES TO UKRAINE: BUSINESS OPPORTUNITIES

PHASE I. SHORT-TERM BUSINESS OPPORTUNITIES

1. Current Sources of Natural Gas Supply to Ukraine

A. Gas Supply from Russian

Russia supplies natural gas to Ukraine under the contract signed between Gazprom and Naftogaz of Ukraine in January 2009.

According to the contract agreement, Naftogaz is the only importer of Russian natural gas in Ukraine. However, since 2012, Ostchem Gas Trading AG (Switzerland), a company-member of Group DF owned by Dmitry Firtash, has been importing gas from Gazprom.

In 2012 the government of Ukraine stated that the 2009 contract does not specify that solely Naftogaz may import the contracted amounts of gas and any other company may import Russian gas within the contracted amounts for the country. Neither Naftogaz, Ostchem, nor Gazprom ever objected this statement. At the same time, Ostchem concluded a separate agreement with Gazprom on gas supplies with a price formula that differs from that of Naftogaz's one.

In June 2013, it was announced that VETEK Company, owned by Sergiy Kurchenko, started negotiations with Gazprom on natural gas supplies up to 5 billion cubic meters (cm). No further details over the likely terms of the contract were provided. It is also unknown when VETEK is going to start Russian gas imports - already in 2013 or next year.

Amounts and Cost of Imported Natural Gas

Under the 2009 gas contract, Ukraine had to buy not less than 40 billion cm of gas in 2009 and 52 billion cm in 2010. The amounts for 2011-2019 had to be specified in Amendments to the contract. These amendments must be agreed and signed by November 1st of the year preceding the year of supply. In case the Amendment is not signed, the amounts and quarterly distribution of supplies for the year have to be the same as in the previous year. The minimum obligation on gas imports (take-or-pay) is equal to 80% of the amount specified in the contract or Amendment to the contract. This means that starting from 2010 this amount should have been 41.6 billion cm per year. However, upon the agreement of both parties the volume of gas imports for the next year may be decreased by not more than 20%. The respective request has to be submitted not later than 6 months prior to the beginning of the year of supply. The delivery place is specified as place where the pipeline crosses the border of Russian Federation with Ukraine or the border of Belarus with Ukraine.

On 24 November 2009, after long and complex negotiations Naftogaz and Gazprom signed the Annex to the Agreement reducing the volumes of gas supply for 2009 and 2010. These volumes were equal to 33.5 billion cm in 2009 and 33.8 billion cm in 2010. After this Annex was signed, Gazprom stated that in the future, 33 billion cubic meters is the minimum import requirement for Ukraine. Actual imports were equal to 36.6 billion cm in 2010 and 40 billion cm in 2011.

Ostchem started importing gas in 2011. However, that year the company imported Central Asian gas. In total, Ostchem imported 4.8 billion cm of gas (1.7 billion cm from Turkmenistan, 1.5 billion

cm from Uzbekistan, and 1.5 billion cm from Kazakhstan), which was transported through Gazprom pipelines. In 2012, Ostchem bought 8 billion cm of gas from Gazprom, while Naftogaz decreased its imports to about 24 billion cm (see Annex 1 for details).

The 2009 Gas Contract specifies that price of gas for Ukraine with the minimum calorific power of 8050 kcal per cm is determined on a quarterly basis in accordance with a specially designed formula (see Annex 2). In short, the price for a quarter depends on the base price of $450 per 000 cm and evolution of world fuel oil and gasoil average prices over the three previous quarters. The price is adjusted in case the actual lower calorific power of supplied gas is below or above 8050 kcal per cm. Also coefficients are applied to the price of gas withdrawn over the established monthly supply amounts depending on the month of withdrawal.

In 2010, Ukraine signed an agreement with Russia to prolong the stay of Russian Black Sea fleet in Sevastopol. In return, Ukraine received a natural gas price discount equivalent to Russia's 30% gas export price but not more than $100 per 000 cm.

The price formula for Ostchem was never disclosed but the published statistical data shows that the company pays more than Naftogaz. In particular, Naftogaz paid $406 per 000 cm in Q1 2013, while the price for Ostchem was around $30 per 000 cm higher. As a result, the average price for Ukraine for Russian gas in general was $417 per 000 cm. In October 2013, it was announced that Russia provided a significant discount on 5 billion cm of gas to be purchased by Ostchem by the end of the year. As a result, the price amounted to $260 per 000 cm for the company.

B. Gas Supply from Domestic Sources

Ukraine started natural gas extraction in 1912. It gradually increased volumes of extraction to reach a record of 68 billion cm in 1975. However, due to exhaustion of deposits, domestic gas extraction volumes dropped to around 20 billion cm at the beginning of 1990s. Over the last 15 years domestic extraction volumes have ranged between 18 and 21 billion cm per year. In 2012, Ukraine extracted 19.3 billion cm. These volumes allow Ukraine to remain the fifth largest producer of natural gas in Europe. The country still possesses more than 350 deposits of different hydrocarbons, including 89 of natural gas deposits, 111 of liquid natural gas deposits, and 13 of gas-and-oil deposits.

The current main features of domestic natural gas production are as follows:

- the largest gas deposits are exhausted by 60-70%;
- exploration work is unsatisfactory;
- new deposits are of low quality (there are many small deposits difficult for extraction);
- there is a need to increase drilling for both existing and new deposits (the average drilling depth is around 3.5 km, while the maximum one is more than 6 km).

Extracting Companies

State companies produce around 90% of domestic natural gas in Ukraine. The largest of them are affiliated with Naftogaz: SC Ukrgazvydobuvannia, PJSC Ukrnafta, and PJSC ChornomorNaftogaz. SC Ukrgazvydobuvannia accounts for more than 70% of total domestic gas extraction. The share of PJSC Ukrnafta is around 10%. PJSC ChornomorNaftogaz has the smallest share, but it may increase in the near future, if Ukraine intensifies extraction of offshore natural gas thanks to two offshore drilling platforms bought in 2011.

The remaining 10% of domestic gas extraction is under control of private companies. However, experts estimate that the share of private business in total domestic natural gas extraction is 15%,

taking into account that 42% of PJSC Ukrnafta belongs to Privat Group of Igor Kolomoyskiy and that operation management of the company is also controlled by Privat. There are also several private joint companies within the structure of SC Ukrgazvydobuvannia,

Overall, there are more than 20 companies extracting natural gas in Ukraine. Foreign capital is also involved in extraction. For example, British JP Kenny Exploration & Production Ltd holds 49% of JV Poltava Petroleum Company. Carpatsky Petroleum Corporation of Delaware owned 45% of JV UkrKarpatOil Ltd. And its stake was transferred to Carpatsky Petroleum Corporation Texas through succession procedures. Later the deal was contested in court, and rejected, allowing Ukrnafta (controlled by Privat group) to consolidate 100% of the company, which was renamed UkrKarpatOil. Burisma Holding Ltd of Cyprus is a co-founder of PARI LLC, while Canadian Corporation Zhoda 2001 co-founded JV Kashtan Petroleum Ltd. The list of gas extracting companies and their volumes of extraction in 2007-2011 are presented in Annex 3.

Cost of Extraction

There are no statistical data available on the cost of natural gas extraction in Ukraine. According to Roman Storozhev, the President of Gas Traders of Ukraine Association[1], the cost of natural gas extraction ranges from $150 to $250 per 000 cm depending on geological conditions of a particular gas deposit. The cost was determined based on own calculations of the Association.

However, some analysts believe that the above extraction cost may be overestimated. According to the director of the Nadra Group of Companies, Pavel Zagorodnyuk,[2] the cost of extraction is lower at about UAH 400-800 (around $49-98) per 000 cm, based on cost data from the Group's enterprises. According to this data, the average capital investments to develop a new gas deposit vary from UAH 20 million to UAH 100 million (from $2.3 million to $12.2 million). Therefore, the average cost of equipment necessary for commercial gas production is estimated at about UAH 1 billion ($122 million), Given that the economically recoverable period for deposit exploitation ranges from 20 to 60 years, the company calculated the likely extraction cost at $49 to 98 per 000 cm for an average gas deposit.

According to the Minister of Energy and Coal Industry Eduard Stavitsky,[3] the cost of natural gas extraction in Ukraine is equal to UAH 340 ($41.5) per 000 cm. However, Mr. Stavitsky did not disclose the methodology of the calculations.

Prices paid to Gas Producing companies

The prices for natural gas paid to gas extracting firms are calculated on the basis of a special cost-plus methodology introduced by the Decree of NECRU #1177 as of September 13th, 2012. It is based on rules and major principles of natural gas extraction cost calculation commonly used in the EU. To calculate the price of extracted gas, the enterprise may include both economically justified production costs, the profits necessary to fulfill its investment program, including a profit margin and taxes. This is the "cost plus" principle widely used in Europe. The production cost includes the costs to operate and maintain gas wells, equipment and facilities to extract gas (so called lifting costs) as well as the costs for exploring and developing reserves, and royalties (finding costs). Overall, the pricing formula is as follows:

[1] The statement was made in November 2011.
[2] The statement was made in September 2012 during the seminar for journalists.
3 The statement was made in September 2013 during the hour of the government in the Parliament of Ukraine.

$$PRICE = (E_{extr} + P_{extr} + R)/V_{extr},$$

where E_{extr} is natural gas production cost of a particular enterprise;

P_{extr} is the profit of a particular enterprise from natural gas extraction;

R is a royalty interest for natural gas of own extraction, excluding royalty for volumes of extracted natural gas used for technological needs; royalty is calculated in accordance with the rates established by the Tax Code of Ukraine;

V_{extr} is the volume of marketed natural gas (gross withdrawals less gas used for technical purposes (e.g., repressuring) and losses[4].

As noted earlier, according to some sources, the cost of the natural gas extraction in Ukraine is around $50-60 per 000 cm but extracting companies inflate the final cost up to $250 per 000 cm using loopholes in the methodology, in order to justify higher gas prices.

Gas Price for Consumers

All natural gas tariffs are regulated by the National Electricity Regulatory Commission of Ukraine (NERCU). The current tariffs for the population were set on July 13th, 2010 by the NERCU Decree No. 812. The price for households varies from UAH 725 to UAH 2,954 ($88.5-$360 per 000 cm) and depends on the amount of gas consumed and the presence/absence of a gas consumption meter in the apartment (see Annex 4 for details). However, the cost for most households does not exceed $100 per 000 cm, which is about ¼ of the price for Russian imported gas.

The tariff for enterprises which produce heating energy was set the Decree of NERCU No. 813 of July 13th, 2010 and is equal to UAH 1,309 ($160) per 000 cm, including VAT. Finally, industrial and associated consumers, and budget-supported organizations pay UAH 3,459 ($422) per 000 cm, excluding target-markup charges but excluding VAT, and tariffs for transportation and distribution. The methodology used for tariff calculations is not publicly available.

C. Gas Supplies from Europe

Routes of Gas Supplies

In May 2012, Naftogaz concluded a framework agreement with German RWE Supply & Trading on natural gas supplies of up to 5 billion cm per year. As of now, Ukraine imports gas through Polish gas distribution facility Hermanovice and Hungarian Beregdaroc. The first natural gas supplies from Germany through started on November 1st, 2012. The reverse flow capacity of Hermanovice is equal to 4 million cm per day. As of the beginning of November 2013, gas from Hungary is imported by VETEK and DTEK companies.

Origin of Gas, Amounts and Cost

Currently Ukraine imports gas from Germany and Austria. For the purposes of imports some gas transportation capacities of Poland and Hungary which are usually used to deliver Russian gas to Western European countries now work in reverse mode. According Ukrainian state officials, the

[4] In the volumes that do not exceed the established standard volumes and volumes used to satisfy own needs of an enterprise.

contract with RWE does not specify the origin of gas for imports meaning that it can be Russian gas or gas of any other country depending on which country's gas is in storages of RWE on the day of actual supply to Ukraine.

In November and December 2012, volumes of imports from Poland were low. Actually, Ukraine just tested the pipelines and other equipment. Then the country started to increase import volumes (except for March 2013). Overall, for January-July 2013, Ukraine imported 0.92 billion m3 in reverse order, although this amount is small compared to total natural gas imports (see Annex 5 for details). At the same time, Ukraine has opportunities to further expand its gas imports from Europe. In particular, the country wants to import gas from Romania and Slovakia. Supplies from these two countries potentially may reach 30 billion cm per year (see part 4 for greater details).

The price of gas imported from Germany is linked to the spot gas price in the German stock exchange. Therefore, the import price is affected by seasonal fluctuations. In particular, gas prices in the European market traditionally go up at the beginning of the heating period. Thus, prices went up from around $390 per 000 cm at the beginning of the year to $410-420 per 000 cm in ???. At the same time, the price of imported Russian gas to Ukraine went down in line with world crude oil prices. As a result, in September, for example, the average price of Russian gas to Ukraine stood at $399.3 per 000 cm, while the price of gas imported from Europe averaged to $397.3 per 000 cm. High spot natural gas prices in Europe made Naftogaz to temporary stop imports of gas from Europe in October.

2. Current LNG Supplies to Europe

A. Major European Importers of LNG and Countries of Origin

Although a patent for LNG was filed back in 1914 and the first commercial production was in 1917, the technology for LNG remained under-developed until 1960s. As building of a liquefaction facility is very capital intensive, the LNG market developed very gradually. The development of new technologies allowed reducing the LNG costs. In addition, LNG is more flexible than pipeline gas and many countries consider it as an essential aspect of energy diversification. As a result, by early 2000s LNG became a mainstream transport technology. In 2011, global LNG trade amounted to 331 billion cm, almost 100 times higher than in 1970.[5] The number of LNG exporting countries grew from 13 in 2013 to 19 in 2012, while the number of importing countries has approached 30 by the end of 2012 compared to 15 in 2006.

As a number of European countries rely on a relatively limited number of energy supply sources, the North Sea gas reserves are declining and the costs of natural gas were increasing, the European Union became a large importer of LNG. Its imports significantly declined in 2012, affected by a protracted Eurozone recession. The total imported amount of LNG declined from 65.7 million tonstons in 2011 to 48.4 million tonstons (-26.33% yoy) in 2012. Imports fell in 6 out of 9 major European LNG importers - Belgium, France, Greece, Italy, Netherlands, Portugal, Spain, Turkey, and the UK. Spain remains the largest consumer of LNG even though its imports have been declining for the last three years. In contrast, Turkey increased its imports by 25.3% yoy to 5.74 million tons in 2012, which was the largest increase observed that year. At the same time, the largest decrease of 43.7% yoy in imports was reported by the UK, the second largest LNG importer in Europe (tonssee Annex 6 for details).

[5] Source: The Economist. LNG: A Liquid Market.

Qatar remained the largest exporter of LNG to Europe but its exports to the region decreased by 27.2% yoy in 2012. Algeria was the second largest exporter although its exports to Europe decreased for the second year in a row. In 2012, Equatorial Guinea returned to the list of LNG exporters to the EU after one year of absence, while the US left the list for the first time in three years.

B. Price of LNG in Europe

As of now, there are two natural gas pricing systems in Europe. These systems are: German oil-linked pricing and BNP spot pricing. The first one is associated with Germany, the largest market where this system is applied. The second system is related to the National Balancing Point, a virtual trading location for the sale and purchase and exchange of the UK natural gas. NBP is the most liquid gas trading point in Europe and is similar to the Henry Hub in the US. The spot and short-term LNG market grew from 5% at the beginning of 2000s to 31% in 2012. There are many reasons for that but in case of Europe the major reason was the decline in competitiveness of gas relative to other fuels. Economic crisis led to a decline in demand for gas and substitution of it with other energy sources (coal, for example).

Both long-term contract prices and spot prices of LNG are not openly available to the public. Spot prices may be tracked through the number of paid services which publish quotations for different exchanges (for example, ICIS at www.icis.com or PLATTS at www.platts.com). The average price of spot pipeline gas was about $358 per 000 cm in September 2013, while the average spot LNG price was equal to $408.12 per 000 cm.

However, it is regasification cost that causes the biggest difference in prices among the European LNG final consumers. Regasification is the most controversial and nontransparent procedure in the LNG exports to Europe. For instance, the UK regulator Ofgem has no records of LNG regasification costs at all. LNG regasification terminals do not publish their regasification tariffs because national legislation does not oblige them to. As their representatives say “should one contractual slot become available for a spot delivery, the regasification cost shall be agreed between buyer and seller”. In contrast, other European countries introduced formulas to calculate the regasification prices (Spain, Italy, France etc.). Usually, these formulas are quite complex and easy to misinterpret. Since formulas are different, the regasification costs also differ significantly. ICIS Heren Company held a study of regasification prices for 140,000 cm of LNG stored in a tank at a terminal on a one-off spot basis by a third party user in European countries in 2010. The study showed that regasification in Italy was 5 times more expensive than in Spain, while regasification in the Netherlands and France was 3.5 times cheaper than in Italy.

3. Feasibility of Short-Term LNG Supplies from Texas to Ukraine

A. Extraction of Shale Gas in Texas: Companies, Volumes and Costs

Shale gas is a relatively new form of extracting natural gas from shale rock. Two major drilling techniques are used to produce gas - ***horizontal drilling and hydraulic fracturing.*** At first, a vertical well is drilled to the desired depth. Then, the drill bit is turned to bore a well that stretches through the reservoir horizontally. ***Hydraulic fracturing*** (also known as "fracking") is a technique in which water, chemicals, and sand are pumped into the well to unlock the hydrocarbons trapped in shale formations by opening cracks (fractures) in the rock and allowing natural gas to flow from the shale

into the well (see Annex 7 for schematic geology of natural gas resources and hydraulic fracturing). When used in conjunction with horizontal drilling, hydraulic fracturing enables gas producers to extract shale gas at reasonable cost. Without these techniques, natural gas does not flow to the well rapidly. Industrial production of shale gas requires constant drilling of new wells and exploration of large areas. In Annex 8 one can find a comparative analysis of conventional natural gas and shale gas extraction.

Texas is a leader in shale gas production in the US. It has the largest deposits of both shale gas and oil. Moreover, Barnett Shale was the first developed shale deposit in the country. Works on it started in 1981 with the discovery of East Gas Field. Therefore, there are many companies extracting gas in Texas. In particular, there are 10 major operators of the Barnett Shale, including Devon Energy, Quicksilver Resources, and Barnett Shale Operating, 8 major operators extract gas on the Texas part of Haynesville Shale, including ExxonMobil/XTO, Anadarka Petroleum Corp., and EXCO Resources. Eagle Ford Shale is being developed by more than 100 operators, including already mentioned Devon Energy, ExxonMobil/XTO, and Anadarka but also Shell, because the field contains both shale gas and shale oil deposits.

A large number of extracting companies in the region led to significant increase in volumes of extraction over the last five years. According to Energy Information Administration (EIA) data, shale gas extraction in Texas grew from 28 billion cm in 2007 to 50.7 billion cm in 2009 to 82 billion cm in 2011 (the latest available data).

Since shale deposits mentioned above have different geological structure and rock composition, the cost of gas extraction also differs. According to estimates of the Houston based Universal Pegasus International Inc., the break-even cost of shale gas extraction at the Barnett Shale was equal to $144.6 per 000 cm in 2011. The cost of gas extraction at Eagle Ford Shale for dry gas was equal to $144.3 per 000 cm, while that at Haynesville Shale was $103.1 per 000 cm.

B. Current Liquefaction Capacities in Texas and Nearby States

The only operational liquefaction facility in the US is Kenai LNG in Alaska. Total liquefaction capacity of the facility was equal to 2 million tons in 2012. According to the International Gas Union the capacity was loaded by 12% that year.

One more liquefaction facility is planned to start operation not earlier than 2015. This is the Sabine Pass Project initiated by Cheniere Energy Partners, under its subsidiary Sabine Pass Liquefaction, LLC, to add liquefaction services at the Sabine Pass LNG receiving terminal. The current scope of the liquefaction project allows for up to four modular LNG trains, each with a peak processing capacity of up to approximately 20 million cm a day of natural gas and an average liquefaction capacity of about 3.5 million tons per annum. The initial project phase is anticipated to include two modular trains and the capacity to process on average about 34 million cm a day of pipeline quality natural gas.

C. Current LNG Transportation Capacities from the US to Europe

LNG fleet consisted of 362 vessels of all types with a combined capacity of 54 billion cm at the end of 2012. In addition, the order book for new vessels consists of 96 vessels with a total capacity of 16 million cm. Among the operating LNG vessels there are no US-flag vessels. This creates additional difficulties for LNG transportation as a vessel under foreign flag needs to obtain a special permission to operate in the US.

All the operations, routes and statuses of the LNG vessels may be found at the paid service Lloyds Intelligence. The service may be found via the following link:

http://www.lloydslistintelligence.com/llint/gas/index.htm

As for routes of LNG transportation via LNG vessels, there is a base route of delivering goods from Gulf of Mexico to Europe, which is presented in Annex 9.

D. LNG Terminals in Europe with Free LNG Re-gasification Capacity

According to the International Gas Union, European regasification facilities are heavily underutilized. This provides quite wide list of opportunities to regasify the LNG in the region. Major regasification capacities and the level of their utilization in 2012 are presented below:

Country	LNG regasification capacity, million tons	Utilization, %
Spain	43	36
the UK	38	28
France	17	44
the Netherlands	9	7
Turkey	9	66
Italy	8	63
Belgium	7	52
Portugal	6	38
Greece	3.6	50

E. Gas Transportation Routes from Europe to Ukraine, after Regasification

A map of existing gas pipeline networks of Europe and neighboring countries in Annex 10. To minimize the number of countries to hold negotiations and reduce transportation costs, the most plausible route for LNG gas transportation to Ukraine looks as following. Following LNG regasification at Marmara terminal in Turkey, natural gas is transported to Ukraine via a pipeline through Bulgaria and Romania. Currently, however, there are two major obstacles for with this route. First, reverse-flow gas imports through Romania and Slovakia are closed. Second, due to environmental and safety concerns Turkey may restrict LNG tankers movements through the Dardanelles and the Bosporus straits (see Section 4.5 for details).

The alternative route could be the following: regasification at Greek Revithoussa terminal and transportation through Bulgaria and Romania to Ukraine. through Romania to Hungary and then to Ukraine if reverse-flow gas supplies remain blocked. All other routes involve four or more transit countries from LNG terminal to the Ukrainian border, negotiating gas transportation with which may be very time consuming.

F. Possibilities for Gas Swaps (Non-Physical Deliveries) with European Countries

The issue of gas swaps was raised in Ukraine several times but each time negotiations were unsuccessful. Russia proposed gas swaps involving Moldova yet in 2009. Ukraine did not agree to apply this gas supply scheme arguing that it was technically impossible at that moment. On April

4th, 2013, idea of gas swaps was raised again. This time Ukraine proposed Azerbaijan gas swaps involving Russia. Minister of Energy and Coal Industry of Ukraine Eduard Stavitsky proposed to his Azerbaijan's college Minister of Energy Natig Aliyev to arrange swap operations involving Azerbaijan and Russian gas. In particular, Azerbaijan would supply some gas to Russia, while Russia would supply the same amount to Ukraine. Ukraine then would pay for Azerbaijan gas. Mr. Natig Aliyev admitted that the proposal was interesting but it needed some adjustments and solution of purely technical issues. These involved the issue of payment for transport services, participation of several companies in the project, and problems with technical possibilities of swap operations. Technical problems were never disclosed but the idea of swaps was not realized either.

G. Potential Buyers of LNG in Ukraine and Trade Arrangement

There is at least one big potential buyer of regasified LNG in Ukraine. This is DTEK group of Rinat Akhmetov as enterprises of the group consume 3 billion cm of natural gas per annum. Since Russian gas is expensive, DTEK is looking for diversification of gas supplies and cheaper alternatives. Therefore, the group consolidated 50% of shares of the Naftogazvydobuvannia, which is the largest private domestic gas extracting enterprise, and holds negotiations with other enterprise owners concerning the sale of the rest shares. The maximum amount DTEK can import through Hungary is 100 million cm per month. This equals about 40% of its gas needs. Naftogazvydobuvannia may provide another 800 million cm per year, which would mean that the group will still need to buy about 1 billion cm of gas.

Any company entering the gas trading market has to obtain a special license allowing it to supply gas. Also the company needs to conclude the contract with the operator of the gas transportation system concerning transportation and storage of gas. Given non-transparent and relatively closed energy business in Ukraine, obtaining a license and conclusion of necessary contracts may be costly and time consuming process.

H. Calculation of the Cost of Gas Supplies from Texas to Ukraine

Cost of gas supplies from Texas to Ukraine will have the following components:

1) price of LNG exports from the US;
2) cost of transportation to the liquefaction facility;
3) cost of liquefaction;
4) cost of transportation from the US to Europe;
5) cost of regasification;
6) cost of transportation via pipeline to the border of Ukraine.

The US does not have necessary infrastructure to start exporting LNG. However, big companies invested a lot into construction of this infrastructure which may push the price of gas inside the US up a bit. Experts in the field expect the price to grow but we will use current prices of $107-143 per 000 cm.

The cost of delivery to the liquefaction facility, calculated based on typical maximum system-wide base rate for firm and interruptible transportation service of $7 per 000 cm plus a 3% fuel and lost and unaccounted for (LAUF) gas charge, the total variable cost per unit for transportation from processing plant to a liquefaction facility 300 miles away can be estimated at $11.5 per 000 cm.

The liquefaction cost estimates vary from $38.5 per 000 cm to $100 per 000 cm. Moreover, it may increase with the growing export capacity (currently there are 15 applications for gas exports into countries which do not have free trade agreements with the US are under consideration).

LNG transportation cost declined by around 40% in 1997-2007. It is likely to continue declining thanks to technical progress reducing and construction of new LNG carriers. Recently a new technology of re-liquefying of boil-off gas was introduced. It will allow decreasing cargo losses during transportation. We think that the transportation cost will be around $45 per 000 cm.

As for regasification, we assume regasification cost at the level of $14 per 000 cm.

Cost of transportation via pipeline will depend on the length of the pipeline to the border of Ukraine and tariff per 000 cm for 100 kilometers.

According to our calculations, the cost of gas supply may be $323-359 per 000 cm plus cost of transportation via pipeline to the border of Ukraine.

PHASE II. MEDIUM-TERM BUSINESS OPPORTUNITIES

4. Possibilities for Further Shale Gas Development in Ukraine

***Shale gas deposits*.** Ukraine has significant gas reserves in shale formations and in consolidated rocks. According to the State Commission of Ukraine on Mineral Resources, shale gas resources are estimated at 7 trillion cm. At the same time, the Energy Information Administration assessed technically recoverable shale gas reserves at 3.6 trillion cm (1.75% of world shale gas reserves). The EIA world shale gas resources estimates were updated in June 2013. Ukraine's initial shale gas estimates, made in April 2011, stood at 1.2 trillion cm.

There are two major deposits of shale rocks in Ukraine, where an extraction of shale gas is possible (see Annex 11). Lviv-Lublin basin on the west (reserves are estimated at 1.47 trillion cm) and the Dnipro-Donets basin on the east (reserves are estimated 2.15 trillion cm).

Recent Developments. The first tender on the right for signing the production sharing agreement (PSA) for shale gas extraction was held in 2012. In January 2013, Ukraine awarded the first shale gas PSA to Shell. The company has the right to develop Yuzivska area (the area of 7886 km2) in the eastern Dnipro-Donets Basin for 50 years. The contract allows for 70% investor recovery and a 16.5% government revenue share. Chevron won the right for signing the production sharing agreement on the development of Olesska area (the area of 6324 km2) on the territory of Lviv-Lublin basin. A PSA was approved by two local councils (Lviv and Ivano-Frankivsk), following which the document should be submitted and signed by the Cabinet of Ministers of Ukraine. Shell and Chevron investments including extraction after exploratory drilling could reach USD10 billion each.

In addition, Italian oil and gas company ENI has announced its plans to extract shale gas in Lviv-Lublin basin. In 2012 ENI signed a PSA with Ukrainian state-owned National Joint Stock Company NJSC Nadra Ukrainy and Cadogan Petroleum Plc to acquire a 50,01% interest and operatorship of the Ukrainian company LLC WestGasInvest. LLC WestGasInvest currently holds subsoil rights to nine unconventional (shale) gas license areas in the Lviv Basin of Ukraine, totaling approximately

3,800 km2. The company and its partners, including UK-based Cadogan Petroleum, plan to spend about $95 million exploring for shale gas in the Lviv basin from 2012 through 2015.

Early experience. In 2011, Hawkley, an independent Australian company, drilled a shale gas well in the Dnipro-Donets basin. In November 2011, Kulczyk Oil, an international upstream company, announced that it had successfully completed the hydraulic fracturing of a well in a previously non-commercial zone of the Dnipro-Donets basin, yielding 65,000 cm per day of gas and condensates. Annex 12 provides a map of hydraulic fracturing wells in Ukraine.

Potential Production. According to Energy and Fuel Ministry, the two shale gas projects could provide Ukraine with an additional 11 to 16 billion cm of gas in five years' time. The start of commercial gas extraction may start in 2015-2022.[6] Annual extraction volumes may constitute 3-5 billion cm for Olesska field (see Annex 13 for more details) and 8-10 billion cm for Yuzivska field.

Costs

Investments. According to Energy and Fuel Minister, total investment into development of Yuzivska and Olesska fields is estimated at $50 billion and $30 billion respectively. Shell's first stage investment commitment is $200 million. Chevron's exploration works in Olesska field are estimated at $350 million.

Projected production cost. According to Baker Tilly estimates, based on comparative analysis of shale gas extraction in areas with comparable characteristics, the projected cost of shale gas in Ukraine equals $260-350 per 000 cm. Likely due to exclusion of investments on exploration and construction of infrastructure, the cost of production is estimated to be in the range of $100-150 per 000 cm (Source: Apostolaka, 2013).

Environmental concerns

There are a number of environmental issues that raise concerns over the ecological consequences of the fracking process.

1. Water availability for other uses. The drilling and fracturing of wells requires large amounts of water. In some areas (e.g. Lviv region, which is known for water supply shortages, including the city of Lviv) significant use of water for shale gas production may affect the availability of water for other uses.
2. Wastewater. During the drilling and fracturing, large amount of wastewater, which may contain dissolved chemicals and other contaminants, is produced. It requires special treatment before recycling or reuse. In case of leakages, it may cause contamination of groundwater.
3. Failure to deal with the chemicals.
4. Air pollution. Air pollution occurs from leaking methane and the use heavy machinery (diesel-powered rigs and trucks) for drilling.
5. Unwanted seismic activity. It is known that pumping fluids into or out of the Earth has the potential for inducing seismic events. A series of small seismic events in Arkansas, Ohio, Oklahoma and Texas in the US over the past several years raised concerns they may be linked to shale gas production in these regions. In 2011, two earthquakes were felt in the

[6] The Ministry of Energy and Coal Industry of Ukraine expects the start of shale gas extraction in 2015. This assumption is based on the study of the international company INS CERA, executed for the Ministry. According to KPMG study, the start of extraction may be in 6-7 years (2018-2019). At the same time, Baker Tilly experts believe that the start of commercial shale gas production will start not earlier than in 2022.

Blackpool area, UK. They were suspected to be linked to hydraulic fracturing at the Preese Hall (UK), which caused a temporary ban on shale gas extraction in Great Britain.

Accident statistics in the US. According to a group of Yale economics graduates, led by Yale Professor Emeritus Paul W. MacAvoy, who published their findings in a report "The Arithmetic of Shale Gas", in 2011 the Secretary of Energy Advisory Board counted 19 times of frackwater leakages, amid thousands of wells drilled. However, groundwater contamination was not confirmed for any of these instances. The Oklahoma Corporations Commission, which regulates the 100,000 oil and gas wells that have been hydraulically fractured in that region, documented no instances of groundwater contamination. In Wyoming, it was reported two instances of groundwater contamination from fracking.

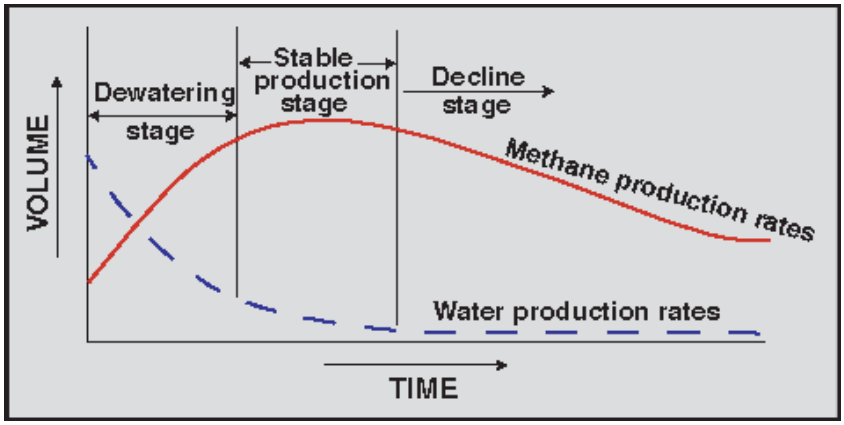
Environment costs. Despite the absence of pollution evidences, the authors of the above mentioned report calculated the environmental costs for a scenario that assumes 100 spills a year out of 10,000 new wells drilled each year. They figure that if around 19,000 liters of polluted frackwater were to spill into a field, the cost to scrape up a hypothetical 3,800 cubic meters of contaminated soil and dispose of it at an offsite landfill would be about $2.5 million. Given 100 incidents per year, the clean-up costs associated with fracking accidents would be around $250 million. The authors, however, did not include the likely costs of gas leaking into the air as well as associated with the pollution legal costs.

In Ukraine, the environment costs may be much lower than in the US as well as much higher. First, the total number of wells is projected to be much lower in Ukraine than in the US. The speed of well drilling in Ukraine will be contained due to the lack of equipment and qualified employees necessary for drilling and hydraulic fracturing. For example, the number of wells at Olesska field is forecast to reach around 15, 260 and 1000 in five, ten and fifteen years respectively. On the other hand, any relatively large pollution case may lead to local community as well as national protests against fracking, which have already caused Chevron to suspend shale gas exploration in Romania. A number of European countries, e.g. France, the Czech Republic, the Netherlands, Bulgaria, banned or imposed moratorium on the fracking method (the whole map of shale gas industry in Europe is presented in Annex 14).

5. Development of Coalbed Methane

Coalbed methane is a form of natural gas extracted from coal beds. For its extraction, hydraulic fracturing is used. After fracking, there is a dewatering stage, which lasts about 2-3 years. Gas production peaks at the third-fourth year and declines thereafter.

Coalbed Methane Production Cycle



Source: Wikipedia

Ukraine has considerable unconventional gas potential in the form of coalbed methane in the main coal-mining areas of eastern Ukraine (Donetsk and Luhansk regions). According to Ukrainian Institute of Geological studies, coalbed methane resources are estimated at 13 trillion cm. At the same time, EIA/ARI estimates are more modest, at close to 3 trillion cm. Such variation may be explained by the differences in methodology. Ukrainian Institute likely estimated total potential deposits, while EIA/ARI provided estimates of deposits, where extraction was possible.

Potential coal bed methane extraction is estimated at the level of 2-12 billion cm per year.

According to the Energy and Fuel Ministry of Ukraine, ***potential cost of coalbed methane extraction*** is estimated at around $100 per 000 cm. However, expert estimates are much higher – at about $290-410 per 000 cm due to the fact that coal seams in Ukraine lie at considerable depth (from 500 to 5000 m) and have a small thickness (2 m), according to Baker Tilly report on Gas extraction industry in Ukraine. To reach an annual production of 2-4 billion cm, about $1.5-1.9 billion is required (including exploration expenses, construction of necessary infrastructure and extraction per se).

Likely due to relatively high potential cost of extraction, coalbed methane extraction projects remain at premature stage so far. In addition, during 2010-2011, several hydrofracking operations in coal beds and accompanying formations were performed in South-Donbass fields of Donbass. None of them resulted in commercial flow of methane. Several drillings in the region are planned in 2013. In particular, at the beginning of 2013, the company Iskander Energy announced plans to drill 4 pilot wells in South Donbass area in 2013. So far, one well was drilled but there is no information on the amount of gas sufficient for commercial production.

A number of mines produce coalbed methane during mines degasation. The largest producers include Mine named after A.F.Zasyadko, Coal Company Pokrovske from DonetskSteel group of companies and DTEK Mine Komosomolets Donbassa (DTEK is part of Akhmetov holding).

Ukraine provides state support to gas extraction from coal seams. In particular, according to the Law of Ukraine ‘On gas of coal seams’, profit from economic activities foreseeing extraction and utilization of coal seams gas is exempted from profit tax till 2020.

6. Development of Black Sea Offshore Natural Gas

Black Sea gas potential resources remain widely unknown due to the lack of exploration activities. High costs of exploration, a lack of infrastructure, high investment risk and difficult access via the Bosporus Straits are among main challenges for Black Sea gas development. So far, there was only one major discovery of gas in Romanian part of the Black Sea. At the beginning of 2012, OMV Petrom ROSNP.BX and ExxonMobil made successful drilling, discovering 42-84 billion cm of gas reserves at its Domino 1 well (Romania).

Deposits. According to various estimates, Ukraine’s part of Black Sea may hold from 3 to 13 trillion cm of natural gas.

Ukrainian Energy and Fuel Ministry expects ***annual production*** from shallow shelf areas in the Black Sea may account to 5 billion cm. However, to reach this production level, about $10 billion of ***investments*** is required.

As the depth of the Black Sea part of Ukraine reaches 2000 m, ***the cost of extraction*** in comparable environment is estimated at $75-125 per 000 cm.

The Ministry forecasts ***commercial extraction*** to start in 2022. Current activities on offshore natural gas extraction are presented in Annex 15, while the map of gas Black Sea gas fields is presented in Annex 16.

Over the first nine months of 2013, Naftogaz subsidiary – ChornomorNaftogaz - increased extraction of natural gas from Black Sea shell by 37.6% yoy to 1.2 billion cm and plans to raise extraction to an annual 3 billion cm until 2015. According to expert opinion, if shale gas projects turn to be unsuccessful, Black Sea offshore gas projects will be the most prospective.

In mid-October 2013, the Ukrainian government gave formal approval for signing the production-sharing agreement with Eni (Italy) and EDF (France). The companies will be involved in exploration and production of oil and gas on the Black Sea shell (likely in Foros field).

7. Reverse-Flow Gas Supplies from Europe

In 2012, Ukraine approached a number of gas companies from Germany, Poland, Slovakia, Hungary and Romania for natural gas supplies in reverse flow. Lower EU spot market prices for natural gas than the price Russian energy monopoly Gazprom charges Ukraine was the principal reason for reversing some of the pipelines that were originally designed to ship gas from Russia to Europe.

The mechanism of the reverse imports is the following. Russian gas is transported to Europe through the territory of Ukraine, registered as deliveries to the EU at the gas metering station, and then immediately reversed back to Ukraine at the spot market price. Russia considers such mechanism as illegal 'virtual' imports. However, Ukrainian authorities are confident that since reverse gas deliveries to Ukraine are legally registered as imports from European states, the country does not violate international laws.

Currently, gas from Europe is supplied through Poland (Hermanowichi) and Hungary (Beregdaroc). According to Ukraine's Minister of Energy and Fuel, potential annual imports from Europe via these two routes may amount to 5-6.5 billion cm.

At the same time, the most prospective route of European natural gas imports (due to its massive capacity) is through Slovakia. As of the beginning of November 2013, the route was closed. One of the 2009 contract provisions between Naftogaz and Gazporm makes the latter not only seller of gas but also operator of the gas transportation network in Ukraine to the border with Slovakia. As a result, Ukrtransgaz (Ukrainian transmission system operator) does not have complete information about the breakdown of Russian gas transited through the territory of Ukraine to European consumers. Without this information, the reverse mechanism may violate natural gas supply contracts with third countries. An existence of a special clause on gas re-import ban in the agreement on Russian gas price discount, which was reached by Slovakia last year, may be another reason. Likely for similar reasons, another route of natural gas supplies from Europe, through Romania, was also closed.

Separation of functions of gas seller and operator of a gas transportation system is one of the basic principles of European energy market. Since Ukraine is a member of the European Energy Community, its 2009 gas contract with Russia violates European legislation. Therefore, Ukraine needs either to revise the contract and bring it into the correspondence with EU legislation or terminate it. However, negotiations with Gazprom to revise the contract unsuccessfully last since 2010. For some reason, its termination by applying to International Arbitration Court is not considered by the Ukrainian officials as an option.

At the end of October 2013, Ukrainian Fuel and Energy Minister announced that under support of EU authorities Ukraine and Slovakia reached an agreement on reverse gas flow and imports may start in November 2013. If all routes are open, Ukraine may technically import up to 35-40 billion cm of natural gas from Europe.

Reverse Flow Natural Gas Routes from Europe to Ukraine

Country, TSO	No. of lines	Available tech. capacity bcm/year	Maximum tech. capacity bcm/year	Reverse flow status (starting from)
Poland (Gaz-System)	2	6.6-1.8	5	Yes (Nov. 2012)
Hungary (FGSZ)	2	1	5.4	Yes (March 2013)
Slovakia (Eurostream)	5	5	10--30	No (May 2013)
Romania (Transgaz)	4	1.8	2	No (NA)

Source: Opimakh, R., 2013. 'Ukraine's Gas Upstream Sector: Focus on International Investment'.

Main Eurasian Oil and Gas Pipelines

Source: McNamara et. Al., 2010 'Counting Turkey's Strategic Drift.' www.heritage.org

8. Building LNG Terminals in Ukraine

As a part of its national strategy to increase energy independence, Ukraine has developed a LNG Terminal National Project. The project envisages a construction of a LNG terminal on the Black Sea coast that will allow diversifying Ukraine's gas imports. According to the Project details, a LNG terminal potential capacity is planned at 10 billion cm of natural gas per year.

The project will be realized in two stages. During the first stage a floating storage and regasification unit (FSRU) will be delivered and placed in Ukraine. It is planned that the floating platform with an annual capacity of a 5 billion cm will be permanently moored to a jetty alongside the Ukrtransnafta oil terminal in Yuzhny Port (near Odessa). The second stage envisages construction of an onshore terminal and storage facility (a total of 540,000 cm) with the capability of unloading large 178,000 cm LNG tankers. This will allow receiving natural gas up to 10 billion cm per year. Proposed locations for the LNG terminals are presented on a map (see Annex 17).

Required investment. According to the National Project team, realization of the first stage will require about $1 billion and additional $1.3 billion for the construction of a terminal.

Timing of operation and costs. According to the head of the State Agency for Investment and National Projects, Vladyslav Kaskiv, the first stage is expected to be completed in 2014. In April 2013, Ukraine has signed a service agreement with US LNG solutions company Excelerate Energy to rent a re-gasification station. The rent payments are reported to amount to $60 million per year. Preparatory excavation works are estimated to cost approximately $160 million. Building the connection to the existing high pressure gas pipeline and installation of the rented terminal will require additional $150 million. The construction of the onshore terminal will take three-four years and is scheduled to be launched in 2018. The second stage is estimated to cost about $1.3 billion.

Ukraine has been considering two main routs of LNG imports: from Caspian gas producing countries such as Azerbaijan and Turkmenistan through Georgia and from Gulf producers such as Qatar, Angola, etc. through the Bosporus and Dardanelles straits (see Annex 18 for details).

In autumn 2011, Ukraine established a joint venture with Azerbaijani state-controlled oil and gas company SOCAR to study the feasibility of supplying the Ukrainian LNG terminal. Azerbaijan may deliver up to 5 billion cm of gas to Ukraine. For this, however, a liquefaction plant on Georgia's Black Sea coastline should be constructed. Ukrainian officials expect the price of Azerbaijani gas to be de-coupled from the oil price. By their initial assumptions, the price of Azerbaijani LNG would be at around $300 per 000 cm after re-gasification.

Ukraine has been negotiating LNG supplies on a long-term basis with Algeria, Egypt, Nigeria, Qatar and UAE. Data on gas deposits and LNG production of the mentioned countries is presented in Annex 19.

Project Challenges

Relations with Turkey. Both the Bosporus and Dardanelles straits are controlled by Turkey. According to its energy strategy, Turkey is seeking to become a key energy transportation hub. In addition to the existing oil and gas pipelines, the country has two LNG terminals, Marmara Ereglisi inTekirdag and the Aliaga terminal in Izmir. Annual and a maximum daily sendout capacity is 8.2 billion cm and 22 million cm for Marmara Ereglisi and 6 billion cm and 16 million cm per day for the Aliaga terminals respectively. Moreover, at the beginning of 2013, the country announced plans to build the third terminal, which may be located close to the country's borders with Greece and Bulgaria, with planned annual capacity of 5-6 billion cm. According to Turkish Energy Minister, the new terminal will allow reducing tanker shipments through the straits.

According to international lawyers (US Law firm Baker Botts), LNG tankers have the right to transit both the Dardanelles and the Bosporus unrestricted, which is guaranteed by the 1936 Montreux Convention. However, citing environment and safety risks as well as congestion, Turkey opposed Ukraine's construction of an LNG terminal on the Black Sea coast. Instead, Turkey proposed to buy LNG from one of Turkey's existing or planned terminals. In this case, gas may be shipped only through the Bosporus strait or even bypassing the Bosporus and Dardanelles (the existing Soyuz pipeline likely was meant).

An agreement between Ukraine and Turkey for the transit of LNG through the Bosporus can be a viable option. The Ukrainian government continues bilateral negotiations with Turkey on the issue. However, no meaningful progress was achieved so far.

At the same time, the timing for these negotiations may be critical if both countries (Ukraine and Turkey) have ambitions to deliver the received gas to European consumers. First, growing Asian countries demand for energy resources (Japan, South Korea, and Taiwan) already pressured LNG prices upwards, reducing its attractiveness to the European market (see Annex 20 on prices of LNG in Japan). China and India are also expected to become the biggest sources of LNG demand. Second, the attractiveness of LNG supplies from Turkey and/or Ukraine may decline following the construction of Trans-Anatolian Pipeline (TANAP), which will bring gas from Shah Deniz (Azerbaijan) through Turkey to the European market, implementation of the Azerbaijan-Georgia-Romania Interconnector (AGRI) LNG project or development of Mediterranean LNG projects (first of all by Cyprus or Israel).

Infrastructure bottlenecks for Caspian gas supply. Currently there are no facilities on the Black Sea to liquefy Caspian gas for shipment. Therefore, Azerbaijan (or Turkmenistan)-Georgia-Ukraine route is technically not feasible.

Annexes

Annex 1

Volumes of Russian gas imports in 2009-2013

Year	Quarter	Company	Price of Gas, $per 000 cm	Amount supplied, billion cm
2009	1	Naftogaz	360	33.5
	2	Naftogaz	NA	
	3	Naftogaz	NA	
	4	Naftogaz	NA	
2010	1	Naftogaz	NA	36.6
	2	Naftogaz	NA	
	3	Naftogaz	NA	
	4	Naftogaz	252	
2011	1	Naftogaz	264	17.9
	2	Naftogaz	297	9.3
	3	Naftogaz	355	5.3
	4	Naftogaz	400	7.5
2012	1	Naftogaz	416	7.145
		Ostchem	~432	1.39
	2	Naftogaz	425	4.6
		Ostchem	~430	2.765
	3	Naftogaz	426	6.76
		Ostchem	~430	1.94
	4	Naftogaz	430	5.85
		Ostchem	~429	1.905
2013	1	Naftogaz	406	2.95
		Ostchem	~428	4.0
	2	Naftogaz	421	1.05
		Ostchem	~430	1.7
	3	Naftogaz	401,5	NA
		Ostchem	NA	NA

Source: Naftogaz, State Statistics Service of Ukraine

Annex 2

Procedure to determine the price of Russian gas for Ukraine under the Contract of 2009

The Contract specifies that price of gas with the lower calorific power of 8050 kcal per cm for Ukraine is determined on the quarterly basis in accordance with the following formula:

$$P_n = P_0 \times \left(0.5 \times \frac{G}{G_0} + 0.5 \times \frac{M}{M_0}\right) \times k,$$

where P_n is the contract price of gas for Ukraine in $per 000 cm of gas;

The contract price is determined as of January 1st, April 1st, July 1st, and October 1st each year of supply and is valid though the corresponding quarter of the year. For the first quarter of Q1 2009 the price was specified in the contract at the level of $360 per 000 cm of gas.

P_0 is the base price of $450 per 000 cm of gas. It was stated that $450 is the average price of the long-term gas contracts of Gazprom with European countries.

G_0 is a parameter numerically equal to the arithmetic mean of gasoil 0.1 prices in $per metric tonne for the base period of April-December 2008. Prices were taken from Platt's Oilgram Price Report. In particular, from the Chapter "European monthly averages" Cargoes FOB Med. Basis Italy. These prices are arithmetic means of the highest and the lowest quotations accurate to two decimal places; G_0 is equal to $935.74 per metric tonne.

M_0 is a parameter numerically equal to the arithmetic mean of prices of fuel oil containing 1% of sulfur in $per metric tonne for the base period of April-December 2008. Prices were taken from Platt's Oilgram Price Report. In particular, from the Chapter "European monthly averages" Cargoes FOB Med. Basis Italy. These prices are arithmetic means of the highest and the lowest quotations accurate to two decimal places; M_0 is equal to $520.93 per metric tonne.

G is a parameter numerically equal to the arithmetic mean of monthly gasoil 0.1 prices in $per metric tonne for 9 months determined as following: to calculate the price for January 1st – April-December of the previous year; to calculate the price for April 1st – July of the previous year-March of the year of supply; to calculate the price for July 1st – October of the previous year-June of the year of supply; and to calculate the price for October 1st – January-September of the year of supply. Gasoil prices to be taken from Platt's Oilgram Price Report. In particular, from the Chapter "European monthly averages" Cargoes FOB Med. Basis Italy. These prices are arithmetic means of the highest and the lowest quotations accurate to two decimal places.

M is a parameter numerically equal to the arithmetic mean of monthly prices of fuel oil containing 1% of sulfur in $per metric tonne for 9 months determined as following: to calculate the price for January 1st – April-December of the previous year; to calculate the price for April 1st – July of the previous year-March of the year of supply; to calculate the price for July 1st – October of the previous year-June of the year of supply; and to calculate the price for October 1st – January-September of the year of supply. Gasoil prices to be taken from Platt's Oilgram Price Report. In particular, from the Chapter "European monthly averages" Cargoes FOB Med. Basis Italy. These prices are arithmetic means of the highest and the lowest quotations accurate to two decimal places.

k is a coefficient, equal to 0.8 in 2009 and 1 later on.

All the preliminary calculations should be executed with the accuracy to six decimal places inclusively, while the contract price is determined with the accuracy to two decimal places.

In case the actual lower calorific power of the supplied gas is different from the mentioned 8050 kcal per cm, the contract prices is corrected in accordance with the formula:

$$P_x = P_n \times \frac{Q_{act}}{8050}$$

where P_x is the actual price of gas, P_n is the contract price of gas, and Q_{act} is the arithmetic mean of monthly lower calorific power of the supplied gas.

In case Ukraine withdraws gas in amounts exceeding those specified in the Contract 2009 by more than 6% of a monthly supply without notifying Gazprom, the price of such gas is calculated by multiplying the contract price by 1.5, if the mentioned withdrawal took place in April-September, and by multiplying the contract price by 3, if the mentioned withdrawal took place in October-March.

Annex 3

Companies Extracting Natural Gas in Ukraine and Volumes of Extraction, million cm

	2007	2008	2009	2010	2011
Total	20769.3	21016.2	21182.2	20049.3	20143.3
NJSC Naftogaz	19224.6	19209.9	19346.4	18328.6	18112.2
SC Ukrgazvydobuvannia	14726.7	14832.7	15234.1	14832.9	14909.5
PJSC Ukrnafta	3237.9	3165.8	2947.2	2445.2	2146.6
PJSC ChornomorNaftogaz	1260.0	1211.4	1165.1	1050.5	1056.1
Other companies	1544.7	1806.3	1835.8	1720.7	2031.1
JV Poltava Petroleum Company	436.6	439.3	456.8	414.1	395.5
JV UkrKarpatOil Ltd	4.0	2.0	1.8	19.2	31.2
JV Kolomyia Petroleum Company Delta	18.9	14.6	12.0	8.0	7.3
Closed JSC Ukrnaftoburinnia	0.0	0.0	0.0	79.1	126.2
Closed JSC Plast	33.2	45.2	41.3	39.0	39.6
JV Boryslavska Oil Company	10.5	10.9	9.9	11.4	12.1
PARI LLC	0.0	0.0	0.0	8.8	13.2
Maryanivske LLC	25.1	29.4	25.7	14.9	8.2
Private JSC Naftogazvydobuvannia	362.5	539.4	823.5	637.5	773.2
Private JSC TISAGAS	12.1	10.5	5.2	3.4	3.4
Cube-Gas LLC	122.2	86.9	67.4	57.6	88.2
Closed JSC Natural Resources	101.1	138.1	128.5	165.1	252.3
Prom-Energo Product LLC	0.0	16.7	15.6	14.7	15.7
Krymtopenergoservice LLC	0.1	0.1	0.1	0.1	0.1
Eastern Geological Union LLC	36.6	39.2	27.4	18.5	17.6
Esko-North LLC	5.8	11.4	19.2	95.1	160.4
JV Kashtan Petroleum Ltd	2.2	2.9	2.5	1.6	0.8
Division of Regal Petroleum	47.3	38.2	62.9	84.9	35.9
NJSC Nadra Ukrayny	326.5	381.6	136.3	47.8	45.8
Nadragas LLC	0.0	0.0	0.0	0.0	4.3

Source: Baker Tilly

Annex 4

Natural gas tariffs for population under the Decree of NERCU No. 812 of July 13th, 2010

Category	Tariff, including the VAT, per 000 cm			
	In case the gas consumption meter is installed		In case the gas consumption meter is nat installed	
	UAH	USD	UAH	USD
Volume of gas consumptions is not higher than 2,500 cm per year	725.4	88.46	798.0	97.32
Volume of gas consumptions is not higher than 6,000 cm per year	1,098.0	133.9	1,207.8	147.29
Volume of gas consumptions is not higher than 12,000 cm per year	2,248.2	274.17	2,473.2	301.61
Volume of gas consumptions is higher than 12,000 cm per year	2,685.6	327.51	2,954.1	360.26

Source: National Electricity Regulatory Commission of Ukraine

Annex 5

Imports of natural gas from Germany and Austria though Poland and Hungary

Period	Country of supply	Volume, million cm	Price, $per 000 cm
November 2012	Poland	28	425
December 2012	Poland	29	407.5
January 2013	Poland	43.5	390
February 2013	Poland	50.3	390
March 2013	Poland	29.66	390
April 2013	Poland	102	388.6
	Hungary	18	393.9
May 2013	Poland	129	388.6
	Hungary	18	385
June 2013	Poland	124.9	407.87
	Hungary	137.8	
July 2013	Poland	269.6	406.56
	Hungary		
August 2013	Poland	113.03	393.5
	Hungary	131.170	
September 2013	Poland	105.016	397.3
	Hungary	238.184	

Source: Naftogaz, State Statistics Service of Ukraine

Annex 6

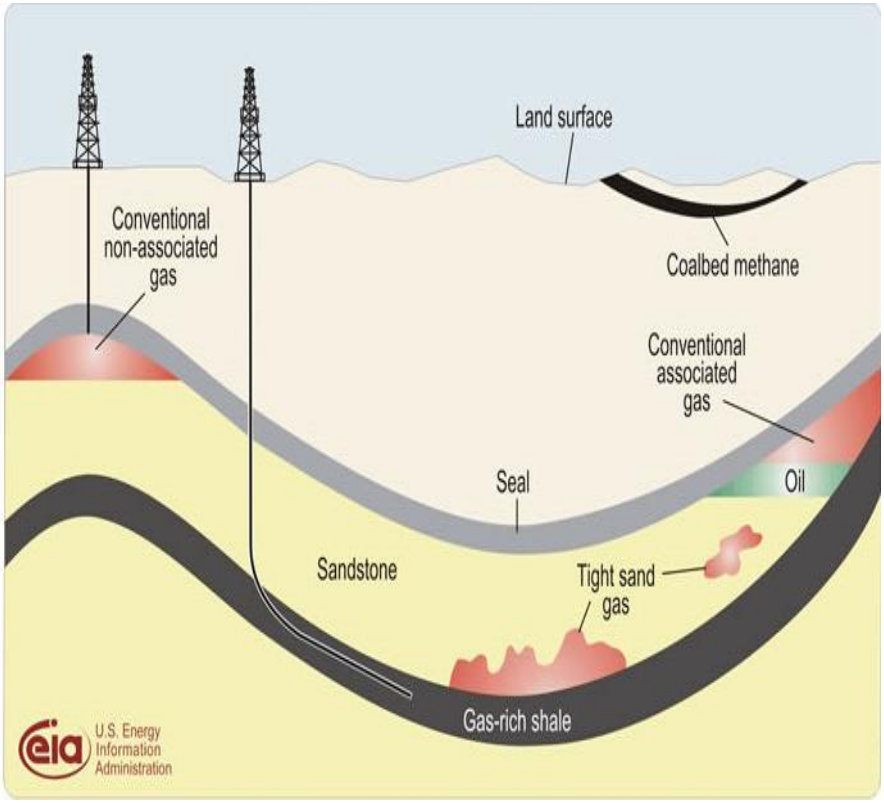
LNG trade volume between countries in 2010-2012, million tons

	Algeria	Egypt	Eq. Guinea	Nigeria	Norway	Peru	Trinidad	Qatar	US	Reexports received	Reexports loaded	Total
2010												
Belgium		0.13		0.06	0.06	0.08	0.06	4.51			-0.39	**4.51**
France	4.68	0.46		2.82	0.33		0.24	1.77				**10.35**
Greece	0.71	0.06	0.06				0.06	0.03				**0.92**
Italy	1.2	0.44	0.06		0.12		0.24	4.56				**6.63**
Netherlands												
Portugal				2.06			0.13	0.06				**2.25**
Spain	3.54	2.1		5.71	1.33	0.49	2.5	4.2	0.09			**20.52**
Turkey	2.78	0.19		1.08	0.12		0.18	1.46				**5.87**
UK	0.95	0.12		0.31	0.7		1.29	10.57	0.14			**14.28**
Total	13.86	3.59	0.12	12.04	2.66	0.57	4.7	27.16	0.23		-0.39	**64.93**
2011												
Belgium	0.06			0.06			0.06	4.59			-0.52	
France	4.23	0.65		2.66	0.39		0.3	2.38				
Greece	0.72	0.06		0.06				0.12				
Italy	1.16	0.38			0.12		0.12	4.48				
Netherlands	0.06			0.05	0.06		0.06	0.27				
Portugal	0.06	0.06		1.91	0.06			0.12				
Spain	2.94	1.73		4.74	0.93	1.43	1.87	3.52	0.12		-0.55	
Turkey	2.96	0.26		0.92				0.43				
UK	0.18	0.06		0.88	0.26		0.42	16.15	0.13			
Total	12.37	3.2		11.28	1.82	1.43	2.83	32.06	0.25		-1.07	64.17
2012												
Belgium								3.15			-1.24	1.91
France	3.15	0.69		2.25	0.2			1.35			-0.16	7.48
Greece	0.56	0.12	0.06	0.06	0.2					0.07		1.07
Italy	0.72	0.12			0.06			4.24		0.08		5.23
Netherlands	0.06			0.05	0.44		0.06					0.61
Portugal		0.13		1.25			0.06	0.18		0.09	-0.05	1.66
Spain	2.66	0.48		3.93	1.22	1.94	1.81	2.98		0.51	-1.31	14.22
Turkey	3.1	0.39		1.05	0.12			0.92		0.16		5.74
UK	0.06	0.06		0.13				10.21				10.45
Total	10.3	1.99	0.06	8.72	2.24	1.94	1.93	23.02		0.92	-2.76	48.43

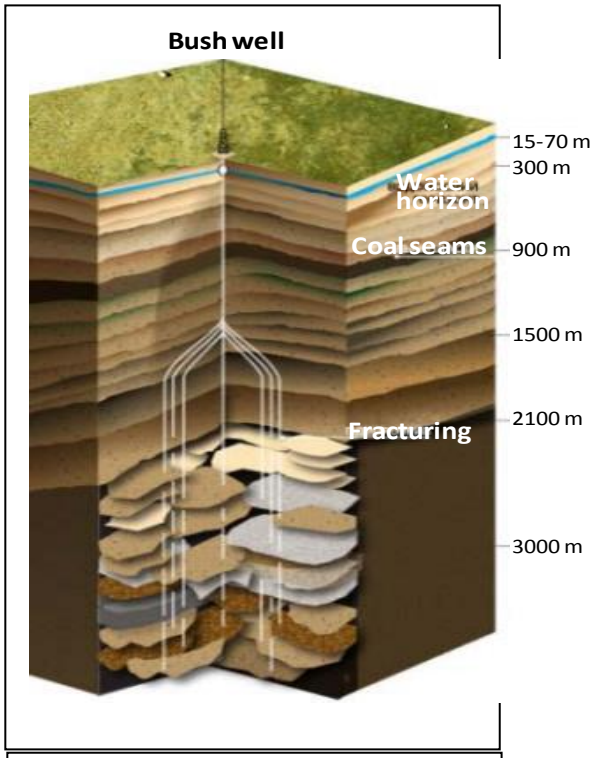
Source: International Gas Union

Annex 7

Schematic Geology of Natural Gas Resources and Hydraulic Fracturing



Source: EIA



Source: Royal Dutch Shell Plc in Rudko, G. and Lovyniukov, V.I., 2013. 'State Classification of Mineral Resources and Reserves of Ukraine as an Evaluation Instrument of Investment Proposals on Energy Resources.' Black Sea and Caspian Sea Energy Conference

Annex 8

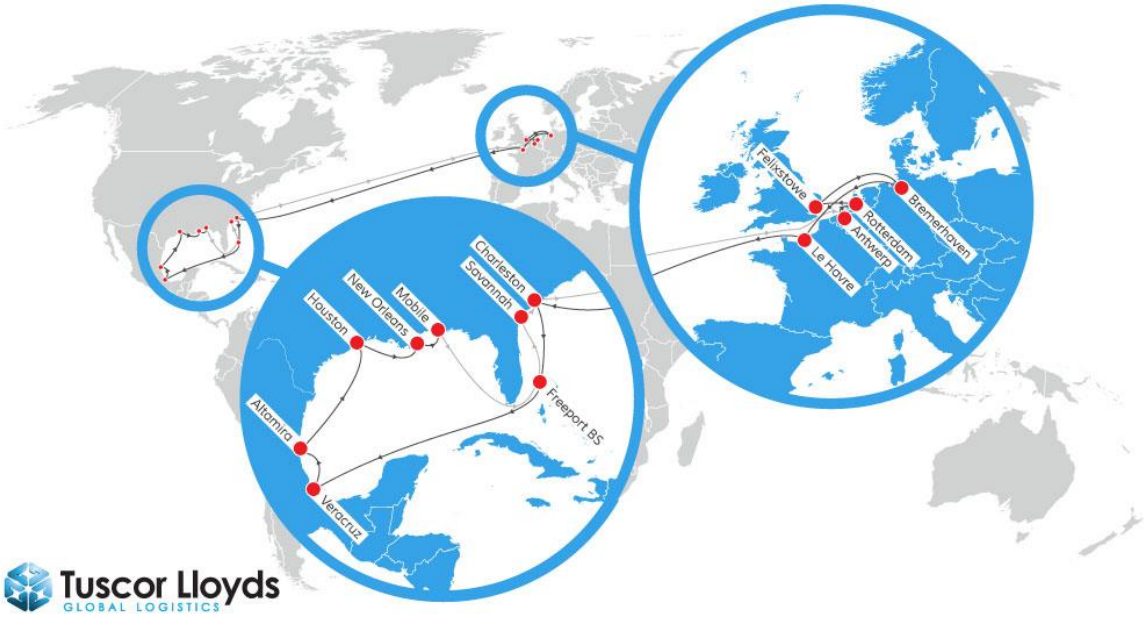
Comparative Analysis of Conventional Natural Gas and Shale Gas Extraction

	Conventional Gas	Shale Gas
Vertical wellbore	Yes	Yes
Horizontal section	Rare	Always
Hydraulic fracturing	Rare, as one of the methods to enhance production	Always
Possibility of well preservation	Yes	No
Well cost ($ per linear m)	1500	3300
Gas quality	Close to standardized. Can be supplied into a unified system after little processing	Requires significant processing
Estimated production cost (excl. taxes, rent payments, investments), $ per thsd. cm	30-60	100-150
Average drilling depth	700 - 4000	2500 - 5000
Estimated number of wells per field	From 3 to several dozens	From 100 to several thousands
Flow dynamics	Uniform flow for the first 2-3 years with a gradual decay over 5-10 years	80%-90% during the first year after fracturing and a sharp decline thereafter

Source: Apostolaka Sergei, 2013. "Costly Shales." Forbes.us **(http://forbes.ua/opinions/1359259-dorogie-slancy)**

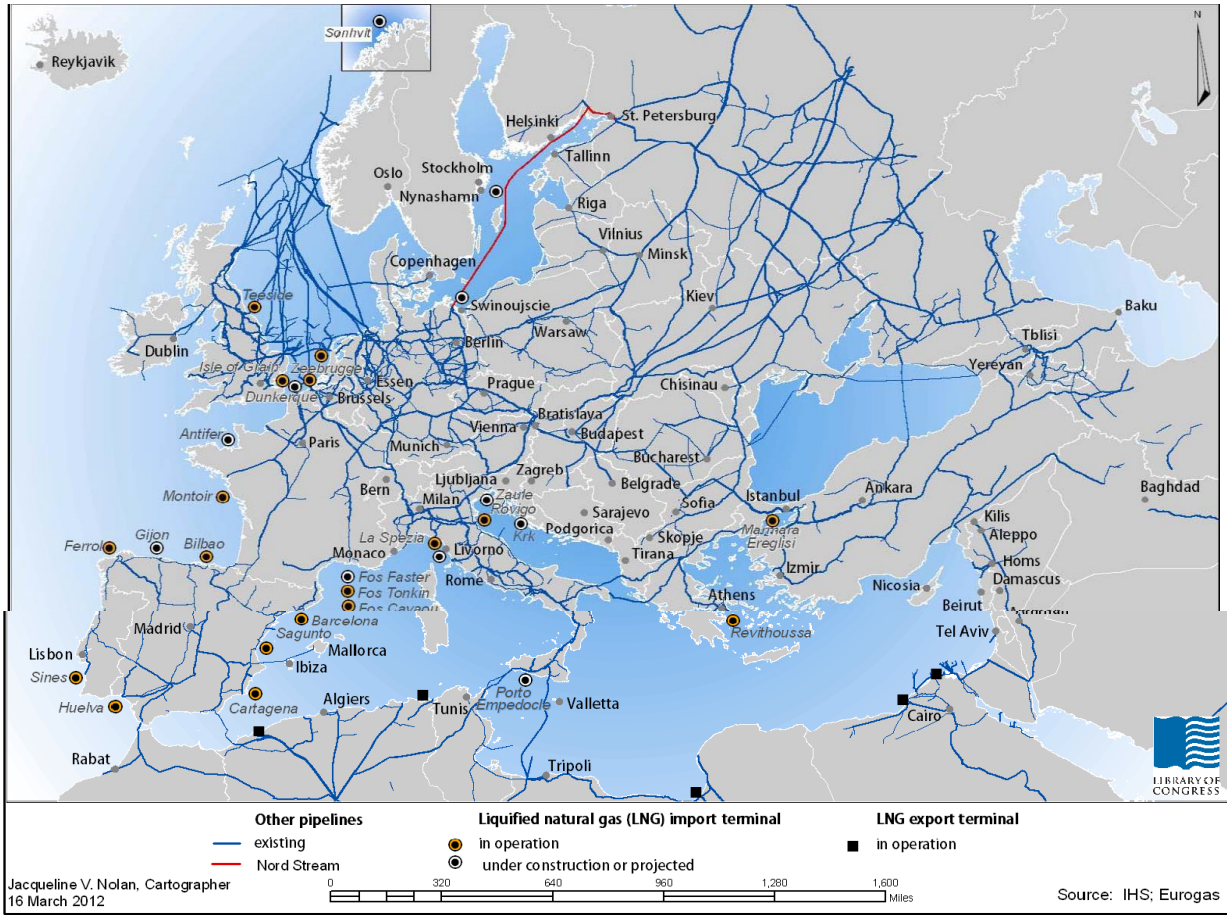
Annex 9

Basic maritime route from Gulf of Mexico to Europe



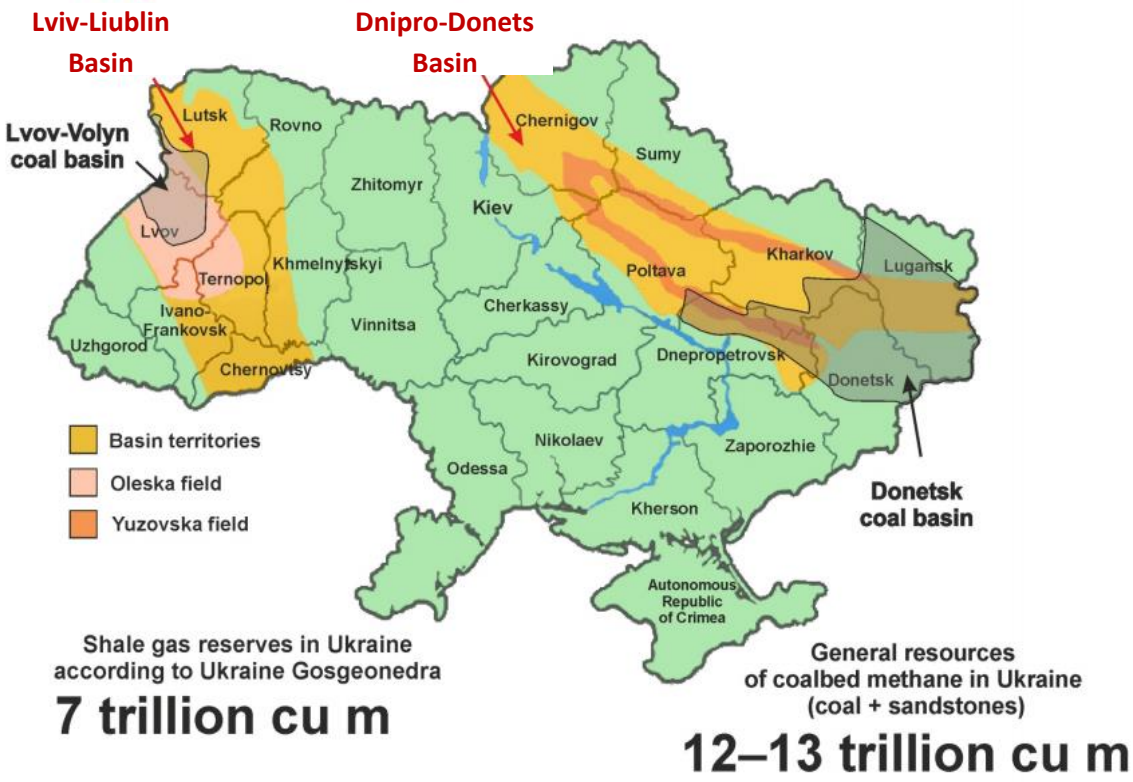
Annex 10

Map of existing gas pipeline networks in Europe



Annex 11

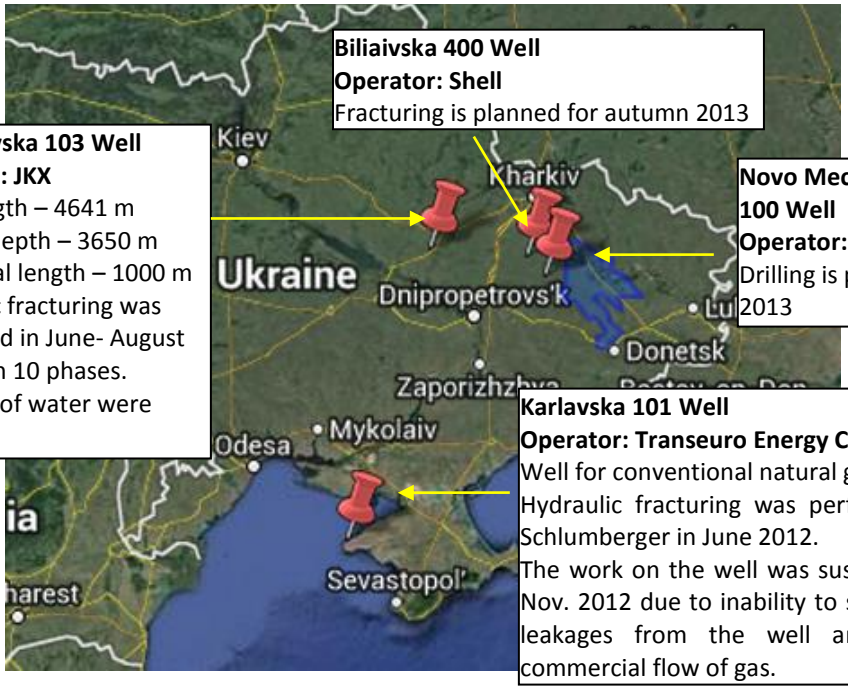
Shale Gas Basins in Ukraine



Source: Rudko, G. and Lovyniukov, V.I., 2013. 'State Classification of Mineral Resources and Reserves of Ukraine as an Evaluation Instrument of Investment Proposals on Energy Resources.' Black Sea and Caspian Sea Energy Conference

Annex 12

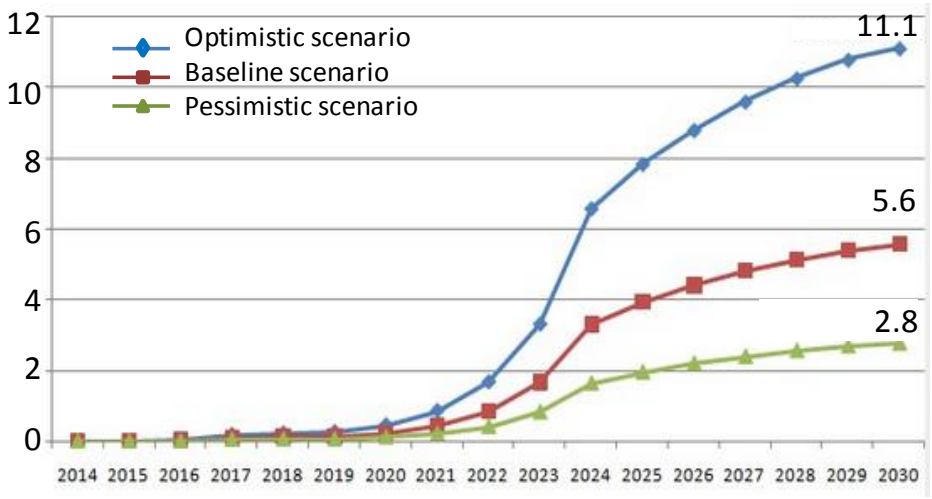
The Map of Wells in Ukraine with Planned or Carried Out Hydraulic Fracturing



Source: Shale Gas Project in Ukraine

Annex 13

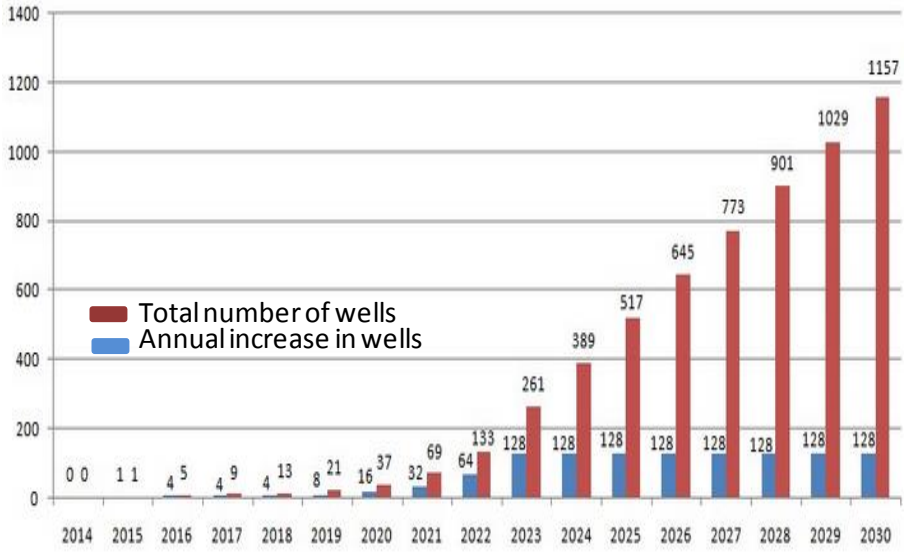
Olesska Field Shale Gas Production Forecast



Note: To reach specified production volumes about 1000 wells should be drilled and around 200 well pads with the area from 1 to 3 ha each should be constructed. Commercial shale gas extraction is expected to commence in 2019. It is assumed that each well is exploited for 7 years, producing from 22 to 88 million cm of gas. About half of all shale gas produced by each well will be extracted during the first year of its operation with declining production rate thereafter, which will constitute only about 10% of initial production at the end of 7th year.

Source: Shale Gas Project in Ukraine

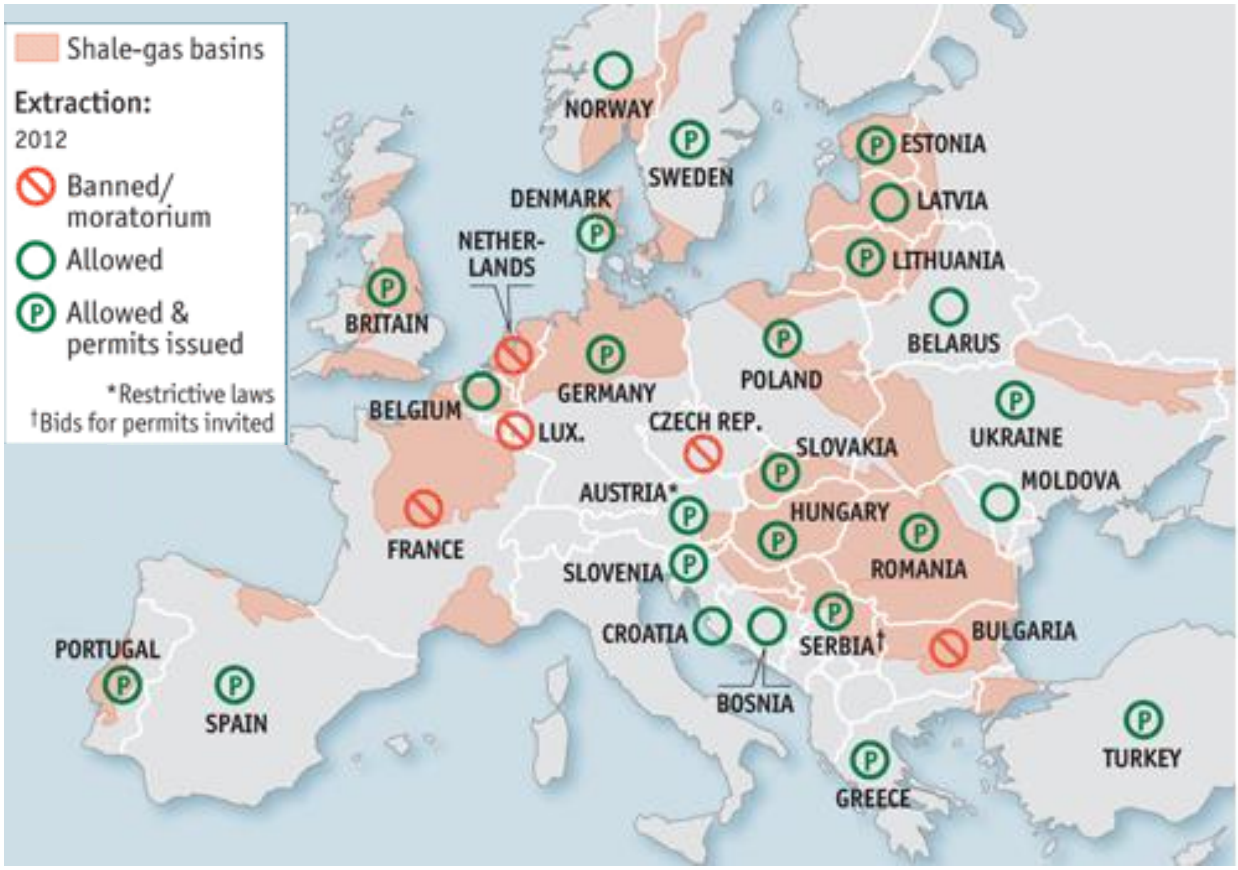
Projected Number of Wells at Olesska field



Source: Shale Gas Project in Ukraine

Annex 14

Shale gas industry in Europe



Source: The Economist

Annex 15

Current activities on offshore natrual gas extraction in Ukraine

Black Sea Area		Prikerchenska	New Skifska	Pallas	Foros
Area, km2		12960	16700	16200	13600
Depth, m		300-2000	300-2000	450-850	n/a
Potential annual extraction rate	Oil, million t	4.0			
	Natural gas, billion cm	4.5	8-10	2-3	2-3
Potential reserves	Natural gas, billion cm	n/a	200-250	75-160	n/a
Required investment	Exploration	$1 billion (first 8 years) with min $330 million in the first 3 years	$400 million	n/a	$8-10 billion
	Extraction	$15 billion	$10-12 billion		
Company/ies		Vanco Prykerchenska (50% is owned by Akhmetov's DTEK, which controls the enterprise*)	Consortium: Exxon Mobil (40%, the operator), Shell (35%), OMV (Petrom**) – 15% , NJSC Nadra Ukrayny (10%)	NJSC Naftogaz through Chornomor-Naftogaz	n/a (a tender is expected at the end of 2013)

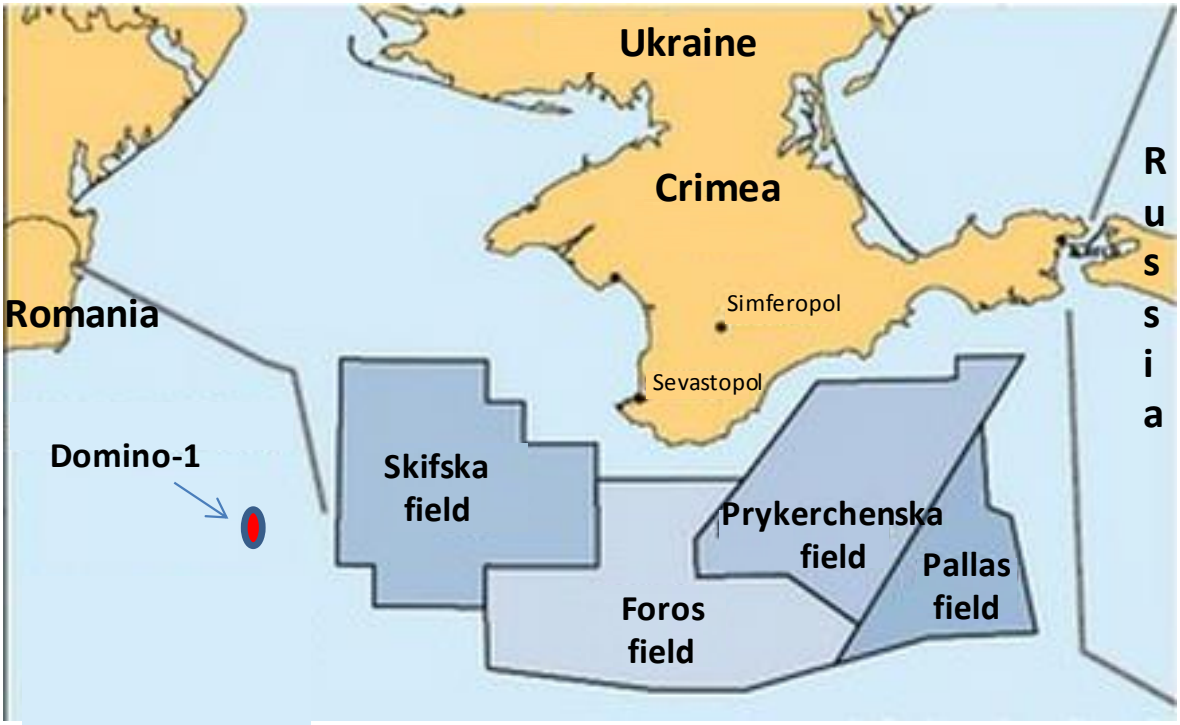
** Other owners may include Vanco International Ltd, Shadowlight Investments Ltd (associated with Russian businessman Novitskyi) and Integrum Technologies Ltd*

*** Petrom is Romanian subsidiardy of OMV*

Source: Shale Gas Project in Ukraine, Ministry of Ukraine of Environment and Natural Resources, president.gov.ua, Ukrainian mass media

Annex 16

Ukraine's Natural Gas Areas in the Black Sea



Source: KyivPost

Annex 17

Prospective LNG Terminal Locations

Source: InvestUkraine

Annex 18

Potential Routes of LNG Supplies

Source: InvestUkraine

Annex 19

LNG Production and Trade in Select Countries of Potential Interest to Ukraine, 2012

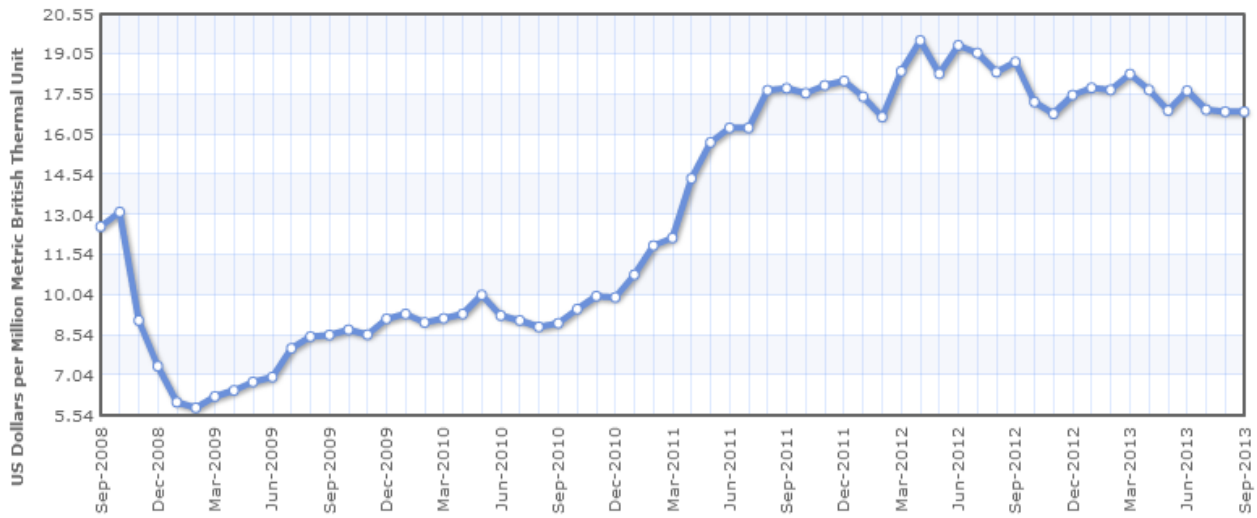
	Algeria	Egypt	Nigeria	Qatar	UAE
Proved natural gas reserves, trillion cm*	4.5	2.0	5.2	25.1	6.1
Natural gas production, billion cm, 2012	81.5	60.9	43.2	157	51.7
LNG exports, billion cm	15.3	6.7	27.2	105	7.6
Main destination countries	France, Turkey, Spain	Japan, India, S. Korea, France, Spain	Japan, Spain, France, S. Korea	UK, Italy, Belgium, Spain	Japan
Distance from Ukraine, km	4200	2200	14000	7800	7900

** As of end-2012*

Source: BP, 2013. 'Statistical Review'.

Annex 20

Evolution of Liquefied Natural Gas Monthly Price (cif Japan), US$/mmBtu



Source: IndexMundi base on World Bank data