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Non-Conventional Gas Regulation in Europe: Implications for Ukraine

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Non-conventional gas Regulation in Europe: Implications for Ukraine

Executive Summary

Non-conventional gas may become a significant part of national energy supply in Ukraine in the next decades. Thereby, this type of resource can be applied as complement to national conventional natural gas and may be used as a substitute in the long run.

The utilisation of given non-conventional potentials in Ukraine requires elaborating a long-term strategy, which takes into account the economic and technical challenges and the extensive environmental hazards. A clear regulatory framework is necessary for the attraction of investments, for creating public acceptance, and for an economical use of natural finite resources.

We revise the EU progress regarding non-conventional gas regulation, and introduce the existing regulatory framework in the EU27 and in the Member States since they might be useful for Ukraine.

In view of the European development it emerges that regulations are necessary regarding (1) mining, (2) property rights, (3) fresh water use, (4) habitat and biodiversity hazards, and (5) waste management.

Whether non-conventional gas will play the predicted dominant role in European and Ukrainian energy supplies will mainly be influenced by the development of gas prices and the technical progress in non-conventional gas production, which reduces costs.

The further European demand on natural gas (conventional and possibly non-conventional) will influence the technical progress of mining, the amount of firms in the sector, and thereby gas prices. Obviously, the European overall gas demand resp. the share of natural gas in the energy mix (as discussed in section 3) will have a major impact on how much non-conventional gas will be demanded. This gas demand also depends on further steps regarding European climate targets, global energy price development, cost of drilling and several environmental issues regarding non-conventional gas. Furthermore, the uncertainties related to nuclear power plants' safety represent a major challenge for the European energy resp. electricity strategy.

Environmental hazards are one major obstacle in the development of non-conventional production in Europe. Public acceptance is mainly influenced by concerns about water pollution and habitat destruction. Strict environmental rules for non-conventional production in Ukraine can help to reduce risks and to ensure public acceptance, which has a positive impact on investors' reputation and thereby investors' decisions.

Summarizing, we recommend the following Ukrainian policies on non-conventional gas:

(1) Observe the international progresses and learn from successes and failures, (2) Perform a fundamental investigation of national reserves, (3) Develop the basis of a regulatory frame for exploration and production of non-conventional gas resp. clarify if existing regulations on conventional gas is applicable for non-conventional gas production, (4) Improve the legislative framework for foreign investments attraction to non-conventional sector for participation in knowledge and technology transfer, (5) Establish the legislative framework for public participation process.

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Contents

1 Introduction

Non-conventional gas resources may play an essential role in Ukrainian energy policy in the next decades. The exact amount of economical extractable reserves is unknown. It is undisputed that the development of exploration and following production of non-conventional gas in Ukraine will need further time and will not take place before 2020. The development of a stringent legal frame for a contemporary exploration today will establish the basis for an efficient and accepted use of the given opportunity in the future.

After witnessing a non-conventional gas boom in the United States, a use of this resource for stabilising European decreasing production of conventional natural gas is in discussion for several years. Currently, neither a progress in exploration is visible nor a production in Europe. However, non-conventional gas emerges as a new opportunity for European primary energy supply. How this opportunity will be used is vague today.

We will give an overview on the current discussion and the (weak) legal basis in the EU27 and in some Member States, and we will highlight in chapter 2 why the development of non-conventional gas production lies behind the progress of the United States.

Ukraine may benefit from two possible developments: (1) Non-conventional gas can be used for own national energy consumption and may reduce import dependency. (2) The EU27 may become a market for Ukrainian non-conventional gas.

It is uncertain today, which development will take place and the future of non-conventional gas will be influenced mainly by the development of the global gas market and gas price and European gas demand. Therefore, we will give an overview of actual demand scenarios for the EU27 in chapter 3.

Furthermore, in chapter 4 an overview of the need for environmental regulation regarding the exploration and production of non-conventional gas is given. Moreover, we will highlight the environmental concern on this technic and we will highlight how existing regulations in the EU27 is applicable on non-conventional gas production.

In chapter 5 we make some recommendations how Ukraine may develop the regulation basis for the use of non-conventional gas resources.

2 Non-conventional gas in the EU27 and in the Member States

2.1 Energy Policy and the legal basis for non-conventional gas

Energy policy is one major topic in the EU27; however, a consistent and common approach is only visible in the overall targets. The legal basis of European energy policy is set by §194 of the "Lisbon Treaty". The members of the European Union agree on common objectives such as ensuring the functioning of the energy market and the security of supply, a promotion of energy efficiency and on common activities for promoting an interconnected energy networks, while every Member State retains the right to determine the conditions for exploiting its own energy resources, its choice between different energy sources, and the general structure of its energy supply.

The "Lisbon Treaty" – just as no further agreement – does not define how and to what extent the member-countries have to sue their energy resources. Rather, the "European Climate and Energy Package" – agreed in 2008 – obligates EU27 Member States to reduce overall GHG emission (European wide by 20% until 2020) and to increase the renewable consumption share in the energy balance (European wide up to 20%); furthermore, it has the target to reduce energy use by 20%. These targets may influence mid-term energy strategies of the Member States and affect national energy policy.

The „Strategic Energy Technology Plan" includes a roadmap for the renewable sector, the sector of nuclear industry, carbon capture and storage and further targets on e.g. grid connection. The plan does not include strategies and information on European targets regarding the sector of non-conventional gases.

On 10th of November 2010, the European Commission adopted "A strategy for competitive, sustainable and secure energy", which sets the frame for internal European energy policy until 2020. The adapted new version of the former strategy 2007 focuses mainly on the same points: (1) Achieving an energy efficient Europe, (2) Building a truly pan-European integrated energy market, (3) Empowering consumers and achieving the highest level of safety and security, (4) Extending Europe's leadership in energy technology and innovation and (5) Strengthening the external dimension of the EU energy market (EU 2011).

While the overall targets in European energy strategy have not been changed, the need for an European non-conventional gas policy is mentioned: "The potential for further development of EU indigenous fossil fuel resources, including unconventional gas, exists and the role they will play must be assessed in all objectivity" (EU 2011, pg. 5). The European Council, which took place on 4th February 2011, confirmed this need (EU Council, #7, pg.2).

A public participation process further accompanied the work on the 2010 Energy strategy. As one result of this process, it was pointed out that "The potential for additional unconventional gas reserves in the EU is still to be fully assessed but should be kept in mind" (EU 2010, pg. 8).

Regarding exploration activities, "Directive 94/22/EC" of the European Parliament and of the Council (1994) (on the conditions for granting and using authorizations for the prospection, exploration and production of hydrocarbons) sets the frame on European level for exploration and production of hydrocarbons. Directive 94/22/EC, which does not include separate regulatory framework on non-conventional resources, defines that the EU27 Member States "retain the right to determine the areas within their respective territories to be made available for the exercise of the activities of prospecting, exploring for and producing hydrocarbons" (EU 1994). The directive further includes the provisions, which defines conditions „under which the authorizations shall be granted" (EU 1994). Thereby, the regulatory rights and its execution remain to a large extent by the Member States.

As result follows that on EU27 level currently neither strategy nor regulation on non-conventional gases exist. "The laws and regulations covering oil and gas exploration and

development in Western Europe are underdeveloped in terms of managing unconventional gas; so much so that current regulations do not even make reference to these types of resources." (Petersen)

2.2 Non-conventional gas deposits in Europe

Non-conventional gases (shale, tight gas and coal bed methane (CBM)) are distributed across Europe. Shale gas is represented in three major geological plays (see Gény, pg. 48): (1) Lower Paleozoic play (from Eastern Denmark and Southern Sweden to Northern and Eastern Poland), (2) Carboniferous marine basin (North West England, Netherlands and North West Germany to South Poland) and (3) Lower Jurassic bituminous shales (South England, Paris Basin, Netherlands, Northern Germany and Switzerland).

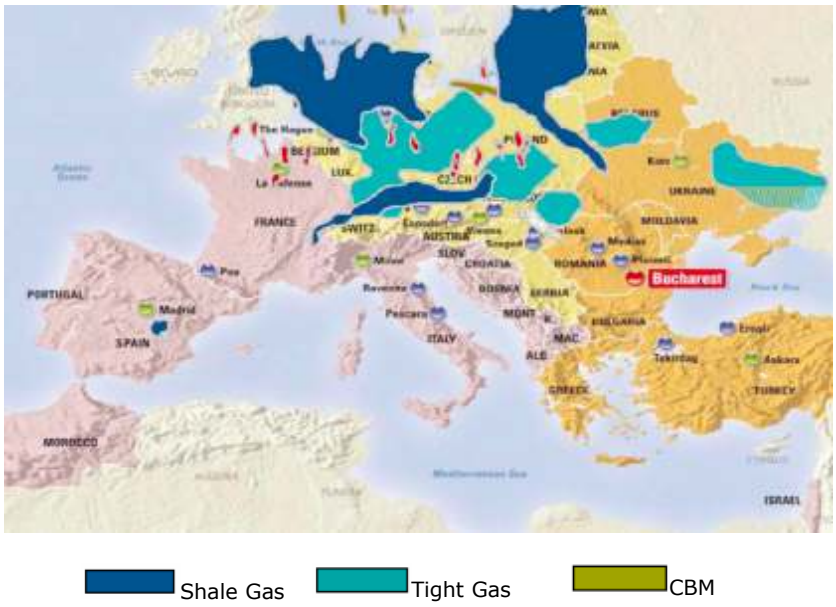
The range of estimates is considerable. "Advanced Resource International" expects the amount of recoverable non-conventional gas resources with 5,600 bcm, while Wood Mackenzie estimates 4,200 bcm (Geny, pg. 8).

Further, Wood Mackenzie (2006) gives estimations for CBM and tight sands (which includes tight gas and shale gas) as recoverable resources for European countries (Gény pg. 50). (For an overview on the distribution of non-conventional resources in Europe see Figure 1.)

With 1,404 bcm (approx. 324 bcm CBM and 1,080 bcm tight and shale gas) Ukraine has the largest recoverable resources, followed by Poland (1,350 bcm) and Hungary (800 bcm). Estimations are built on the knowledge of geological structures, reserves on coal, natural gas and oil and comparisons of the structures with proved US reserves. However, none of them is confirmed, yet.

Figure 1

Non-conventional gas deposits in Europe



Source: Korn A., Prospects for unconventional gas in Europe, Eon, 2010

Differing from above figures, US Energy Information Administration (EIA) (2011a) estimates the (technical) recoverable shale gas deposits in Europe with 17,800 bcm. Poland (5,200 bcm), France (5,040 bcm) and Norway (2,300 bcm) possess the largest shares of this amount in this analysis (EIA 2011a pg. 4).

The technical recoverable deposits only give a hint on the long-term potential of non-conventional resources. The prices on gas market and the costs of extraction will mainly influence the question how much of these deposits will be mined. While the production costs of new conventional natural gas resources range from $12 per th cubic meter to $150 per th cubic meter, the range of costs for non-conventional gases is between $65 and $220 per th cubic meter (IEA ETSAP Technology Brief P02, May 2010).

The amount of resources (in place, and technical and/or economic recoverable) differs in the literature. This is for two reasons: (1) All numbers were built on expectations and (2) the assumptions on what is technical and/or economic feasible may differ.

2.3 Status of non-conventional gas activities

Since 2007, triggered by the success of American non-conventional sector, an intensive phase of "land grabbing" has been starting in EU27. Licensing acreage is the first step in the process of further exploration and, after a successful identification of local recoverable resources, extraction of non-conventional gas. France and Poland had been licensed large acreages for some of around fifty companies, which are active in Europe (France approx. 60,000 sq km resp. Poland 55,000 sq km). Germany licensed approx. 20,000 sq km and the UK, Denmark and Netherlands approx. 10,000 sq km (Gény, pg. 54). The major companies of these fifty are Exxon Mobil, Shell, Total, ConocoPhillips and Chevron.

The development in the sector of non-conventional gas is currently less dynamic in the EU27 compared with the United States. An unclear positioning of European governments and the negative public discussion play a major role for this. Furthermore the cost differences for conventional and non-conventional gases prevent a strong economic pressure on an accelerated extension. Several further reasons for this development are discussed in the literature, whereas these reasons determine each other and overlap:

a) There is a heterogeneous legal basis of mining in Europe in difference to the United States, which makes it complicated for companies and local authorities to start explorations resp. allow them to do so. Differing from the US, where the landowner holds the sole property rights of mineral reserves, these rights of subsoil hydrocarbons are in the hand of the state in a number of European countries (e.g. Germany, France). In Europe, petroleum legislation has no mention of unconventional gas. For industry, it is up to now not clear at all, how they will be regulated and on what basis.

b) The European industry for exploration in this field is less developed (with regard to the amount of companies and their capacities) compared to the United States, which has a long history of non-conventional gases development.

c) Further, European environmental standards are less negotiable compared with the United States. Public awareness in this field is highly pronounced. A strong public awareness is taking place on regional and national level and will influence the development of non-conventional gas production.

d) Water is an essential production factor for the non-conventional gas industry. The access to water is – differing from the United States – constrained in many parts of Europe (e.g. in Central Europe where largest shale gas resources are expected) (Stevens P. and C. Chatham).

e) Stevens and Chatham regarding Europe see the population density as one problem of acceptance for the mining of non-conventional gas. Comparing with the United States, with a density of 27 people per sq km, the population density in England is

approx. 383, in Germany approx. 230, in France approx. 100 and in the Netherlands approx. 400. On the other hand, Gény argue that the population density in Barnett shale basin (Texas, USA) is much higher than these 27 people per sq in average. The main challenge that is essential for the public acceptance of drilling is astringent security regulation for high-populated areas.

f) The non-conventional gas plays in Europe are varying in their deposits. European plays are smaller and more complex and they are heterogeneous within. An economical extraction from such plays is uncertain and increases the costs.

While a uniform European-wide policy regarding non-conventional gases is not visible, national activities and efforts differ. This is reflected by different exploitation activities and the speed projects are launched.

2.3.1 Poland

The activities regarding non-conventional gases in EU27 are most advanced in Poland[1]. This results from following main reasons: Poland's expected recoverable reserves on non-conventional gas – mainly tight and shale gas – are estimated with 1.5 to 3 trillion cm, but are currently unknown (Rumiński). Further, Poland is strongly dependent on Russian gas deliveries - around 70% (Mott MacDonald) in imports. Non-conventional gases are one option to decrease this dependency and would allow Poland to reduce the use of own CO_2 intensive coal reserves.

As shown above, Poland´s activities regarding licensing acreage for exploration goes further than in most EU27 Member States. Poland will be the test case for the development of non-conventional gas in Europe and will become important for the further process. However, for enriching the stage of commercialization of Polish shale gas, Slutz estimates a need for 7 to 10 years of further development. Rumiński estimates that in 2015 284 drills are planned to be done (84 for sure and 200 optionally).

As announced by the Polish Environment Ministry, 11 concessions were issued for preliminary exploration of non-conventional gases at the end of 2010. Further, 68 licenses were issued for conventional and non-conventional resources (International Law Office). Up to 2010, Slutz mentioned around 70 licenses, which had been issued.

The legal basis of exploration and exploitation of non-conventional gases is not explicitly defined in Poland and so it doesn't differ from the legal framework for conventional hydrocarbons or other underground natural resources (International Law Office).

Slutz indicates four main relevant legal regulations for licensing exploration and exploitation:

Act on Freedom of Economic Activity, which sets the overall framework for entrepreneur's activities in the Republic of Poland and defines that foreign entrepreneurs (from EU and EFTA) "undertake and carry on economic activities on the same terms as Polish entrepreneurs" (Act on Freedom of Economic Activity Art. 13).

Act on Environmental Protection, whereby Poland adopted the European environmental directives.

Geological and Mining Law, which sets the overall frame for mining activities, but without a concrete reference to non-conventional gas.

Environment Information Act, which defines that "everyone shall have the right to be informed of the quality of the environment and its protection (...) (Art. 74.3), that everybody has the right to obtain information on the activities of organs of public authority (Art. 61) and that a free access to documents regarding environment information has to be guaranteed" (Jendrośka 4, Art. 74/3). With this act, Poland implemented Directive 2003/4/EC on public access to environmental information of the European Parliament.

[1] For this reason, the Polish situation is described in more detail.

Some reasons – and mainly the same, which apply for the entire EU27 – are obstacles for the development of non-conventional gas extraction in Poland. Beside these (a) a lack of liberalisation and regulation of the energy market, (b) long-term and complex license acquirements, (c) lack of tax and financial incentives, and capital for exploration, (d) lack of drilling enterprises and trained personnel and (e) a lack of infrastructure represent the main barriers for the development of non-conventional gas in Poland (Rumiński, 2010).

2.3.2 The UK

Non-conventional gas activities in the UK (here especially shale gas) are currently confined on preliminary exploration of deposits with a view to further development (Wood et al., 2011). However, the national Department of Energy and Climate Change stated that a drilling and production would be started soon (Harrabin). According to the British Geological Survey (BGS), the potential of shale gas in the UK is approx. 150 bcm (Wood et al, pg. 34).

British CBM resources are estimated up to 2,900 bcm, whereby this amount is not economically usable. "If 10% of the UK CBM resource potential could be developed, the produced 290 bcm would correspond to over three years of the UK natural gas supply (annual UK natural gas consumption in 2009 was approximately 86 bcm)" (DECC, 2010). The amount of every non-conventional resource in the UK is not confirmed yet.

Wood stated several activities regarding exploration in the UK by the companies "Cuadrilla Resources", "Island Gas Limited" and "Composite Energy" for 2010 and 2011, which were authorized by the Department of Energy and Climate Change. Thereby, Cuadrilla Resources plans to start fracking operations at the first test shale gas well within the second quarter of 2011 (Platts).

Currently, the UK doesn't have specific grants for non-conventional gas exploration or production, neither the British tax regime grant special privileges nor tax treatments. "(…) but it is included in the value allowance for small fields if the size of the development qualifies. (…) Companies are able to offset their small fields costs against tax from these operations." (DECC 2010). This means that companies only pay taxes if they exceed specific amounts of gas production.

Non-conventional gas is discussed with "mixed feelings" in the public. A moratorium on fracking in the UK is demanded by environmental groups until newer scientific studies have been completed and environmental effects can be estimated (Platts).

Mainly the same reasons as in other European countries make the drilling and production of unconventional gases uncertain for the UK (see also DECC 2011 pg. 30). Besides, this licensing scheme is inefficient and licenses are given only for short term, "if the license's duration is just six years, for example, there is clearly not enough time to properly define, which areas should be relinquished and which could be converted into production." (ICIS Heren).

2.3.3 Other European Countries

Drilling activities are visible in several other European countries. One of the first was Hungary – which is according to Stevens P. and C. Chatham the only country in Europe with a formulated tax advantage for non-conventional gas. Exploration started here in 2009 in Mako Trough. The results were disappointing, since large amounts of water were found (Gény).

In Germany, the Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Institute of Geologic Science) is commissioned by the German Ministry of Economy and Technology to evaluate potentials of non-conventional gas resources in Germany. First exploration activities started in 2008, up to now, confirmed numbers are not available. In Germany, unconventional gas is regulated under coal mining legislation, a specific law for non-conventional fuels does not exist and is demanded by the industry. Environmental concerns are essential for the further development of explorations in Germany and France. "The

German government has been primarily criticised because environmental risks are not yet sufficiently explored, although Exxon Mobil has been carried out in five test wells and plans two more by the end of the year." (Natural Gas for Europe). The same critique was "formulated when Nicolas Sarkozy allowed test drilling in March 2010" (Natural Gas for Europe).

2.4 Conclusion

"Europe has little knowledge about the potential, quality, precise location, and location of sweet spots of its unconventional gas resources." (Gêny). A couple of factors would influence the possibility of an European non-conventional gas production, but as Member countries practice evidences non-burden regulation and political will to develop non-conventional gas play the core role.

We follow the assessment of Gény that a significant European production of non-conventional gas will not take place before 2020, whereas a start of production is assumed in 2015. Depending on the speed, the European countries will formulate a consistent regulatory framework, a peak of drilling activities may be visible around 2030. Thus, the European gas demand will be essentially stable around its current level or even increase. For the period after 2040, we expect that a decline of gas demand will reduce expensive European gas production and therefore non-conventional production due to European target of un-carbonisation of its energy use.

How serious such a development will be depends to an essential extent on the distribution and amount of present unknown non-conventional resources in Europe, their specific extraction costs and locality.

Further, the public acceptance of non-conventional gases will play a major role. This acceptance – for its parts – will be influenced by the legal basis, especially regarding environmental issues and the progress, which is possible in the drilling methods.

3 Demand forecast for gas in the EU

European gas demand will become one criterion for Ukrainian development of non-conventional gas extraction. As long as Europe is consuming natural gas in the same – or higher – amount than today, two effects become important for Ukraine: (1) Non-conventional gas production in the EU27 might accelerate and animate development of nonconventional technics in Ukraine and (2) the EU27 may become an export market for Ukrainian non-conventional gas in the long-run under the assumption of high gas prices. Therefore, a look on demand scenarios in the EU27 is the subject of interest for Ukraine.

3.1 The EU in context of global demand for gas

According to the International Energy Agency (IEA), growth of demand for natural gas will surpass the demand for other fossil fuels in long-term due to its more favourable environmental and practical attributes. According to three IEA scenarios[2], the natural gas will be the only fossil fuel around the globe for which **demand will be higher in 2035 than in 2008** in all scenarios. IEA *New Policies Scenario* predicts global demand for natural gas will reach 4.5 trillion cm in 2035 that is by 44% higher than in 2008 and an average rate of increase will be 1.4% per year. Global demand will be mainly driven by China's demand at an average rate of almost 6% per year while demand for gas in the EU will grow moderately (according to EIA (EIA 2011b) estimates gas demand will grow in OECD Europe by only

[2] *New Policies Scenario* that takes into account the policy commitments and plans to reduce greenhouse gas emissions; *Current Policies Scenario* in which no change in policies as of mid-2010 is assumed; and *450 Scenario* which sets out an energy pathway consistent with the 2°C goal through limitation of the concentration of greenhouse gases in the atmosphere to around 450 parts per million of CO_2 equivalent (ppm CO2-eq).

0.6% annually between 2007 and 2035). It is remarkable that around 35% of the global increase in gas production is forecasted to be derived from unconventional sources — shale gas, coalbed methane (CBM) and tight gas — in the United States and, increasingly, from other regions, notably Asia-Pacific (IEA).

Renewables and nuclear power are seen as the most efficient tools to decrease CO_2 emissions worldwide but require large amounts of state-driven investments. In the New Policies Scenario, government intervention in support of renewables (electricity from renewables and biofuels) increases from $57 billion in 2009 to $205 billion (in 2009 dollars) by 2035. The share of modern renewable energy sources, including sustainable hydro, wind, solar, geothermal, modern biomass and marine energy, in global primary energy use triples between 2008 and 2035 and their combined share in total primary energy demand increases from 7% to 14% (IEA World Energy Outlook 2010).

Recent economic crisis resulted in gas demand dropdown in the EU in 2009. According to EUROGAS, the EU gas demand dropped by 6.4% in 2009 in comparison with 2008. One of the main reasons for this was the slowdown in industrial sales, which represent more than one third of the EU gas consumption. Industrial consumers use natural gas mainly to generate process heat; any decline in industrial production, therefore, has a direct impact on gas demand in this sector. Key factors, which reduced gas sales to power plants, included the low demand for electricity and comparatively high gas prices during the first months of 2009 (EUROGAS). Meanwhile, economic recovery (1.8% GDP growth in 2010 in Eurozone), severe weather conditions in winter 2009/10 and switch to gas from other fuels for electric power generation resulted in gas demand growth in 2010 by 7.2% to 522 bcm.

The long-term demand for gas in Europe is expected to be influenced by the following factors: (1) CO_2 emissions policy or implied price for CO_2 emissions; (2) economic development of the EU in the long run and gas consumption by the residential consumers and industry (incl. power energy); (3) availability of pipeline gas substitute (e.g. LNG and non-conventional gas) might stimulate stronger demand for gas than projected, especially in power sector.

During the recent years, the energy policy of the EU has been shifted towards a greater focus on energy efficiency and renewables in the framework of more environmental friendly climate policy (EU 20/20/20 targets[3]). So, the forecast of gas demand in the EU-27 to large extent will depend on policy decisions and especially from climate policy goals. Given the last updates of the EU strategy, it's hardly visible which definite energy mix will have the priority in the long-term in electricity generation. Thus, it creates quite an uncertain situation for gas demand forecasting and it's currently not obvious whether Europe will support more fossils fuels combustion plus carbon capturing scheme (CCS) or nuclear energy, or renewables etc. The only policy restriction that applied for generation now is reduction of coal combustion without use of CCS.

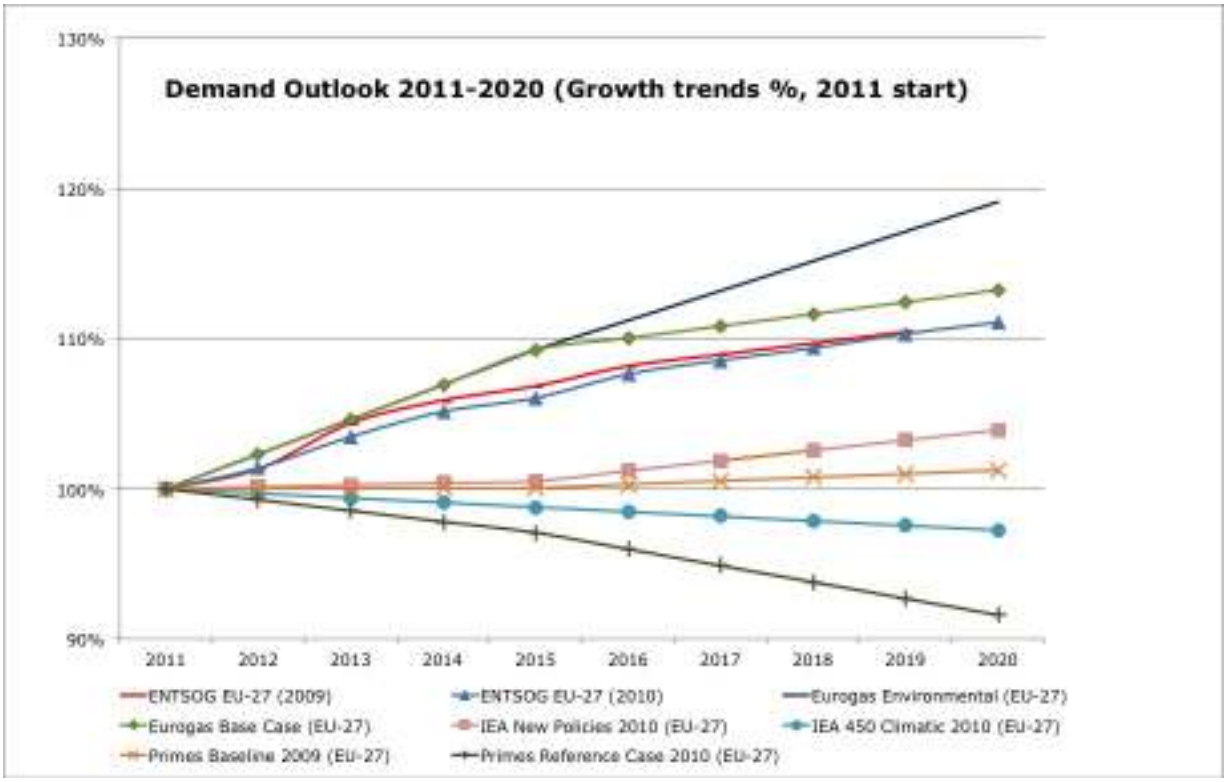
Further development of gas demand will be determined by policy decisions about CCS scheme implementation and development of nuclear power plants. Based upon strong forecasted demand for electricity that is projected to increase by 20% at average till 2030, in all scenarios the gas consumption will depend on the EU Commission's final targets for CO_2 emissions. Namely, if the strict carbon reduction targets will be applied, demand on the gas-based electricity generation is expected to be replaced by massive expansion of renewables and increase the share of coal (+ CCS) consumption in energy balance. Thus, gas-fired power plants will be used for short-term peak loads balancing. To the opposite, if CCS scheme and renewables expansion will not be widely expanded, the role of natural gas will grow as the least CO_2 intensive fossil fuel. Its consumption would be expected to

[3] Defined in EU Directive 20/20/20 that set the following targets are to be reached in 2020: (1) 20 percent increase in energy intensity (efficiency); (2) 20 percent reduction of CO_2; (3) 20 percent share of renewable energy in energy balance.

increase until the mid of this century, as gas-fired power plants will dominate in electricity generation.

Figure 2

Different scenarios of gas demand in the EU27



Source: PRIMES, IEA, Eurogas, ENTSO-G

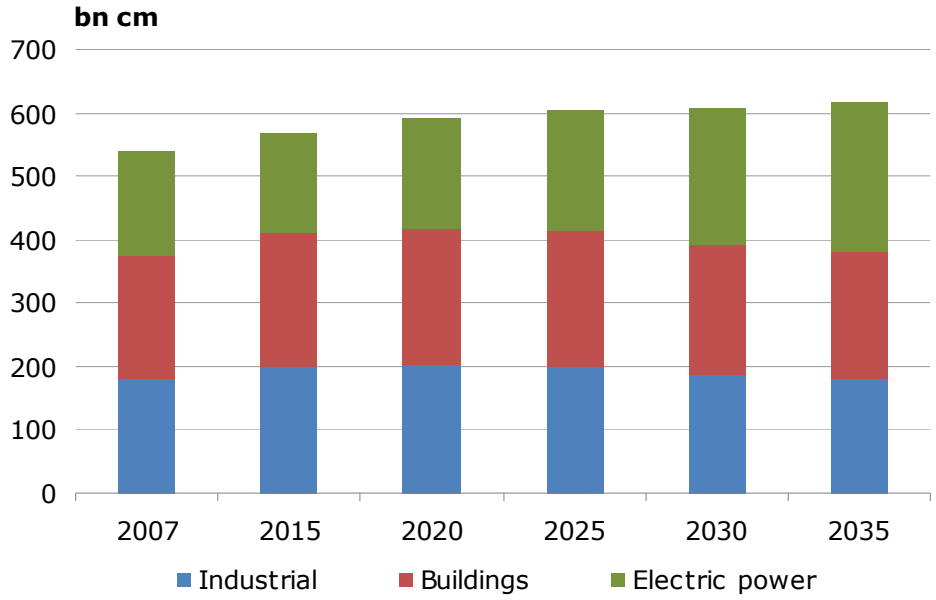
The uncertainties in EU policy towards decarbonisation of economy and future fuel mix and power plant park structure are reflected in a wide range of gas demand forecasts for the EU in the long term (see Figure 2). The forecasts obtained from EU PRIMES model (Energy Trends 2030, 2009), IEA World Energy Model (World Energy Outlook 2010) and Industry models (ENTSO-G, Eurogas) reflect quite an uncertain gas demand development (from -5% to +15% growth between 2011 and 2020).

The industrial associations (ENTSO-G and Eurogas) tend to increase demand figures, as those are not affected by strict carbon policy targets. For example, EUROGAS estimates demand for natural gas in the EU in the framework of two scenarios: (1) Base scenario, which comprise the current business and regulation framework in the EU; and (2) Environmental scenario that imply faster economic growth, more favourable policy towards natural gas and higher CO_2 prices at the upper end of the assumed period. According to EUROGAS, gas demand will grow by 14% in base scenario and by 23% in environmental scenario between 2010 and 2030 that mean annual average growth between 0.6% and 0.9% p.a. As a result, the share of gas in primary energy demand in the EU-27 is expected to increase from 24% in 2007 to 27%-29% in 2030 (18% in 1990). Given the estimate that primary energy consumption per GDP or energy intensity will contract by 31% most of the growth is expected to come from power generation that increases gas consumption from 38% in base scenario to 55% in Environmental scenario in 2007-2030, which means that power generation would increase its share from 30% (2007) to 36-38% of total gas demand in 2030.

To the contrary, IEA and PRIMES models take into consideration possible effects from CO_2 emissions policy restrictions and predict slow growth and even decline of gas demand as carbon containing fuel. For example, according to IEA low carbon scenarios, the changes in energy mix will be primarily driven by renewables and nuclear energy expansion that imply decreasing demand for natural gas in the long term.

Figure 3

Natural gas consumption forecast in OECD Europe[4] by end-use sector



Source: EIA (2011b), World Energy Projection System Plus (2010)

The EIA forecast implies the decrease of energy intensity in Europe in industrial and residential sectors and decrease of their gas consumption. Thus, power generation is expected to be a major driver of gas demand growth in Europe in the long term (see Figure 3). In regional breakdown gas demand will grow faster in Southern and Eastern Europe than in EU-15, driven by faster economic growth and gas-based electricity generation structure.

3.2 Long-Term pipeline demand in EU27

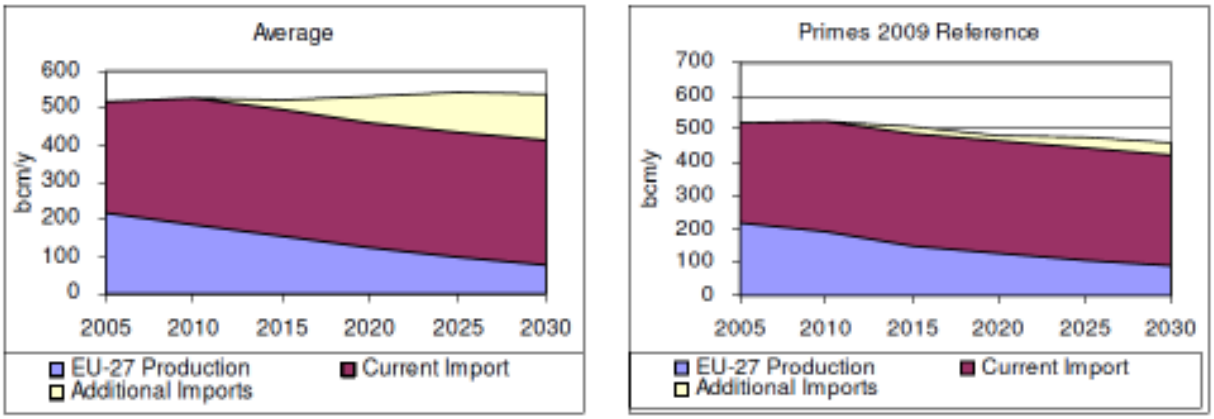
Long-term gas demand in Europe to a large extent will be driven by recent changes in world gas market and possible structural changes in European energy mix. In 2009 the EU was faced with gas market oversupply, fuelled by demand shortfall during the crisis, rapid development of shale gas in the US and excessive supply of cheaper LNG into the European market (see PP06 for details). As a result, the EU market became more convergent for other than pipeline gas supplies that disrupted long-standing linkage of gas-to-oil prices and changed the gas import structure to the EU (see PP06 for details).

In mid-term (till 2015-2020) the projections for gas balance in European market looks more or less definite and no gas shortage is expected. Two major gas suppliers to the EU – Russia and Norway – intend to increase their export to EU-27, thus securing the supplies through pipelines. The LNG flows from Far East and Africa in mid-term will also be directed primarily to the EU market that remains the most solvent one after the United States ceased to import LNG. Moreover, it is expected that the United States will start to export the gas outside the country increasing extraction of non-conventional gases. Therefore, in mid-term the EU can choose from different gas sources and thus to diversify its gas supplies.

[4] EU15 plus the Czech Republic, Hungary, Iceland, Norway, Poland, Slovak Republic, Switzerland, Turkey.

Figure 4

The EU-27 long-term gas supply projections



Source: Mott MacDonald, November 2010

In the long term the situation is less clear. There are two different scenarios for future gas supplies in the EU-27 (see Figure 4). One of them comes from industry (Eurogas and ENTSOG; indicated as Average) and another – from the EU Commission (PRIMES). The core question is whether the EU will require additional pipeline supplies in the future to meet the long-term gas demand.

According to EUROGAS estimates of long term gas supply the EU will encounter with gradual contraction of indigenous gas production that is projected to squeeze almost by 70% between 2007 and 2030. Volumes of Norwegian gas export to the EU are estimated to be quite constant and are to be increased by moderate 3.9% only according to conservative estimate of ENTSOG. As a result, long term gas supply in Europe from internal sources (including Norway) is forecasted to contract by over 40% comparing with 2007 level. Taking into account current contracted and possible prolongations of gas imports total gas supply will not meet demand in the longer term so new imports are seemed to be necessary from 2015 onwards. EUROGAS estimates these additional import volumes in 2030 from 105 bcm in base scenario to 144 bcm in environmental scenario.

The Commission estimates lower gas demand growth in long-run based upon strict carbon emission targets. According to PRIMES model the EU will not require high amounts of additional gas pipeline supplies and thus expects that it will be less than 40 bcm in 2030 (see Table 1).

Table 1

Projected additional gas import to the EU27, 2010-2030, bcm

	2010	2020	2030
PRIMES Reference 2009	0	15	35
EUROGAS Environmental 2010	0	42	144

Source: Mott MacDonald, Eurogas

Recent gas market changes also brought high uncertainty into projected long-term world gas demand/supply balance. Rapid development of LNG infrastructure and resources will increase gas flows fluctuations at world market. It means that pipeline supply will not be dominating in world gas trade and gas flows are expected to be influenced by gas price in

separate regions. For the EU, the major risk might be derived from increasing demand for gas by the fast growing Asian region (primarily China), growth of the prices on spot market and redirecting LNG supplies there. Development of non-conventional gases is also one of the new factors that influence long-term gas demand: it would be the background for indigenous gas production increase in the EU and/or the factor of decreasing competition for LNG supplies. Thus, it would potentially decrease pipeline supplies of gas to Europe.

The most important conclusion from these forecasts is that long-term development of gas consumption in Europe remains still uncertain being strongly affected by EU climate policy goals. If the EU will be able to reach the targets concerning CO_2 emissions, renewables and energy saving long-term gas demand in the EU is expected to be quite flat. In the opposite case, high demand for electricity will incur an additional upward pressure on gas demand and the EU will seek the additional volumes of gas in world market at the cheapest price. As recent development shows, LNG and non-conventional gas will remain two major conventional gas substitutes in the long term that are economically viable for export to the EU.

4 Environmental risks and regulation concerning extraction of non-conventional gas

Environmental hazard and risks will define mainly the development of non-conventional gas in Europe. Until these problems are not solved, an exploration and production as seen in the USA are unlikely. The use of environmental resources is – relatively to conventional gas – enormous. According to several explanations (e.g. Zittel) up to six wells are necessary per sq km resp. 850 fractures for a typical full field development. This might occupy 280 sq km, over a period of 40 years (Wood et al.).

This land consumption has a major impact on local biodiversity, agricultural activities and existing forests. Beside the land needed for the fracture, roads have to be build for the transport of water, sand and chemicals. At the Barnett Shale (USA) typically 100 trucks were needed for one fracture in the installation phase (Zittel) resp. approx. 85,000 for a typical full field development.

According to Stevens and Chatham, the amount of water injection is approx. 10 m litres of fresh water per multi-stage fracture per well. The necessary water is added by approx. 0.5 – 1% chemicals with up to 200 partially toxic different substances. Therefore, the risks of drinking water contamination by hydraulic fracturing fluids, and the risks of surface water and soil contamination are given (Gény). Negative impacts on agriculture, drinking water resources and biodiversity are feared. Experiences from the United States shows that production of non-conventional gas may lead to regional negative impacts as described in Zittel. Until May, a moratorium for shale production in state New York takes place and initiatives in the United States require a temporary stop of drilling as long as environmental issues are not investigated resp. more investigation is possible (The Charleston Gazette). Until today, hydraulic fracturing is excluded from the Environmental Protection Agency's Clean Water Regulations in the United States (Stevens P. and C. Chatham).

The need for a strict regulation of non-conventional gas production regarding environmental issues results from the hazard potential described above. Regulations on EU27 level are much more specific than in the United States. Regulations, especially on local level in the Member States are tougher than these in the USA. "Thus, hydraulic fracturing (…) will be even more seriously challenged there than it has been in the US (…)." (Petersen)

According to Gény and Europe Unconventional Gas following European legislative Directives are relevant for the regulation of environmental issues regarding the exploration and production of un-conventional gas: (1) Drinking Water Directive, (2) Water Framework Directive, (3) Groundwater Framework Directive, (4) Birds Directive, Habitats Directive, (5) Natura 2000 network, (6) Mining Waste Directive and (7) Noise Directive.

All regulation is imbedded into the overall European Environmental strategy, which is formulated in the Environment Action Programs since 1971. The current program (sixth) expires in 2012 and is called "Environment 2010: Our Future, Our Choice". The program gives the priorities, objectives and direction of European environment policy. The program gives a systematic approach for tackling environmental problems in the EU27 and the Member States (EU 2002).

4.1 Regulation regarding water consumption

Drinking Water Directive (1998)

The EU Council Directive 98/83/EC from November 1998 "(…) concerns the quality of water intended for human consumption" (EU 1998, Art. 2.1). The directive sets quality standards for drinking water quality and regulates valid microbiological, chemical and organoleptic parameters of water. Furthermore, the directive requires that Member States have to establish a monitoring program for water quality and demands that consumer has to be well informed regarding the quality of their water (EU 1998, (23), (32)).

Water Framework Directive (2000)

The Water Framework Directive (2000/60/EC) defines general provisions for protection and conservation of groundwater. Further, Directive regulates the "(…) framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater" (EU 2000) Art. 1). Target of this directive is to set a framework for how Member States have to deal with their aquatic ecosystem. It is demanded that every Member State has to ensure a progressive reduction of pollution of groundwater at their territories (lakes, rivers) and marine waters. (Art. 1, b,c,d,e). Moreover, the directive demands an appropriate handling of hazards by floods, which is secondary in the context of this document.

Groundwater Framework Directive (2006)

With the Groundwater Framework Directive (2006) the specific measures are defined in order to prevent and control groundwater pollution. This includes criteria for assessment of good groundwater chemical status, the definition of specific threshold values (EU 2006, Art1, (a)).

Directive on environmental quality standards in the field of water policy

Additional to the Groundwater Framework Directive, European Parliament with the Decision No 2455/2001/EC established a list of priority substances in the field of water policy. In this, those substances are defined that have to be monitored by the Member States (EU 2001). In this list 33 substances and groups of substances are defined that are of major concern for European water.

With the Directive 2008/105/EC the European Parliament implemented the Decision 2455/2001 into European law and defined maximum allowed concentrations for 33 priority substances and 8 other pollutants.

Conclusion: Industries, which are active in exploration and production of non-conventional gases, have to ensure that the pollution of water resources – territorial water, marine waters and groundwater – does not exceed defined maximum concentrations of chemicals and pollutants. Monitoring schemes have to be established and an adequate information system has to be established for public information.

4.2 Regulation regarding biodiversity

Beside the protection of water resources the preservation of biodiversity is another major topic in European environment policy. Today's European policy in this field has its legal basis in the Birds Directive (1979) and in the Habitats Directive (1992).

Birds Directive (1979)

The Bird Directive relates to the conversation of "all species of naturally occurring birds in the wild state (…)". The directive regulates the establishment of protection areas for threatened birds and their habitats, the establishment of biotopes and the re-establishment of destroyed biotopes (EU 1997, Art.3). Further, the directive formulates the demands regarding national law formulation in the Member States.

Habitats Directive (1992)

With the Habitats Directive the centrepiece of European biodiversity and nature policy is defined. Its "aim (…) is to assure the long-term survival of Europe's most valuable and threatened species and habitats." (EU Environment). The directive protects over 1000 animals, plants (defined in Annex 2 of the directive) and over 200 different habit types that are important for European environmental surface resp. it´s biodiversity. Such habitat types are special types of forests, meadows, wetlands, etc. and are defined in Annex 1 of the directive (EU Environment). The Member States are requested to define protected areas for ensuring a domestic resp. regional specific biodiversity (EU 1992, Art. 6). Further, the directive defines possible funding schemes for the Member States and defines that every six year "Member States shall set up a report on the implementation of the measures taken under this directive." (EU 1992, Art. 17).

Natura 2000 network

The Habitats Directive and their amendments (e.g. 97/62/EC, Regulation (EC) No 1882/2003, 2006/105/EC) led to the founding of Natura 2000, a European wide network of nature protection areas. "The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats " (Natura). In 2010 this Natura 2000 network was protecting 18% of European surface. The list of protected areas has been expanding currently. A last update took place in January 2011 with the implementation of further Alpine, Atlantic and Continental biogeographic regions (Official Journal EU).

Protection does not exclude economic activities. The extent of economic activity depends on the possible impact of such an activity, the importance of the protection and the monitoring concepts. For example: several existing mining activities, e.g. in Germany, are allowed in Natura 2000 areas although new ones are forbidden. However, touristic and agriculture play a much larger role than industry activities.

Conclusion: With the increasing economic prosperity, the awareness of habitat conditions increased during the last decades in Europe. European regulation on biodiversity and habitat issues refers to this increasing awareness. The further exploration and production of non-conventional gas recourses has to consider these regulation.

4.3 Regulation regarding mining wastes

Directive 2006/21/EC – Mining Waste Directive – "provides for measures, procedures and guidance to prevent or reduce as far as possible any adverse effects on the environment" (EU 2006b), which result from mining activities in the EU27. Aim of the directive is the protection of "water, air, soil, fauna and flora and landscape, and any resultant risks to human health" (EU 2006b). The directive demands that the Member States implement regulation for waste management plans, formulated by the operators of mining activities. Regarding EU 2006b, objectives of such a waste management plan are, (1) the reduction of waste production, (2) installation of waste facilities depended of the waste category and established by the operator of mining activities and (3) monitoring for operating and closed waste facilities. Further plans for "major-accident" prevention and information have to be formulated. The directive demands that the Member States implement monitoring systems for necessary measures to protect human health.

Conclusion: Non-conventional gas resources are not mentioned in the mining waste directive. The specific of wastes, which originated from non-conventional production – mainly, polluted water – and the fact that these are hardly to collect, requires specific regulation on this issue.

4.4 Regulation regarding public information

With the Directive 2003/4/EC on public access to environmental information, European Parliament demands that public authorities in the Member States provide a free access to environmental information. This access guarantees a democratic participation and decision process regarding construction activities, industrial production and policy measures.

The regulatory framework of European environment policy is comprehensive and applicable for a wide range of industrial activities. The specific characteristics of non-conventional production – e.g. the enormous use of surface and water – require concrete consideration in existing regulatory frameworks. Environmental issues mainly influence the public acceptance of non-conventional production. Strengthening environmental awareness in the European public will make it difficult to neglect possible negative effects of non-conventional production. Therefore, an on-going discussion process in Europe is taking place and will lead to further extensions of existing and formulation of new regulatory frameworks in the EU27 and the Member States.

5 Recommendations

As in whole Europe, only preliminary estimations for the amount of existing non-conventional gas resources in Ukraine are available today. The first necessary step for a long-term use would need a monitoring and exploration strategy for Ukraine. Ukraine has to be aware that a fast economic use of non-conventional gas is not possible.

Before a far-reaching exploration can take place, several regulations have to be implemented. This would give security for Ukraine and possible investors. Beside this regulation further aspects have to be fulfilled, otherwise an economic efficient use of the non-conventional gas – for export reasons or for the use in Ukraine – would be impossible.

The fundamental corner marks of our recommendations are:

(1) Observe the international progresses and learn from successes and failures

(2) Perform a fundamental investigation of national reserves

(3) Develop the basis of a regulatory frame for exploration and production of non-conventional gas resp. clarify if existing regulations on conventional gas is applicable for non-conventional gas production

(4) Improve the legislative framework for foreign investments attraction to non-conventional sector for participation in knowledge and technology transfer

(5) Establish the legislative framework for public participation process.

Further, the set of particular steps are to be stipulated in Ukrainian regulation regarding:

1. Mining activities
2. Environmental issues
3. Recovery and liability
4. Support schemes
5. Energy efficiency, and
6. Information policy

5.1 Regulation regarding mining

A regulation regarding mining has to define (1) how licenses will be granted, (2) where a exploration is allowed, (3) which conditions the explorer has to fulfil in respect of economical and technical securities, (4) which technics should be allowed, (5) how long licenses for explorations are granted, and (6) how the transition from exploration to production has to look like.

Subsoil resources are the subjects of Ukraine´s people property. On behalf of Ukrainian people public and local authorities under the powers defined in the Constitution take the proprietorship rights. On the other hand, citizens, legal entities and the state according to the legislation can obtain the property rights on land. The situation is comparable to these in most EU27 Member States.

The Subsoil Code of Ukraine and the PSA Law have to expand by necessary regulatory regarding the use of non-conventional gases. Situation might be complicated if the owner of a surface and the mining industry entity differ. Therefore, it has to be defined (1) how compensation looks like, (2) to which extent mining is possible in adjacent areas around wells, (3) how land use for infrastructure facilities (e.g. roads) is possible on adjacent areas and how a compensation looks like. Further, it has to be defined how renaturation is demanded.

5.2 Regulation regarding environmental issues

The environmental issues are essential for non-conventional gas production. These includes regulation on water security, identification of protected nature reserves and regulatory on the use of chemicals in the drilling process.

For three reasons Ukraine should be aware of the environmental issue: **First**, public acceptance will be influenced by the environmental standards of the technics, especially if environmental awareness will increase in Ukraine, too. With this, the **Second** point interacts: for global companies a half-hearted behaviour becomes more and more problematic for their external presentation resp., reputation. Concrete and stringent environmental constraints may help to increase companies' reputation. And as **Third** a possible European import of non-conventional gases in the long run will enhance dependency on environmental regulation in Ukraine.

5.2.1 Chemicals

For environmental protection reasons, it has to be guaranteed by the industries that all used chemicals, independent of the fact that they might be "corporate secrets", will be registered. A regulatory for monitoring this use of chemicals has to be implemented early. Therefore, a catalogue of allowed chemicals has to be formulated by the law.

5.2.2 Biodiversity and protected areas

Ukraine defined several protected areas e.g. Prypyat-Stokhid National Nature Park, Galytskiy National Nature Park, Vyjnitskiy National Nature Park, Ujanskiy National Nature Park, and Carpathian Biosphere Reserve. According to Sorokin, the protected Ukrainian aim is to increase the protected areas up to 10.4% of the national territory. As of January 1st, 2009, the nature reserve fund consisted of 7424 areas and sites of 11 categories, its total area was at 3.04 m ha, or 5.04% of Ukraine's total area.

Exploration, and resp. production activities and biodiversity policy has to be brought into accordance. Therefore, Ukrainian regulation on biodiversity (e.g. Law on Wild Life, Law on Vegetation and Law on Biosafety and National Concept on Biological Diversity etc.) has to be expanded by such regulatory, which regards to non-conventional.

Existing barriers on biodiversity has to be diminished. According to Sorokin, "poor understanding of biodiversity concerns by national authorities and decision makers", a "low level of public information and awareness", a "poor cooperation and collaboration on vertical

and horizontal levels (interdepartmental)" and a "poor mainstreaming into sectorial policies (transport, land planning etc.)" are the most problematic barriers. Further, a monitoring scheme has to be established, which guarantees a compliance of regulation on protection regarding non-conventional activities.

5.2.3 Radioactivity

Up to 30% of the used fresh water will be flushed back during the production. Radioactive materials might contaminate this water. Zittel describes that in the Barnett Shale 0.5 millilitre radioactive material results from 1 cubic meter of back flushed water. Between 2005 and 2007 these summed up to 13 cm Radium 226 and Radium 228. Test at the Marcellus Shale (New York) show that the amount of Radium 226 lays 1,000 times above the limit value for water.

Therefore, the hazard from radioactive contamination – increased by the nuclear accident in 1986 in Ukraine – has to be minimized by previous test of the underground. Further, a strategy for disposal of radioactive materials has to be planned and regulated. It has to be defined who is responsible for this disposal and how this is monitored.

5.2.4 Water management by sewage plant

If 30% of injected water will be flushed back from a fracture, the amount of 3 m litres per fracture has to be processed. Experiences from the United States – described in Zittel – show several massive environmental problems resulting from a lax behaviour on this issue. Therefore, a sewage plant system for used water has to be developed. It has to be defined which limit values for probable chemicals are tolerable, who is responsible for the cleaning process and who is responsible for the monitoring, provided with which rights.

5.3 Regulation regarding recovery and liability

Liability regulation has to be an essential part of the several regulations discussed above. However, an overall liability framework for non-conventional production would increase the security for Ukrainian state, private and public landowners and population. It has to be defined who has the "burden of proof" – industry, affected entities or state authorities. Experiences of previous accidents – mainly in the United States - show that the legal proceeding against industry might be complicated and is difficult for private persons (e.g. affected landowners or agricultural entities).

It has to be defined, further, how a recovery after production has to look like. This recovery includes all technical facilities like wells and roads.

5.4 Regulation regarding support schemes

With a tax credit on the production of non-conventional gas, the United States fostered the development of non-conventional production until mid of the last decade. The regulation was defined in the Section 29 (tax credits) of Nonconventional source fuel credit legislation. A credit of up to 3$ per barrel equivalent was granted until 2010 (EIA). The installation of this support scheme was driven by the target to increase domestic energy production and supporting domestic industry.

As long as non-conventional gas is more expensive than natural gas and oil – and it is expected that this will hold for longer in Europe – a support scheme would help to initialise the development of a domestic non-conventional production in Ukraine.

On the other hand it has to be taken into consideration that a support scheme (by tax credits, grants or subsidies) is efficient from a macroeconomic point of view only if produced gas is used domestically and/or value added is mainly hold in Ukraine. Otherwise, a subsidy for export markets would result.

As long as Ukraine disposes of unused conventional gas resources, supporting the production of non-conventional gas would be inefficient in terms of production costs

However, the knowledge on national deposits will influence the long-term strategy of Ukrainian energy policy.

Therefore we recommend the development of a support scheme for Ukraine, which follows a long-term strategy and does not refer to a short-term increase in the domestic production. The objective has to be that in the long term Ukrainian industry will be able to participate in the production of non-conventional gas. This could mean that only exploration activities are supported, due to positive externalities regarding the knowledge on national deposits.

5.5 Energy efficiency

For the mid of this century, the use of non-conventional gas may be essential for the Ukrainian energy supply. Only if the efficiency of the overall energy use can be increased this would be economically efficient. Therefore, a mid-term modernisation process for the Ukrainian infrastructure buildings, heat and power supply, heat and power use has to be stared soon.

Beside this, a modern, well operating infrastructure for gas transports, incl. produced from non-conventional sources in Ukraine would be necessary for an economically efficient use of domestic resources. Therefore, the existing gas infrastructure has to be modernised.

5.6 Information policy

Public acceptance is, as described, an essential issue for large-scale industry activities like non-conventional production. Therefore, steps have to be defined how the public is imbedded into decision processes and how information is shared. This concerns mainly the regions where resources are expected to be produced.

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