EUROPEAN UNCONVENTIONAL GAS DEVELOPMENTS

Environmental Issues and Regulatory Challenges in the EU and the U.S.

Co-chairs
Gen. Richard Lawson
William Ramsay

Rapporteur and Program Director
John R. Lyman

Associate Director
Mihaela Carstei

June 2011

Acknowledgment: “This material is based upon work supported by the Department of Energy under Award Number DE-FE0000016.”

Contributors

The Atlantic Council would like to thank the French Institute for International Affairs for their tireless efforts in organizing the meeting in Brussels and obtaining the participation of government and industry participants. Special thanks to the U.S. Department of Energy and Marathon Oil for their generous sponsorship of this workshop.

This report was greatly enhanced from the input and expertise of those who attended the workshops. Speakers at the workshops included:

Jim Bolander
Vice President Health, Safety and Environment
Southwestern Energy

Mark Boling
Executive Vice President, General Counsel and Secretary
Southwestern Energy

Nick Douglas
Minerals & Realty Management
Bureau of Land Management

Malcolm Fergusson
Head of Climate Change
UK Environment Agency

David L. Goldwyn
Former Special Envoy for International Energy Affairs
U.S. Department of State

Heinz Hilbrecht
Director Security of Supply, Energy Markets & Networks
DG Energy
European Commission

Chris Hopkins
Vice President, Unconventional Gas
Schlumberger

Brian Horsfield
Director, Chemistry and Material Cycles
GFZ German Research Centre for Geosciences

Valerie Jochen
Unconventional Gas Technical Director
Schlumberger

Scott Kell
Former President
Ground Water Protection Council

Lena Kolarska-Bobinska
Member, Group of the European People's Party
European Parliament

Sally Kornfeld
Team Leader, International Oil and Gas Activities
U.S. Department Of Energy

Chitra Kumar
Director Drinking Water Protection Division
Environmental Protection Agency

Vello A. Kuuskraa
President
Advanced Resources International

Richard L. Lawson
Vice – Chairman
Atlantic Council of the United States

John Lyman
Director, Energy and Environment Program
Atlantic Council of The United States

Amy Mall
Senior Policy Analyst
Natural Resources Defense Council

Mike Moore
Blue Source

Brenda Pierce
Energy Resources Program Coordinator
U.S. Geological Survey

William Ramsay
Senior Fellow, Director
European Governance and Geopolitics Of Energy
IFRI

Michèle Rivasi
Greens/European Free Alliance
European Parliment

Michael Schaal
Director Office of Petroleum, Natural Gas and Biofuels Analysis
Energy Information Administration

Michael Schuetz
Policy Officer, Indigenous Fossil Fuels
Directorate General for Energy
European Commission

Kate Sinding
Senior Attorney
Natural Resources Defense Council

Stephan Singer
Director Global Energy Policy
WWF International

Mike Smith
Executive Director
Interstate Oil and Gas Compact Commission

Klaus Söntgerath
Head of Department
Authority for Mining, Energy and Geology
Lower Saxony, Germany

Michael Sullivan
Senior Advisor
Office of the Coordination for International Energy Affairs
U.S. Department Of State

Mihai Tomescu
Economic Analyst
Sustainable Development and Economic Analysis
Directorate-General for the Environment
European Commission

Marta Wagrodzka
Ministry of the Environment
Poland

Foreword

For over a year, much attention has been given to the potential for shale gas to substantially alter the world's energy markets. Media has focused on the phenomenal success the United States has had in developing significant additional gas supplies, which has reversed the decline in U.S. natural gas production and lowered natural gas prices in the U.S. to $4 per mcf from as high as $9 per mcf during 2005-2009. There are high expectations that this success can be duplicated globally. European counties would like to replicate the U.S. success story and American companies are now actively exploring in locations such as Poland. Other countries are also initiating exploration programs focused on shale resources.

The U. S. Department of State has created the Global Shale Gas initiative to share U.S. industry and regulatory experience with interested countries. China, India, and Australia are pursuing shale gas resources and there is great potential in many other areas, such as Argentina, Brazil, South Africa and Northern Africa. The U.S. Department of Energy's Energy Information Administration recently released a study that shows significant technically recoverable resource potential throughout Europe. The magnitude of the economically recoverable reserves will not be evident without a major industry effort to explore, develop and construct the necessary infrastructure to establish a new energy industry in Europe. Success in these efforts will also depend on both geology and environmental regulations in Europe.

For this potential to be realized in Europe, industry will need to adopt best practices similar to those advocated in the U.S. and to support national and local efforts to establish appropriate regulations, monitoring and enforcement. The EU has in place broad legislation requiring environmental protection of water and disclosure of chemicals utilized in drilling and processing of hydrocarbons. Few, if any, additional EU regulations focused specifically on unconventional gas are expected to be required. Rather, individual national and local governments will need to adopt regulations and procedures that meet their particular circumstances. Industry success will be heavily impacted by public acceptance. This will require considerable up front efforts to inform the public and provide reliable information regarding the management and treatment of wastewater, the maintenance of surface facilities and equipment, controls over gas emissions, noise abatement and the management of transportation to and from drilling sites.

While unconventional gas is likely to strengthen the long-term energy security of some countries, especially in Central and Eastern Europe, the European Union as a whole will not experience the type of bounty created by additional domestic gas resources in the United States. Individual countries will have to work with the international and national oil and gas industry focusing on their particular geological prospects and working within national and local jurisdictions.

In support of the EU-U.S. Energy Council's agenda, the Atlantic Council's Energy & Environment Program convened two workshops on environmental issues and regulatory challenges in the EU and U.S., focused on assisting the development of European unconventional gas resources. This report benefits from the knowledge and guidance of experts from the European Union, the U.S. government, U.S. and European industry representatives, and thought leaders from the NGO community. We give particular thanks to those who attended the workshops as presenters and who thoughtfully reviewed this report.

Frederick Kempe
President and CEO

Table of Contents

Executive Summary

There is a global recognition that the development of unconventional gas resources with the application of new technologies, like advanced seismic and modeling techniques and the new application of old technologies like combining horizontal drilling and multi-stage hydraulic-fracturing operations has enabled the production of resources previously considered uneconomic. Several early assessments have identified the global potential for technically recoverable resources that could considerably increase existing gas reserves. While developments in the United States have led to production increases that resulted in a dramatic reduction in liquefied natural gas (LNG) imports and a lowering of natural gas prices within the U.S., the impact on gas prices elsewhere is only beginning to emerge. This reflects the early stages of unconventional gas exploration outside the U.S., the heterogeneous nature of unconventional gas reserves and the continuing geographic divisions in gas markets. In addition, substantial infrastructure developments and support industries will be required to support unconventional gas development.

The U.S. government, through the State Department led Global Shale Gas Initiative (GSGI) has been sharing the American experience with interested developing nations. At the same time, the US Geological Survey is actively collaborating with a number of countries in Europe, Asia, Africa and Latin America who have signed on to the GSGI to identify their prospective basins. The EU-U.S. Energy Council last November agreed to exchange expertise on environmental issues related to the utilization of unconventional gas resources, including shale gas, especially with a view to addressing the issue of public acceptability. In addition, the U.S. Energy Information Administration (EIA) released a study evaluating resource potential in Europe, as well as in other selected basins throughout the world, based on publically available information. This EIA study shows significant technically recoverable resource potential in Europe, but did not consider the economics of those resources[1].

In the United States, industry developments have raised a number of major environmental concerns. Furthermore, technological developments have been moving faster than the necessary adjustments to regulatory and industry practices. Some of these, associated with the practice of multi-stage hydraulic-fracturing of deep horizontal wells, represent issues that can be readily handled operationally by identifying and enforcing industry practices that ensure well integrity to avoid fluid migration into the shallower underground sources of fresh water. These will include evaluation of stratigraphic confinement, establishing well construction standards, evaluation of mechanical integrity of wells and real time monitoring of frac jobs and well production. Other issues associated with surface impacts will require improved industry practices impacting the sourcing and transportation of water, the management and treatment of wastewater, the use of pad drilling to minimize the surface impact of drilling locations, the siting and maintenance of surface facilities and equipment, controls over gas emissions, noise abatement and the management of truck traffic to and from drilling sites. All of this will require a much better exchange of information among industry, regulators and the public.

1 There are three distinct U.S. federal programs dealing with international resource assessment, including shale gas: the U.S. Geological Survey, the U.S. Department of State's Global Shale Gas Initiative and the U.S. Energy Information Administration. While the first two programs coordinate and collaborate with a number of countries and their perspective geologist, the work of the U.S. Energy Information Administration is solely based on compiling and analyzing publically available technical information.

Although resisted by some companies and some politicians, there is increasingly broad agreement that better industry practices should be combined with robust regulations, monitoring and enforcement to ensure that the public is and perceives itself to be protected– without adversely affecting the expansion of unconventional gas production. Given the importance of establishing greater gas reserves, it is crucial to establish comprehensive environmental and safety policies at all government levels, which are ultimately responsible for establishing appropriate regulations and ensuring monitoring and enforcement. The cost of implementing such regulations and procedures will be minor compared to the economic, environmental and national security benefits to be derived by all stakeholders. Failure to act will result in a continuing string of mishaps that could stifle development in a number of areas within the United States and abroad, and reinforce alarmist attitudes that have caused much of the negative feelings towards unconventional gas development and could otherwise be answered.

The European Union (EU) and its Member States are aware of the environmental concerns raised in the US and are seeking guidance from U.S. government, regulatory authorities, industry and NGOs in their efforts to ensure the development of appropriate procedures and legislation. An eventual European regulatory framework is expected to be similar to the US model that relies on both state and federal regulations that are largely administered at the state level. In the EU, Member States must enact regulations that are consistent with EU Directives that establish guiding principles on a wide range of issues related to the environment. In the U.S., each state implements specific permitting and licensing rules and monitors operators' performance. In Europe, there will be a need to strengthen the capabilities and resources of local and national agencies that may not possess the required manpower and skills to establish locally appropriate regulations as well as the monitoring, reporting and enforcement mechanisms required. While a European regulatory framework is being established – which is likely to take some time, Member States will be pretty much on their own.

Given the early stages of unconventional gas development, contract rigidities in European gas markets and an insufficiently integrated transportation network, it is too early to determine the magnitude and pricing impact of unconventional gas on individual EU Member States. What is certain is that approaches to unconventional gas will vary widely between Member States, which are setting their own priorities on energy developments. These depend inter alia on factors like population density, existing experience with conventional oil and gas production and also the relative importance of energy security considerations compared to environmental concerns. It remains to be seen how public perceptions will balance the environmental and social impacts with the extent to which additional gas supplies could impact overall economic prosperity. Provided a successful completion of a common EU gas market, unconventional gas developments in one Member State would nevertheless have a significant impact across Europe. In fact, the increase in unconventional gas production in the US has already impacted the EU gas market by freeing up LNG capacity.

Introduction

With the recent dramatic reassessment of U.S. natural gas resources associated with the development of unconventional gas reserves from shale, there is a growing realization that unconventional gas resources have the potential to play a major role in supplementing conventional gas resources in many countries. The EU-U.S. Energy Council identified an assessment of unconventional gas developments as a topic for join dialogue. The U.S. Department of State and Department of Energy (DOE) approached the Atlantic Council to organize and hold such dialogues in the US and Europe.

The first dialogue, "A Realistic Balanced Perspective on European Unconventional Gas Developments- a North American Perspective", was held on January 25, 2011 in Washington D.C. The agenda and participants list for this workshop are shown in Attachment A. A second dialogue taking place in the framework of the EU-U.S. Energy Council, on "European Unconventional Gas Developments: Environmental issues and Regulatory Challenges in the EU and the U.S.", was held in Brussels on March 14, 2011. The agenda and participants list are shown in Attachment B. Copies of presentations from both workshops are available on line at the Council's web site at www.acus.org.

This report integrates comments and understandings arising from both dialogues. It provides an assessment of the current outlook on environmental and regulatory issues in both the United States and Europe based on the presentations and discussions held with an impressive gathering of experts from industry, government regulatory and energy officials, and several environmental organizations focusing on shale gas developments.

The workshops provided a comprehensive review and discussion on:

- Geological prospects and challenges of finding and producing unconventional gas resources
- Potential economics and market impact of unconventional gas production
- Evolving environmental and social issues
- Existing regulatory environment and current thoughts on prospective regulations
- Recommendations on transatlantic cooperation

The discussions noted that U.S. shale gas developments were an R&D and policy success story driven by high gas prices. The DOE and the National Energy Technology Laboratory (NETL) helped build the essential horizontal well drilling and advanced hydraulic fracturing technology through collaboration with the Gas Research Institute. Section 9 tax credits (now expired) helped attract the necessary capital to demonstrate the technical viability of unconventional gas development (primarily coalbed methane and tight gas) by employing hydraulic fracturing technology.

The industry believes that "gas shales have changed the outlook for U.S. Natural Gas from fears of impending scarcity to expectations of plenty". Imports of LNG have been dramatically reduced and redirected mainly to European and now Japanese markets. U.S. natural gas prices at Henry Hub that ranged between $7 and $9 per MCF in the 2005 -2009 period fell to between $4 and $5 per MCF in 2010 with the addition of incremental production that has more than offset the declines in onshore and offshore production.

In Europe, shale gas exploration has only recently been undertaken in several countries and has not yet progressed to a stage where the magnitude of the potential for economic production can realistically be assessed. Nevertheless, geological assessments have been prepared by various European national geological departments, the US Geological Survey, and most recently in an April 2011 global assessment "World Shale Gas Resources: An initial Assessment", prepared by Advanced Resources International (ARI) for the U.S. Energy Information Agency (EIA), the statistical and analytical agency within the U.S. Department of Energy (DOE). While the potential for shale gas, tight sands and coalbed methane in some countries could lead to a substantial increase in an individual country's natural gas production, on an European wide base the current "best guess" is that such resources will only cover about ten percent of overall European gas supply; however, the impact could be substantially higher. The cost of production is not yet known, but is not expected to lead to such a dramatic reduction in gas prices as in the US, although in some countries the existence of significant new gas supplies could create a more competitive gas market and greater diversity of supply. Thus, the eventual exploitation of unconventional gas supplies is primarily seen as strengthening domestic production and contributing to European supply security, while softening prices in some countries that are highly dependent upon higher cost imports, including gas whose price is contractually indexed to oil.

The United States provided a very favorable setting for the application of new technologies that led to a dramatic growth in the production of unconventional gas reserves over the last decade. Specifically, the U.S. benefitted from the existence of a dynamic and substantial oil and gas industry that supports over 9 million employees with nearly 4 million in the natural gas sector. Existing infrastructure for natural gas in North America includes roughly 38,000 miles of gathering pipelines, 85 BCF/d of natural gas processing capacity, 350,000 miles of transmission pipelines and 4.5 TCF of natural gas storage to serve the over 450,000 existing natural gas wells as of 2008. While this infrastructure will need to be expanded to accommodate shale gas developments, the existing well -developed industry will enable a continuing rapid development of unconventional gas resources.

Moreover, the U.S. oil and gas industry has a long history (over 75 years) of working with a complex mix of state and federal regulatory agencies and statues dealing with every aspect of the industry. The Federal government has carefully defined roles, with the Federal Energy Regulatory Commission (FERC) regulating interstate transmission facilities. Federal owned lands fall under the jurisdiction of the U.S. Bureau of Land Management, which is a land and resource agency with a multiple- use mission that oversees land use planning, through leasing, permitting, drilling, operating and development through final reclamation.

However, most production occurs on non-federal land and is regulated and monitored by state and local agencies. With most mineral rights owned by private citizens each state acts as a mini laboratory to determine what works economically and is acceptable to the population of the individual states. An act of Congress was passed in 1935 to establish the Interstate Oil and Gas Compact Commission to bring state regulators together to determine how regulations should work with evolving technology and different conditions between states. In addition, the Ground Water Protection Council, a non-profit organization, was established in 1983 for the protection, conservation and management of ground water resources. Its members are the "state regulators who set and enforce regulations on ground water protection and underground injection". [2]

Hence, the U.S. provides a vastly different economic model for the oil and gas industry from that developed in Europe. In the U.S., mineral rights are generally owned by land users and production revenue flows to land owners through lease bonuses and royalties, whereas in Europe, national ownership of in ground resources reduces a land -owner's incentive to undertake exploration and development. Moreover, there is a long history in the U.S. of regulations on oil and gas production, which has created public awareness and acceptance of development in states familiar with the oil and gas industry.

However, public concerns have arisen in non-oil and gas states where proposed exploration and production is unfamiliar territory. These states may well need more time to reach a comfort level with shale gas development. Nevertheless, development is proceeding elsewhere as the

2 Ground Water Protection Council Web site at www.gwpc.org

U.S. has already established a broad energy infrastructure that is well understood by the public and state regulators. Although development of shale gas will entail a significant expansion of this infrastructure, industry is familiar with both the requirements and the process for seeking permitting and approvals. But the public will need more than industry assurances and will insist on transparency, better performance and safe operation.

In Europe, there is a well - established set of legislation and regulation at the EU level as well as in countries where there has been oil and gas development in the past. But, the development of shale gas is new everywhere, and regulatory programs, technical criteria and safety standards are not yet in place. EU Member States have the right to determine the exploitation of their energy resources and their energy mix. While there is a Directive to utilize a growing percentage of renewable energy, there are no requirements to utilize a particular energy mix. Within the framework of EU legislation, Member States do have to establish appropriate licensing and permitting regimes for the production of energy resources. Even though EU legislation does not explicitly address unconventional gas developments, there is a comprehensive set of environmental legislation that will impact the development of unconventional gas resources.

Europe's gas related infrastructure is still evolving to ensure a more competitive market structure that would also be beneficial to the development of onshore unconventional gas, but much more new gas infrastructure, especially in some regions, will be required to gather, transport and potentially export unconventional gas. Member States can be expected to remain responsible for developing the detailed regulations impacting the exploration and development of unconventional gas within the broad limitations imposed by various EU Directives. Each Member State can be expected to develop such regulations to reflect their varying energy requirements and local public perceptions. Many European countries will need to strengthen the capabilities and level of manpower and financial resources available at the relevant government levels to appropriately develop the industry.

The workshop highlighted the issues surrounding surface impacts, both social and environmental, as well as subsurface considerations. Public and media attention has led to confusion over the impacts on water resources caused by the actual practice of hydraulic fracturing and the handling of waste and recycled water from surface facilities. **Discussions among participants indicated that the industries' and U.S. states' use of "best practices" with regard to safety, efficiency and environmental protection accompanied by rigorous monitoring, inspection and public awareness of the same could alleviate most of the confusion and the concerns associated with the technologies required to produce unconventional gas resources.** ***It was recognized that over the past several years' technological developments have been moving faster than the necessary adjustments to regulatory and industry practices.***

The concerns and adverse publicity expressed in the United States have been noted in Europe and are having a major impact on public perceptions that the industry will have to address on a country -by -country basis. In the United States, the economic impact of increased gas production is not only directly benefiting local landowners, but it is also seen to be altering the long- term energy security of the country. Hence there are powerful incentives to make the adjustments necessary to ensure a continuing growth in unconventional production. Moreover, serious industry supported efforts are underway to make the necessary adjustments to practices, monitoring and inspection that will lead to some increase in production costs but should reduce the public's concerns. In the U.S. this is resulting in the development of "green" processes and materials that the industry will be able to deploy globally. However, even in the US the gas industry will need to adjust to operating under a stricter regulatory and enforcement environment, especially in states that have experienced surface pollution as a result of inadequate regulations and poorly employed enforcement procedures.

In Europe, national perceptions of the economic and energy security aspects to be derived from unconventional gas development vary greatly between the Member States. Some countries, such as France, expect only limited benefits from expected incremental production and significant adverse environmental impacts[3] whereas others, such as Poland, are anticipating a major opportunity to diversify energy supplies with acceptable environmental impacts.

3 French government has established commission to look at the issues involved in unconventional gas development that is to be released with policy recommendations by the end of May. This is expected to be a dispassionate look at the issues that will not make the environmental community and many politicians happy. In May 2011, The French Assemblée Nationale adopted a law banning the use of hydraulic fracturing (at the time of printing of this report, the law was pending approval by the Sénat)

Chapter 1: Geological Prospects and Challenges

Over the past decade, U.S. shale gas production has increased twelve-fold with the application of numerous recent technological developments. This has led to major efforts to identify the potential for similar results in other countries. The U.S. Geological Service (USGS) is undertaking a global shale gas assessment in conjunction with national geological services in a number of countries. Historically, in the U.S. unconventional gas was produced primarily from tight sands and coal seams. Production from these sources continues and remains a potential source of additional gas supplies globally. However, the largest resources are now expected to be associated with Black Shale rock that contained sufficient organic material in the right geologic setting to generate hydrocarbons.

The USGS Global Shale Assessment is using a geologically based international collaborative approach to focus on identifying technically recoverable resources. It assumes existing technology and applies probability analysis to screen unique rock volumes that have explicit stratographic characteristics within specific map boundaries. The USGS has a catalog of shale gas resource analogs that it is using to translate real U.S. data into estimates of technically recoverable reserves around the world. The assessment is expected to take three to four years.

Other organizations are also developing independent assessments of available unconventional gas resources. Advanced Resources International (ARI) is an independent consulting organization that is applying a different technique to undertake assessments of shale gas potential utilizing past drilling data to estimate resource potential. The organization has been assessing coalbed methane resources since the 1980's. In an April 2011 report, ARI prepared a global assessment entitled "World Shale Gas Resources: An initial Assessment" for the U.S. Energy Information Agency (EIA), the statistical and analytical agency within the U.S. Department of Energy. Both the USGS and EIA believe that Europe possesses substantial shale gas potential in Poland, Ukraine, France, Sweden and Norway. Other European countries with potential unconventional gas resources include the United Kingdom, Germany, Netherlands, Denmark, Lithuania, Romania, Hungary, Bulgaria and Turkey.

It is important to understand that the existence of resource potential will not automatically translate into economically viable production of gas. All shale formations are different and complex. These complexities cause each individual field to be unique and technology requirements vary across plays. As one workshop expert noted, "Each well could be a PhD thesis." An understanding of both reservoir quality and applying the optimal completion technology is critical. Economic success also depends on achieving efficiencies in all aspects of development. The dramatic growth in U.S. production is directly related to the application and evolving development of a number of sophisticated recent technologies to address the heterogeneity associated with shale gas development.

It is also related to the massive quantity of wells that have been drilled for unconventional gas in the U.S. For example over 14,000 wells have been drilled in the Barnett Shale in Texas and Oklahoma. It was noted that during 2009, 1,121 wells were drilled in the Marcellus Shale in Pennsylvania and West Virginia. In Europe, exploratory wells targeting unconventional resources have just started to be drilled in the last year, and it is generally recognized that it may take over a decade before there is a reasonable ability to estimate the long term potential for unconventional gas development even in countries, such as Poland, which is actively supporting the search.

An understanding of shale gas reservoirs requires a much larger set of information than necessary for conventional natural gas production. This requires an integration of core, log and laboratory data at all scales to assess petrology, geo-mechanics, fluid sensitivity and fracture conductivity. Real- time fracture monitoring changes the way wells are stimulated and the control of the fracture propagation path. This analytic complexity requires the use of an integrated approach that involves dynamic simulation, advanced software, sophisticated measurements and real-time fracturing technologies to optimize lateral well placements. This information enables a comprehensive understanding of physical events occurring in wells that are typically 5,000 to 10,000 feet under the surface.

European understanding of the technological challenges is growing rapidly as experience gained in the U.S. is being transferred through operating and service companies, joint ventures and numerous technical discussions. While many believe that the potential for unconventional gas resources may exceed that existing in conventional resource plays, the eventual economic exploitation of these resources will vary greatly between countries depending upon market and infrastructure conditions as well as policy decisions related to environmental and social issues.

Chapter 2:
The Economic and Potential Market Impacts in Europe

The economics of producing shale gas will largely depend upon both geological factors and a host of market and infrastructure factors. The heterogeneity of shale resources means "shale beds have characteristics that vary not only from region to region but also within specific plays and fields. In fact, there are often significant well-to-well variations in gas production within a single field" as noted by the U.S. Energy Information Agency (EIA)[4].

The variability in initial gas production rates has a profound impact on rates of return. The current low level of gas prices within the U.S. reflects both lower costs of producing incremental supplies and a surplus of gas supplies as companies competed to acquire leases that require establishing reserves to meet contractual commitments. The current very low price levels of gas may have to rise to support the expansion of exploration in emerging prospective areas. In order to improve profitability many companies in the U.S. are now seeking shale resources that may also provide liquid hydrocarbon production.

While initial production rates from shale gas wells are high, the wells tend to decline rapidly before reaching a long-term production rate and to have long lives compared to conventional natural gas wells. In instances where there was suboptimal initial fracturing of reservoirs, terminal decline rates of 12-15 years may be extended before reaching economic limits.

A substantial number of wells will need to be drilled in Europe before a preliminary assessment of Europe's economically recoverable production potential can be made. This is expected to take at least another 5-10 years even in areas now experiencing active exploration, like Poland. As of March 2011 only 5 exploratory shale gas wells had been drilled with a total of 15 planned for the year 2011. (It should be noted that with Poland's very low level of current natural gas production even modest success on shale plays could have a substantial impact on Poland's domestic production of gas.)

The development of and the costs associated with above ground infrastructure will also play a critical role in determining the rate and profitability of European shale gas. Infrastructure requirements include the building of access roads, establishing access to water supplies, waste water treatment facilities, gathering lines, establishing gas processing facilities, and links to transmission lines. Public acceptance of such infrastructure development as well as acceptance of environmental consequences will be crucial to enabling profitable development to occur. This will be discussed further in the next section.

Equally important will be the market price for gas. It is well understood that the rapid expansion of unconventional gas supplies in North America has created a significant divergence between the price of oil and natural gas within the U.S. Gas prices have fallen well below the costs of landing LNG, such that supplies originally destined for the U.S. are now being diverted to other markets, especially towards Europe. While this trade augments supplies and has softened the market for gas in Europe, it has not yet eliminated the basing of major gas contracts on oil prices, as it has in the U.S. The latest projections by the DOE's EIA, included in the Annual Energy Outlook 2011, show U.S. natural gas prices remaining below $6 per MMBtu (or per MCF) in real 2009 dollars for the next 20

4 American Association of Petroleum Geologists, Explorer Magazine, "Shales- Similar, Yet So Different," by Louise S. Durham, September 2010,Pages 28,33 as reported

years. This U.S. price projection could prove low if demand for gas increases and/or higher costs are incurred to meet environmental requirements.

As indicated above, the long- term impact of unconventional gas supplies on European markets will not be clear for some time, although an anticipation of such supplies becoming available at competitive prices will tend to make major suppliers more flexible. Moreover, the development of options, and the timing of additional gas supplies should provide buyers greater leverage over source and price.

Uncertainty over the cost and magnitude of such supplies may also lead to a reconsideration of some pipeline links. However, the long term demand for flexibility and greater supplies of gas, especially into Central and Eastern Europe should continue to make an expansion of pipelines to European markets, as well as of interconnectors between Member States, attractive from both an economic, environmental and physical security of supply perspective.

The eventual impact of unconventional gas in Europe will depend on:

- Establishing the magnitude of the resource base to determine if can become a major solution to meeting energy requirements, to addressing climate change concerns and to providing long term energy security.
- Establishing the technology to create an economically affordable resource base; and
- Establishing the regulatory rules and industry practices in a manner that allows environmentally sound development of resources that address public concerns.

Chapter 3: Evolving Environmental and Social Issues

As drilling increases and production grows, a harsher spotlight will fall on unconventional gas development. It is essential that "Green natural gas development" is rapidly implemented in the U.S., and that best practices from an industry and regulatory perspective are shared with Europe and other countries embarking on exploiting shale gas reserves. The world's energy markets will need all the resources that can be economically developed in an environmentally sound manner.

This will require addressing a number of sensitive physical and social issues, such as:

Physical issues

- Reducing land use impacts
- Reducing water use
- Safe disposal of waste –water and chemicals
- Capturing methane emissions
- Ensuring environmentally safe wells and hydraulic fracturing

Social Issues

- Establishing benefits for local community
- Establishing compensation for possible damages
- Addressing "Boom/Bust Cycle" associated with exploration and initial production
- Addressing specific concerns that arise in highly populated areas

Operators intending to undertake exploration will find it prudent to establish early contacts and dialogue with affected local communities before undertaking activities. Such outreach should establish a "meeting of the minds" with the community to agree on the best approach to the timing and pace of development. This is essential in the U.S., and is expected to be especially important in Europe, where mineral rights reside with the state. It was noted that governments sometimes make the mistake of holding discussions between politicians and planners about the planners' wishes and not between politicians and the public about the public's wishes. In the U.S., land- owners understand that they will economically benefit, but, in Europe, national governments may have to establish special financial mechanisms to provide direct financial benefits for local communities affected by production.

In both the U.S. and Europe, there will be a number of indirect financial benefits that will arise from greater economic activity associated with an initial influx of highly paid workers that impacts housing and demand for goods and services. Local communities will also benefit from expanding job opportunities, although much of the initial employment will involve highly trained exploration and production experts owing to the complexity of operations. Communities will have to learn to adapt to the phase down in economic activity that will accompany the shift to long- term production, which could last decades.

In Europe, as in the U.S., it will be necessary to establish procedures and compensation mechanisms to address the inevitable physical damage and disruptions that will occur from heavy truck traffic to move equipment, materials, water for hydraulic fracturing and waste water disposal. Many rural roads may need to be upgraded through widening, resurfacing and reducing curve angles. Other surface impacts at the

drilling site come from pit construction, chemical storage and erosion control equipment as well the location of compressors, gathering lines, water treatment facilities, and air emissions controls. Neighbors as well as directly affected land -owners will also be impacted by noise from nearby facilities. In the U.S., compensation is only provided for physical damages, i.e. individuals and communities are "made whole"; it is not a "get rich quick" scenario. In addition, neighboring communities can also be impacted by infrastructure requirements, such as right- of -ways to establish gather lines, processing facilities and new transmission lines as well as from road construction and traffic.

The key is finding the right balance. Economic development of low permeability unconventional resources requires technologies that increase well bore conductivity with the reservoir to improve well deliverability and access to hydrocarbon reserves. Fortunately, technology advances in horizontal drilling and hydraulic fracturing have enabled the tapping of large reserves of oil and gas with smaller footprints from an environmental and social perspective.

Water issues have risen as a paramount concern in some communities. This can involve both surface and subsurface issues. In the U.S. conditions vary widely between states and by operations within states. Hence, the U.S. model of regulating water issues through state authorities seems to be logical and most practical. The European regulations are following a similar pattern with broad EU Directives being implemented by Member States and local authorities.

In the U.S., surface issues relating to water supply are being addressed through a number of techniques such as water recycling, the establishment of catchment ponds to meet water supply requirements and the laying of pipelines to reduce disruption from trucking. Recycling and on site treatment also has the advantage of reducing waste- water disposal requirements. In regions where waste water disposal wells are not an option waste water is often sent to state permitted treatment plants before discharge into rivers. However, it is becoming increasing clear that surface facilities can occasionally fail and that the treatment of waste water does not always adequately address all concerns arising from contaminates associated with drilling fluids and increasingly from naturally occurring minerals such as radioactive materials, arsenic, and mercury. Some companies are developing cleaner, so called "green" drilling fluids that are expected to be required under EU regulations. The treatment of waste water to remove radioactive materials etc. that occur naturally in deep formations will most likely require major changes to treatment methods and systems.

Well integrity is seen as the key to resolving concerns associated with the possibility of subsurface fluid polluting underground water resources. In the U.S. efforts are underway to dial down the rhetoric and identify the real obstacles to responsible development of unconventional gas and oil production. Serious consideration of the real issues will enable the development of workable solutions to overcome problems identified by the changing nature of development with deep horizontal drilling and hydraulic fracturing. An industry-initiated effort in cooperation with non-governmental organizations is ocused on four basic components, namely:

- Evaluation of stratographic confinement
- Establishing well construction standards
- Evaluation of mechanical integrity of wells
- Monitoring of frac job and production with real time data

Unconventional production is usually obtained from production horizons 5,000 to 10,000 feet below the surface. Most fresh water is produced from depths less than 500 feet. At the greater depths differences in rock properties (i.e. strength and brittleness/elasticity) between the target formations and surrounding formations act to contain hydraulic fractures within the target formation. Micro-seismic evaluations of stimulation treatment can determine the extent of fluid flow from around a laterally fractured well bore and ensure that migration to higher horizons is being avoided. In contrast, shallow wells create different issues that can arise from abandoned wells and shallow transmission faults. Sometimes gas migration from biogenic or shallow thermogenic sources of gas is mistakenly believed to be associated with the deeper wells involved in unconventional production.[5]

5 In some instances there has been leakage of methane from improperly cemented well casings. The steps to ensure well integrity should greatly reduce such event, which have been relatively infrequent.

Hence, it is critical to establish well construction standards that provide appropriate surface and production casings that have been properly cemented to avoid leakage, or fluid migration along the vertical portion of the well bore. Ensuring this is done correctly involves verifying the appropriateness of the proposed casing program (e.g., size, grade, minimum internal yield pressures) and testing the casing strings to ensure they can withstand the various pressures they will be subjected to during drilling, completion and production operations. In addition, the quality of the cement needs to be verified along with identifying the top of the cement /casing interface and confirming sufficient cement coverage (adherence of casing to cement and cement to formation). Cement bond logs, radial evaluation tools and other devices are available to enable the precise evaluation and regular monitoring of these characteristics to ensure well integrity.

Creating a model regulatory framework for hydraulically fractured hydrocarbon production wells is viewed as essential to establishing industry discipline and public acceptance of unconventional oil and gas production. However, no matter how good the regulatory framework and industry adherence to best practices, more financial resources will likely be required by the regulatory agencies to have regular inspections in the field. It was also recommended that many of the water well contamination claims could be avoided if baseline testing was done on all water wells within the geological vicinity of proposed new drilling prior to conducting any operations.

Chapter 4: Organizations Focused on Environmental Issues Related to Oil and Gas

In the U.S. a number of organizations are focused on influencing and recommending legislation and regulations to protect the environment while supporting the development of oil and gas resources. The Interstate Oil and Gas Compact Commission is a multi-state governmental agency "who aims to ensure oil and natural gas resources are conserved and maximized while protecting health, safety and the environment." It provides state governors a unified voice in Congress and "assists states in balancing a multitude of interests through sound regulatory practices". In addition, the previously mentioned Ground Water Protection Council, exists to assist states in specific issues related to protecting the quality and quantity of ground water. Both groups assist industry in interacting with the state legislatures, the U.S. Congress, the Environmental Protection Agency (EPA), and a myriad of non-governmental policy organizations and local community organizations addressing environmental concerns.

A recent American Petroleum Institute (API) study[6] indicated that produced water represents approximately 98 percent of the total volume of exploration and production waste generated by the oil and gas industry and is the largest volume waste stream generated by the industry. Approximately 71 percent of all produced water is injected for enhanced recovery (a beneficial use) and 21 percent is injected for disposal. For the balance, 5 percent is either treated and discharged or beneficially used for irrigation and or livestock/wildlife watering. The last 3 percent is placed in ponds for percolation or evaporation.[7]

6 API HF2, Water Management Associated with Hydraulic Fracturing, First Edition/June 2010

7 In the US produced water is exempt from regulations under the Resource Conservation and Recovery Act (RCRA). Under the Clean Water Act NPDES rules produced water may not be discharged into navigable waters with two exceptions: 1)west of the 98th meridian where water is clean enough for agriculture and livestock and 2 stripper well (less than 10 barrels per day of oil). Also discharge of Coalbed Methane produced water is mostly unregulated at the federal level.

In the U.S., several major NGO's are focused on the environmental impacts of unconventional gas. Their concerns cover a wide range of issues primarily focused on avoiding the degradation of water, soil and air quality. While concerned over the full range of environmental impacts from all aspects of exploration and production, these organizations usually support the concept that solutions reside in technology and regulations. Technological solutions already discussed are expected to result in substantial cost savings and to be profitable for the industry provided they are embraced by industry. Major U.S. NGOs also support the growing industry efforts to develop appropriate regulations, monitoring and enforcement mechanisms to increase public support and avoid political pressures to impose regulations that would hinder the development of unconventional gas resources. Fundamentally, the U.S. NGOs are interested in ensuring that industry behaves responsibly towards the environment on all aspects of oil and gas production.

The U.S. oil and gas industry has drilled over one million wells utilizing hydraulic fracturing techniques. What is relatively new is the combination of horizontal drilling, improved seismic technology and advanced hydraulic fracturing to develop shale gas. Industry practice and the maintenance of well integrity is key. According to investigations by state and federal regulators, most of the media reports on ground water contamination have not arisen from hydraulic fracturing. However, contamination has occurred in ground water wells from improper abandonment of shallow oil and gas wells, and from surface contamination leaking into ground water supplies. In addition, not following best practices can unintentionally lead to problems. **It is understood that the less consciousness/prudent operator heavily impacts the industry's public reputation.**

The importance of establishing best practices and more comprehensive procedures for surface and subsurface impacts is seen as essential. Again it is recognized that this will entail additional costs, as more monitoring, verification and enforcement will be required on a regular basis. Surface contamination can create air, land and water pollution. The industry has solutions to avoid, or dramatically lower, the impact of such events. For example, methane capture is not only environmentally responsible, but proving highly profitable. An 84 percent reduction of surface footprint, along with erosion control and a move to closed-loop drilling systems can dramatically reduce land pollution. The use of pipelines to transport well water and accessing local water sources can also reduce the environmental impact on land. The exposure to water pollution is being reduced with recycling and the treatment of waste water before disposal. At the same time, waste water treatment facilities (both public and private) may need to be modified to remove some of the naturally occurring contaminates, such as radioactive elements that are being brought to surface facilities and are often not removed by existing treatment facilities.

Importantly, the industry will need to establish and ensure that best practices are clearly understood and are being followed. **The development of unconventional oil and gas has progressed so rapidly over the past decade that it temporarily outpaced the development of industry practices and regulations.** Industry practices and regulatory frameworks are in the process of being adjusted to respond.

The strength of a system that relies on state regulators and the Interstate Oil and Gas Compact Commission is that it creates 50 mini laboratories to determine what works economically as well as for the public benefit in a wide variety of circumstances. The effectiveness of the system depends on the political will of government in each state. It should be noted that the IOGCC also has affiliates in all Canadian province and 76 years of U.S. history with oil and gas industry regulations.

In Europe, discussions indicated that unconventional gas developments could be impacted by the high priority being placed on reducing greenhouse gas emissions. Some influential environmental organizations are taking the position that climate change concerns require becoming 100 percent dependent on non-fossil fuels by 2050. Shale gas is not seen as a transition solution to lowering greenhouse gas emissions, but as prolonging the life of a carbon based energy system. To the extent shale gas were to replace coal it would be viewed more favorably. However, there are concerns the long-term production life associated with unconventional gas and natural gas installations like power stations in general, could delay or prevent the development of renewables, which are still facing fragile economics versus fossil fuels. Such concerns are not focused on conventional versus unconventional production, but on the extent to which the EU will take major steps to reduce carbon emissions to prevent the rise in temperatures above 2 degrees Celsius.[8]

8 These concerns are especially strong in Western Europe and less strong in Central and Eastern Europe where the rebalancing of energy supplies towards non -carbon fuels will be more difficult and there are greater concerns over physical security of supplies on reasonable economic terms.

Chapter 5: European Union Directives

European legislation related to oil and gas development does not distinguish between conventional and unconventional production. As in the U.S., broad industry wide Directives relate to general oil and gas industry requirements to preserve and improve the environment. The industry must be highly sensitive to environmental concerns and to ensure that no new environmental public health problems are created. Industry developments must be in line with EU environmental legislation, with EU Directives binding on Member States which are responsible for their transposition in national law and their implementation.

The most relevant of these regulations are those requiring Environmental Impact Assessments for all projects with significant effects on the environment. For example, natural gas extraction is always subject to an assessment if daily extraction is greater than 500,000 cubic meters. This threshold is being reassessed with a European Commission proposal for a new Directive to be adopted by mid-2012. Below this threshold, projects are subject to a "screening procedure" by which Member States decide whether an assessment is needed. Member States are also required under the Water Framework Directive (WFD) to improve the chemical and quantitative status of groundwater by 2015 by preventing and limiting inputs of pollutants to groundwater, as well as by preventing the deterioration of open water bodies. The WFD requires "River Basin Management Plans" covering surface and groundwater to be established by Member States and to be updated every six years. The WFD also prohibits direct discharges into groundwater (with exceptions for exploration and exploitation of hydrocarbons provided that environmental objectives for respective water bodies are not compromised). Other legislation includes an Environmental Liability Directive, legislation on noise applicable to installations, a network of nature conservation sites according to the Birds and Habitats Directives ("Natura 2000"), and a Directive to ensure public access to environmental information.

Also relevant to unconventional gas development are the regulations on chemicals. These include the Regulation on Classification, Labeling and Packaging (1272/2008/EC) of substances and mixtures before they are marketed and the Directive on Registration, Evaluation, Authorization and Restriction of Chemical Substances (2006/1907/EC). Information on the properties of chemical substances must be registered in a database run by the European Chemicals Agency (ECHA) and identified risk must be managed. In-depth evaluations of suspicious chemicals are undertaken and there is a progressive substitution of the most dangerous chemicals when suitable alternatives have been identified.

Member States are free to set more stringent protective measures than those required by EU legislation. Most often, EU legislation takes the form of Directives, which are not directly applicable to citizens and companies but have to be transposed and implemented by the individual Member States. Frequently, the EU Directives set objectives with the means to be determined by the Member States.

Under the Treaty on the Functioning of the European Union (TFEU, as established by the Lisbon Treaty), "Union policy on energy shall aim […..] to (a)ensure the functioning of the internal energy market; (b) to ensure security of energy supply in the Union; (c) promote energy efficiency and energy savings and the development of renewable forms of energy; and (d) promote the interconnection of energy networks." (TFEU, Art. 194.1). There is also new direct reference that EU energy objectives are to be pursued/achieved "with regard for the need to preserve and improve the environment".

In line with these objectives, the European Commission has recently adopted or plans to adopt a set of energy policy initiatives:

- EU Energy Strategy 2011-2020
- European Energy Infrastructure Package
- Energy Efficiency Action Plan
- Communication on External Energy Relations
- Energy Roadmap 2050

The Third Internal Market Package requires non-discriminatory access to networks to enable fair competition between suppliers through inter alia a new "Gas Regulation" and "ACER Regulation". The former sets conditions for access to the natural gas networks and the latter establishes an Agency for the Cooperation of Energy Regulations. In addition, a new Gas Directive, effective March 3, 2011 establishes common rules for the internal markets in natural gas. Although the Third Internal Market Package does not specifically address unconventional gas, it will further open up gas markets and thereby also facilitate the marketing of natural gas produced from unconventional sources.

The Commission's DG Energy is currently undertaking a legal study of the EU legal framework (including environmental issues) to evaluate its appropriateness while following ongoing projects and Member States activities. The European Commission emphasizes the need to make best use of indigenous fossil fuels and to assessing best regulatory practices, which should be disseminated among the Member States.

Chapter 6: US Federal Oversight

Federal regulation of the oil and gas industry similarly arises from a number of federal acts. The Federal Energy Regulatory Commission (FERC) is responsible for the review and authorization of interstate natural gas transmission facilities in the U.S. Other relevant federal statutes that impact interstate natural gas pipelines include:

- Clean Air Act
- Clean Water Act (CWA)
- Safe Drinking Water Act (SDWA)
- Endangered Species Act
- Costal Zone Management Act
- Fish and Wildlife Coordination Act
- Historic Preservation Act
- River and Harbors Act
- Mineral Leasing Act
- Federal Land Policy Management Act, and
- Wild and Scenic Rivers Act.

The Environmental Protection Agency (EPA) is charged with a wide variety of responsibilities related to protecting the environment. As these relate to the unconventional oil and gas industry the EPA is focused on protecting water to meet the requirements of the Safe Drinking Water Act (SDWA) and Clean Water Act (CWA). Public and congressional concerns related to hydraulic fracturing have focused on the sustainability of water resources and the impact upon drinking water quality.

The SDWA requires the EPA to set legal limits on certain contaminants in drinking water. It also requires the EPA to protect underground sources of drinking water from contamination caused by underground injection, although there are provisions that provide for states to have primary authority. In addition there is a provision to address imminent and substantial endangerment. Under these authorities the EPA regulates six classes of underground injection wells (UIC). Class II wells may inject fluids associated with oil and natural gas production for:

- Enhanced recover of oil and natural gas (including hydraulic fracturing with diesel).
- Disposal wells, which inject fluids, associated with oil and gas production or gas storage operations brought to the surface (include wells used to dispose of flowback from hydraulic fracturing); and
- Hydrocarbon Storage wells which inject liquid hydrocarbons for storage, usually part of the US Strategic Petroleum Reserve.

Under the CWA the EPA is responsible for establishing water quality criteria and standards, setting effluent limitation guidelines, and permitting under the National Pollutant Discharge System. Direct discharges into waters of the U.S. (e.g., rivers and streams) are controlled by state water quality standards and water quality based effluent limits as well as by technology- based standards (effluent limitation guidelines) that are required to obtain National Pollutant Discharge Elimination System (NPDES) permitting. The EPA also sets standards for indirect discharges into sewers with National Pretreatment Standards that are supplemented with local standard to enable permitting by local entities of Publically Owned Treatment Works (POTWs).

At the request of Congress, the EPA is undertaking a study on the Impact of Hydraulic Fracturing on Drinking Water Resources. Public hearings have been held that indicated a wide range of concerns which were sometimes conflicting and that were more strongly voiced in geographic regions that have not historically experienced significant oil and gas drilling. These concerns include: ground and surface water contamination, air pollution, ecosystem impacts, seismic risks, public safety, occupational risks, and economic impacts.

The EPA is developing a draft study plan by working with a Science Advisory Board, undertaking a literature review, an internal EPA review and coordinating with other Federal Agencies, such as the DOE and USGS. The Final Study Plan should be completed by mid-year 2011. An interim report is expected to be available by the end of 2012 that will provide basic information on a range of subjects, such as: an analysis and map of existing water quality and quantity data, the identity of chemical and naturally occurring substances in wastewater, a scientific literature review of surface chemical spill. More detailed analysis that will include an assessment of the impact of water withdrawals and the toxicity of chemicals will follow in a 2014 report.

The Bureau of Land Management (BLM), a division of the U.S. Department of the Interior, is responsible for managing oil and natural gas development on 253 million acres of federal lands and 700 million acres of sub-surface minerals held in federal estate. The bureau manages 12.3 million acres of producing leases, 30 percent of total leased acreage. These leases produce 6 percent of domestic oil and 13 percent of domestic natural gas. Forty- nine percent of federal oil and gas revenue goes to the states. At this time, virtually all the Bureau's responsibilities relate to conventional oil and gas drilling and production, as unconventional leasing is occurring on private and state held lands. The Bureau's very comprehensive policies require best practices and the employment of effective mitigation measures to ensure appropriate land use, and to manage and approve right-of-way process and procedures for oil and gas pipelines. The Bureau uses an open and deliberate process to engage the public and other stakeholders, and modifies routes based on public and other agency feedback. Thus, they also have an impact on the pace and extent of unconventional gas developments, although they are currently having minimal impact on leasing and drilling.

Chapter 7: Recommendations on Transatlantic Cooperation

The U.S. oil and gas industry has a long history (over 75 years) of working with a complex mix of state and federal regulatory agencies and statutes dealing with every aspect of the industry. The Federal government has carefully defined roles related to interstate commerce, developments and right-ways on federal lands, and national environmental standards related to land, air and water. States have extensive authorities to set environmental, drilling and production standards and to regulate development within their jurisdictions. Most importantly, mineral rights on private lands rest with private owners who lease and obtain revenues directly from mineral development.

In the past decade, the U.S. has developed substantial additional gas resources from shale reservoirs that have dramatically altered the long -term estimates of gas supplies in the U.S. On-going assessments in a number of countries indicate that significant potential shale gas resources probably exist globally. In Europe, developers have initially focused on unconventional gas resources in Poland, and are now looking elsewhere, especially in Central and Eastern Europe as well as in the UK and Germany. The eventual level of such unconventional gas resources will not be known for many years as extensive drilling will be needed to determine the actual extent and magnitude of such resources. The geology is extremely complex and the technologies to be employed require sophisticated industry support. Moreover, the technology continues to evolve at a rapid pace.

In the U.S., public issues have arisen in areas where oil and gas production is new, and Europe is likely to have a similar experience. While the U.S. has a complex governmental, industry and regulatory infrastructure to address the environmental and public concerns associated with oil and gas development, it is still confronted by issues which are currently being resolved. Countries interested in developing such resources will need to establish a comprehensive set of regulatory and industry practices to address environmental issues related to development, especially (but not exclusively) related to water. In addition, European countries will need to establish mechanisms for sharing of revenue with local communities and citizens impacted by development.

The U.S. government and industry is in an excellent position to assist other countries in sorting through the issues and regulations needed to safely and responsibly develop unconventional resources. Ultimately development will depend upon the political will in each country, which will arise from local, regional and national discussions. Further, countries will also need to develop their own regulations though a dialogue with their citizens and other stakeholders as appropriate for their own situation.

In the U.S., there is a need to establish a model regulatory framework for both hydraulically fractured hydrocarbon production wells and for the surface infrastructure that must accompany the development of unconventional gas and oil. This framework should reflect best practices and have the ability to accommodate new technology developments. It should include requiring procedures for testing geographically adjacent water wells prior to the start of any drilling activities as well as a willingness to divulge the chemical composition of the hydraulic fracturing fluids. Similar frameworks are likely to be desirable in Europe.

The workshops held in Washington D. C. and Brussels were designed as initial steps in an expanding discussion across Europe, and sought to directly involve the European Commission, as well as Member States' regulatory authorities. The workshops, along with other industry conferences and a

number of bilateral discussions, should develop a network that will enable and support further development of the industry. U.S. and international oil and gas companies should work closely with national oil and gas companies, as well as with governmental regulatory authorities at the federal, national and local level, and with concerned communities to identify best practices that will support processes and procedures to avoid environmental degradation and public opposition. The U.S. federal government should continue to encourage the transfer of U.S. learning overseas.

It is essential that the regulatory framework and industry practices be established in a manner that enables individual countries to address their specific conditions while meeting Europe's overall concerns on ensuring secure, sustainable and competitive energy supply for all of Europe.

ATLANTIC COUNCIL

A Realistic Balanced Perspective on European Unconventional Gas Developments

A North American Perspective

January 25th, 2011
Washington, D.C.

Welcome and Introduction – Atlantic Council
Gen. Richard L. Lawson, Vice-Chairman, Atlantic Council of the United States

Session I: Geological Prospects and Challenges

- Review location of Conventional and unconventional potential gas reserves in Europe. Discuss Shale Gas, Tight sands and Coal Bed Methane

  Brenda Pierce, USGS

- Review specific geological challenges associated with each source of unconventional resources. Provide focused discussion on shale gas resources- "Each well could be a Ph D thesis"

  i. Complexity of formations

  ii. Uniqueness of individual field formations

  iii. Re-fracturing required to maintain production

  Valerie Jochen, Unconventional Gas Technical Director, Schlumberger

Session II – The Economics and Market Impacts of Unconventional Gas in Europe

- Review range of costs for Shale gas, tight sands and coal bed methane; provide perspectives on North American costs vs. potential European costs

  Michael Schaal, Energy Information Administration

- Assessment of current global shift in gas supplies and impact on gas pricing and contract terms of unconventional gas

  Vello Kuuskraa, Advanced Resources International

Session III - Evolving Environmental and Social Issues

- Investments and Surface Impacts associated with Infrastructure requirements
  - Infrastructure Investments
    - Road access to drilling sites
    - Investments for gathering lines and gas plants, connections to /distribution/trunk lines

  Mike Moore, Blue Source

- Social/economic impacts of transportation disruptions and landscape
    - Drilling Pads, truck traffic and right of ways
    - Social/Economic impact of exploration phase

Sally Kornfeld, U.S. Department of Energy

Session IV – Regulatory Environment: Existing and Current thoughts on Prospective Regulations

Review: Exploration, Development and Operating Regulations, Concerns over land ownership and building infrastructure for pipelines and access to facilities. Public Perceptions and Reactions in North America and expected concerns in Europe

a) Company Perspective

Mark Boling, Southwestern Energy

b) NGO Perspective

Kate Sinding, Senior Attorney, NRDC

c) National versus state perspectives

i. U.S. perspectives at State level

Mike Smith, Executive Director, Interstate Oil and Gas Compact Commission

ii. U.S. Land Management

Nick Douglas, Bureau of Land Management

iii. U.S. Environment Protection

Chitra Kumar, Director Drinking Water Protection Division, EPA

Session V – Recommendations on Transatlantic Cooperation

Developing regulations that address environmental and safety concerns without unnecessarily stifling potential development of the industry.

David Goldwyn, Former U.S. State Department's Former Special Envoy for International Energy Affairs

Concluding Comments - Atlantic Council

European Unconventional Gas Developments

Environmental Issues and Regulatory Challenges in the EU and the U.S.

A Joint Project of the Atlantic Council of the United States
and the Institut Français des Relations Internationales

March 14th, 2011
Brussels, Belgium

Welcome and Keynote Addresses

Gen. Richard LAWSON, Vice Chairman, Atlantic Council

William RAMSAY, Institut Français des Relations Internationales

Michael SULLIVAN, Senior Advisor, Office of the Coordinator for International Energy Affairs, U.S. Department of State

Heinz HILBRECHT, Director Security of Supply, Energy markets & Networks, DG Energy, European Commission

Session I: Geological Prospects and Challenges

Moderator: **Chris HOPKINS**, Vice President, Unconventional Gas, Schlumberger

"Each Well could be a PhD Thesis"

Global Shale Gas Assessment of Technically Recoverable Resources

Brenda PIERCE, Energy Resources Program Coordinator, U.S. Geological Survey

US Experience and Outlook

Michael SCHAAL, Director Office of Petroleum, Natural Gas and Biofuels Analysis, Energy Information Administration

Brian HORSFIELD, GFZ German Research Centre for Geosciences

Session II: Evolving Environmental and Social Issues – US Perspectives

Moderator: **Sally KORNFELD**, Team Leader, International Oil and Gas Activities, US Department of Energy

Comments on the Regulatory Framework in the USA, and on the Interactions between the Federal and State Regulators

Environmental Impacts associated with Infrastructure Requirements and Production

Scott KELL, Former President Ground Water Protection Council (GWPC)

Existing and Current Progress on Establishing Operating Standards

Mark BOLING, Executive Vice President, General Counsel and Secretary, Southwestern Energy

Update on Hydraulic Fracturing Study

U.S. Environmental Protection Agency presentation was distributed

Session III: Comments from Major U.S. and EU NGOs

Moderator: **John LYMAN**, Director, Energy and Environment Program, Atlantic Council of the United States

Amy MALL, Senior Policy Analyst, Natural Resources Defense Council

Dr. Stephan SINGER, Director Global Energy Policy WWF International

Session IV: European Parliament Perspectives

Moderator: **William RAMSAY**, Director EU Governance and Geopolitics of Energy (IFRI)

Michèle RIVASI, Greens/European Free Alliance, European Parliament - TBC

Lena KOLARSKA-BOBINSKA, European People's Party, European Parliament

Session V: Evolving Environmental and Social Issues (European Perspectives)

Moderator: **William RAMSAY**, Director EU Governance and Geopolitics of Energy (IFRI)

Unconventional Gas and EU Energy Policy

Michael SCHUETZ, Policy Officer, DG Energy, European Commission

Preliminary Screening of EU Legislation on Environmental Protection of Relevance for Unconventional Gas

Mihai TOMESCU, Policy Officer, DG Environment, European Commission

Licensing and Permitting in Poland

Marta WAGRODZKA, Ministry of Environment, Poland

Licensing and Permitting in Lower Saxony (North-West Germany)

Klaus SÖNTGERATH, Head of Department, Authority for Mining, Energy and Geology, Lower Saxony, Germany

Licensing and Permitting in England; Inquiry by UK House of Commons

Malcolm FERGUSSON, Head of Climate Change, UK Environment Agency

Licensing and Permitting in France; Parliamentary Commission on Environmental Impact

Philippe GEIGER, Ministère de l'Ecologie, du Développement durable, des Transports et du Logement, France

Concluding Comments - Atlantic Council/ IFRI

List of Abbreviations

ACER	Agency for the Cooperation of Energy Regulators
API	American Petroleum Institute
ARI	Advanced Resources International
Bcf/d	Billion Cubic Feet per day
BLM	Bureau of Land Management
CWA	Clean Water Act
DOE	Department of Energy
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EU	European Union
FERC	Federal Energy Regulatory Commission
GSGI	Global Shale Gas Initiative
IOGCC	Interstate Oil and Gas Compact Commission
LNG	Liquefied Natural Gas
Mcf	1000 cubic feet
MMBTU	One million BTU
NETL	National Energy Technology Laboratory
NGO	Non-governmental Organization
NPDES	National Pollutant Discharge Elimination System
POTW	Publically Owned Treatment Works
SDWA	Safe Drinking Water Act
Tcf	Trillion Cubic Feet
TFEU	Treaty on the Functioning of the European Union
UIC	Underground Injection Wells
US	The United States
USGS	The U.S. Geological Service
WFD	Water Framework Directive