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The Global Impact of Unconventional Shale Gas Development

Economics, Policy, and Interdependence

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There is a growing awareness to the role that natural resources, such as water, land, forests and environmental amenities, play in our lives. There are many competing uses for natural resources, and society is challenged to manage them for improving social well-being. Furthermore, there may be dire consequences to natural resources mismanagement. Renewable resources, such as water, land and the environment are linked, and decisions made with regard to one may affect the others. Policy and management of natural resources now require interdisciplinary approaches including natural and social sciences to correctly address our society preferences.
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Introduction

William E. Hefley and Yongsheng Wang

Abstract The booming stories of shale gas development in the US have changed the energy discussion around the world. The supply of cheap shale natural gas from the US and potentially from other shale-abundant countries, e.g., China, Canada, Argentina, Mexico, Germany, UK, Poland, and South Africa, could completely change the energy landscape across the globe. It could have significant impact on not only energy-producing countries, but also large energy consumption countries, e.g., Japan. This chapter provides a background review of global unconventional shale gas development and its potential impacts and challenges. It introduces the breadth of topics addressed in this volume, spanning the economic, policy, and security issues surrounding unconventional gas development globally.

Shale Resources and Global Energy Portfolio

World energy consumption is experiencing significant changes. With the increase of energy efficiency and the availability of alternative energy sources, traditional fossil fuel experienced a steady decline in the global energy mix in recent years and possibly into the future. However, natural gas is not only holding its ground but also projected to increase in the next several decades according to several forecasts (US Energy Information Agency 2013; International Energy Agency 2014; US Energy Information Agency 2015). Natural gas produces lower greenhouse emission comparing to other fossil fuels, which allows it to be a bridge fuel for the transition from traditional fossil fuel to renewable energy (Brown et al. 2009). The steady

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demand of natural gas provides the incentives to explore and develop more natural gas reserves. With technological advancements such as hydraulic fracturing and directional drilling, shale gas became a popular choice in recent decades.

Proved natural gas reserves have grown from 119.1 trillion cubic meters in 1994 to 187.1 trillion cubic meters in 2014, with almost as much reserves in Europe and Asia as there are in the Middle East (BP 2015). Much of this growth is in proved reserves of "unconventional" gas, which is gas that cannot be extracted by "conventional" technologies. There are five main forms of unconventional gas:

- Coalbed methane (CBM), which is contained within the coal from which it was generated.
- Shale gas embedded within the shale from which it was generated.
- Tight gas in reservoirs of very low quality that requires stimulation.
- Biogenic gas, produced through contemporary biological processes.
- Gas hydrates that are preserved in ice on the deep-sea floor or in permafrost. (Andrews-Speed and Len 2014).

Forecasts predict a growth in industrial energy use associated with the growth of energy supplies from shale gas (US Energy Information Agency 2015). One optimistic scenario has predicted that shale gas could become almost a quarter of global gas production by 2030 and account for one-third of global gas production by 2040 (Gracceva and Zeniewski 2013). It also suggests that the share of natural gas in global primary energy supply could reach 31 % by 2040 (Gracceva and Zeniewski 2013). Of course, there are those who caution against these forecasts due to the size of reserves, potential productivity levels that may be achieved or the costs necessary to achieve those levels in these yet to be fully explored deposits (O'Sullivan and Montgomery 2015; Gracceva and Zeniewski 2013).

Shale gas development in recent years has changed the energy discussion in the US, as existing reserves of natural gas coupled with horizontal drilling and hydraulic fracturing make exploitation of these reserves economically feasible. The importance of natural gas is seen as likely to continue to expand over the coming years and is expected to increase even further with environmental considerations, such as greenhouse gas emissions (MIT Energy Initiative 2011). Some have even referred to this phenomenon as a "revolution" (Kolb 2012a).

Shale Gas and Global Energy Supply Chain

Recent analyses have identified in place and technically recoverable shale gas and shale oil in the 95 shale basins and 137 shale formations in 41 countries outside the United States (Advanced Resources International, Inc. 2013).

Natural gas potential and concerns impact many regions of the globe, including the United States, Canada, Russia, the EU-27 (e.g., Poland, France, Germany, United Kingdom, and Spain), Ukraine, the Baltic and Caspian states, Turkey, Asia, including China, Mongolia, Turkmenistan, India, Pakistan, Thailand, Indonesia, and Vietnam; Argentina, Mexico, Brazil, Australia, South Africa, northern Africa (i.e., Morocco, Algeria, Tunisia, Libya, and Egypt), Nigeria, and Middle East (Saudi Arabia and Jordan) (Hefley and Wang 2015; Advanced Resources International, Inc. 2013; Rivard et al. 2014; Raszewski and Górski 2014; Bilgin 2011; Boussena and Locatelli 2013; Paltsev 2014; Hu and Xu 2013; Bilgin 2009; Johnson and Boersma 2013; Pigg 2013; Kropatcheva 2014; Szul 2011; Alexeyenko et al. 2013; Molis 2011; Fackrell 2013; Winrow 2013; Kolb 2012a, b; Umbach 2013; Kuhn and Umbach 2011, Lawson et al. 2011; Sakmar 2011; Aladeitan and Nwosu 2013; Hrayshat 2008; Deemer and Song 2014; Andrews-Speed and Len 2014; Ha 2014; Popp 2014).

While the US has been exploiting hydraulic fracturing and shale gas production (Hefley and Wang 2015; US Energy Information Agency 2015; National Energy Technology Laboratory 2013; US Department of Energy 2009), many of the studies looking at this gas production in other parts of the world focus on the scenarios that may evolve around gas production and the factors that could impact exploration and distribution of shale gas. Weijermars (2013) explored potential gas scenarios in Continental Europe, while Bilgin (2011) has identified multiple policy scenarios reflecting possible European energy scenarios. Paltsev (2014) identified additional scenarios when considering a larger geographic scope, addressing supply and demand in both Asia and Europe. Multiple factors such as oil prices, rate of exploration in various plays, environmental commitments, strategic initiatives, institutional changes, and actions of the concerned nations all could influence the actual future outcomes (Bilgin 2011; Boussena and Locatelli 2013; Paltsev 2014) Gracceva and Zeniewski (2013) explored the global potential of shale gas development and its impacts.

Primarily, natural gas is traded on the local and regional markets. Due to the high transportation cost, only a small percentage of natural gas is shipped across the globe. The shale boom, especially in the US, encourages energy companies to explore ways to internationalize natural gas trade. Some of the shipping companies are investigating possible ways to use liquefied natural gas (LNG) as the fuel for their large tankers in order to lower the transportation cost (DNV 2014).

Concerns that emerge from examination of the scenarios described above are energy security (Filho and Voudouris 2013) and energy interdependence (Verrastro and Ladislaw 2007). An aspect of energy security in many economies is the extent of diversification in sources of oil and natural gas supplies (Cohen et al. 2011). Shale gas plays have increased diversification in gas supplies over the last decade. A key reality facing consumers, businesses, and nations today in the face of this diversification is the reality of energy interdependence (Verrastro and Ladislaw 2007). For example, Rogers (2011) examined the impacts of diversion of LNG that once would have flowed to the US, but which has been replaced in consumption by domestic shale gas. World attention turned to these international interdependencies as energy became an issue in the Russia–Ukraine gas dispute of 2006, the Russia–Belarus oil dispute of 2007, and the 2008 Georgian–Russian War (Moraski and Giurcanu 2013). Interdependence requires that researchers take a global perspective on the economics and impacts of unconventional shale development. Chojna et al. (2013) argue that rising supplies of unconventional gas will improve global energy security over the long run, but these issues and interdependencies must be addressed as this exploration, distribution, and consumption of unconventional gas occur in an interdependent world.

Shale Resources and the Impacts of Its Development

This book examines the economics and related impacts of unconventional shale gas development in this interdependent, international context. The international issues surrounding the exploration and exploitation of conventional and unconventional natural gas span multiple perspectives: policy, international relations, international trade, environmental management, and business management, as well as impacts on businesses and consumers.

Challenges relate to energy security, environmental impacts and climate change, legislative and regulatory frameworks, securing the social license to operate, access to land and water, and the institutional capacity for both governance and development of shale reserves (Jarvis 2014). These concerns are often heavily intertwined. For example, Bahgat (2010) identifies five areas of risk to energy security: geopolitical, national security, economic, reliability, and environmental.

Energy Security and Shale Development

Energy security is a concern among nations dependent upon others for their energy supplies. In reality, that makes it a concern for all nations, as none are energy independent (Verrastro and Ladislaw 2007). Energy security can be considered in terms of access to energy, the availability of energy, and the acceptability of energy sources (WTO 2010). Using these lenses, energy security can be seen as both an economic concern, regarding topics such as energy consumption, market structure, price and supply of energy, as well as a national security concern, both from the standpoint of critical infrastructures for the distribution and storage of energy within the countries, political stability of exporting countries, nations' reliance on depleting conventional oil and natural gas, and the geographic distribution of these reserves (Filho and Voudouris 2013; Flahery and Filho 2013; Löschel et al. 2010). Factors such as sources and diversification in sources of natural gas supplies; political risk associated with supplier nations; the size, energy demands, and internal supplies of importing countries; and transportation risk all impact concerns regarding energy security (Cohen et al. 2011).

There remain great uncertainties about how the shale gas plays will develop in the international context. In examining European energy futures, Bilgin (2011) has identified as many as 16 differing contingencies, depending on the matchup between potential economic and policy scenarios. He predicts that the political outcomes of these scenarios tend to bring different futures. Regardless of which scenario emerges in the coming years, security of supply will likely remain an issue for Europe (Favennec 2005).

One area where energy security concerns have become evident, both as risks to nation states and as levers of foreign policy, can be seen in Russia's relationship as a supplier of natural gas (Sabonis-Helf this volume; Boussena and Locatelli 2013; Szul 2011; Kropatcheva 2014; Bilgin 2009). Scenarios suggest that Europe will continue to import sizable amounts of gas from Russia for some time (Paltsev 2014), so these issues of energy security will likely remain salient in that region. However, this may change in the future should shale gas plays within Europe prove to produce at economically feasible costs and prices (Weijermars 2013).

Policy and Regulatory Discussions

As with any new resource-intensive industry, the shale gas industry faces policy and regulatory challenges. In regions just beginning to explore unconventional gas development, many energy companies and governmental agencies do not have long-term experiences in shale gas development. The rapid technological advancement in drilling and processing brings efficiency to shale gas production and difficulty for governmental agencies to monitor its development properly. Recent years of excess supply of shale gas in the local areas and depressed natural gas prices in the US brought another challenging question to the government: "How much should shale gas industry be taxed in order to keep sustainable development and benefit the regional economy?"

Regulatory concerns often focus on shale gas extraction and its potential environmental impact. A European Commission report concluded that the environmental impacts of shale gas extraction were greater than those of conventional gas extraction (AEA 2012). Numerous potential environmental impacts of unconventional gas development have been identified which could impact both air and water quality. These include carbon footprint and fugitive methane gas, anthropogenic induced seismic activity, surface and ground water contamination, and other water-related concerns, such as waste water reuse, remediation, and storage, and the availability of water resources used for production (US Department of Energy 2014; Vandecasteele et al. 2015; Johnson and Boersma 2013; Boersma and Johnson, 2012; Rozell and Reaven 2012), and environmental impacts and climate change mitigation (Stephenson and Shaw 2013; Rivard et al. 2014; Brantley et al. 2014; Schrag 2012).

Environmental concerns surround unconventional natural gas extraction and production. Brantley et al. (2014), in a review of water contamination issues in the Marcellus Shale in the US state of Pennsylvania, found that there were "relatively few environmental incidents of significant impact compared to wells drilled." Many of these concerns are focused on the after effects of gas plays, but with hydraulic fracturing, there are also significant concerns about water supply and both the impact of fracking on the world's limited water supplies and the availability of water to support unconventional gas production (US Department of Energy 2014). The recommendations of Rahm and Riha (2012), which focused on regional actions to balance environmental concerns and water policy, may need to be extended to a global view of water use and water protection from environmental harm.

Legal, regulatory, and institutional issues relate not just to environmental factors but to larger concerns surrounding shale gas production, transport (Aladeitan and Nwosu 2013; Murtazashvili 2015; Boersma and Johnson 2012) and resulting public health concerns (Finkel et al. 2013). Murtazashvili (2015) and McGowan (2014) have identified that regulatory responses may indeed differ by the economic and political contexts of the regions and countries impacted by shale development and transport.

Other factors may also play a role in the decisions regarding potential development of shale gas. For example, Labelle and Goldthau (2014) attribute the ban on shale gas development in Bulgaria to the existing government's interest in staying in power and policy processes in place, although they note that environmental protests and perhaps foreign interests also played a role.

Economic Impacts and Investment Opportunities

There are investment opportunities surrounding all aspects of shale development, e.g., engineering design, supporting equipment, production materials, drilling services, legal services, and infrastructure construction. These opportunities are both domestic and international. Various studies have examined the economic impact of shale gas extraction (Hefley and Seydor 2015; Wang and Stares 2015; Hardy and Kelsey 2015; Kelsey and Hardy 2015; Tunstall 2015; Brasier et al. 2015; Lipscomb et al. 2012; Halaby et al. 2011; Hefley et al. 2011; Higginbotham et al. 2010; Krupnick et al. 2015; Kelsey et al. 2012; Uddameri et al. 2015; Mănescu and Nuño 2015), while others have criticized some studies for overstating the impacts (Kinnaman 2011).

International capital moves around the world acquiring shale exploration rights, testing shale energy production wells, and investing in production facilities designed for energy export, e.g., LNG terminals. International oil and gas companies, e.g., Exxon Mobile, Chevron, have a presence in all major regions around the world with shale reserves, e.g., Asia, Europe, and America. Major energy importers such as Japan and China invest in either shale wells or LNG production facilities in countries like the US. Countries, e.g., Mexico, that traditionally closed energy market to foreign investments are opening them up. Shale exploration is capital intensive. It is unlikely that developing countries can develop these resources without foreign investments. The various firms that make up the value chain for exploring, developing, and exploiting shale reserves may not exist in all regions that now find themselves with shale reserves (Economist 2009). The ecosystem of firms to support this value chain (Seydor et al. 2012) may need to develop in these nations to effectively exploit their shale reserves.

Unconventional shale gas wells have much faster depletion rate compared to conventional natural gas wells. It is more attractive to investors since they do not need to wait too long to see profit from gas production. However, the difference in ownership of natural resources across countries has complicated the situation for investors. In the US, natural resources such as minerals and shale gas are largely privately owned. On the contrary, these resources are state owned in most other countries in the world (Williams 2012). Thus, the entry barrier of shale gas development is relatively low in the US, which makes it possible for small businesses with limited capital and equipment to participate. It has created another "Gold Rush" moment (Economist 2013). Both return and risk belong to the market participants.

In a market where the government has the ownership of the resources, the extra cost is borne with not only political uncertainty and bureaucracy, but also with potential disincentives to local communities and households who would bear only the inconvenience of the development, but not the financial gain through compensation of royalty (Sakmar 2011).

In certain economies, such as China, where the government is supporting shale exploration to meet domestic energy demands associated with continued economic development, there are questions as to whether granting foreign investors mining rights would be advantageous to speed development of shale gas (Hu and Xu 2013).

Investment opportunities in exploiting shale plays across the globe also bring up potential economic impacts to existing energy producers. Countries such as Nigeria face potential economic changes as a result of energy from shale replacing the use of Nigeria's crude oil and LNG by their importers (Aladeitan and Nwosu 2013).

Policy discussions are not only just relevant at the level of nation states, but also at the level of regions and localities. Studies have identified measurable local and regional impacts of shale plays in the United States (Wang and Stares 2015; Kelsey and Hardy 2015; Kelsey et al. 2012; Brasier et al. 2015). Local policies may be developed to address education and skill creation/upgrading to support the shale plays, incentives and support for local supply chain participation, and fiscal policies (Whyman 2015).

These outcomes cannot emerge without the social license to operate and to develop the proved shale reserves. In countries, such as the UK and Bulgaria, community resistance to shale gas development has led to vocal feelings of "Not In My Back Yard" (NIMBY), or "Not In Any Body's Back Yard" (NIABY) and resulting protests against the development of shale plays (Kemp 2014; Schaps and Twidale 2015; Labelle and Goldthau 2014; Williams 2012; Economist 2012). One forecast shows that negative public opinion could impact the development of shale gas by over ten percent (Economist 2012) and may have contributed to bans in countries such as France and Bulgaria (TCE 2013; Patel and Viscusi 2013; Labelle and Goldthau 2014).

Overview of This Volume

This book has ten chapters. Following this Introduction, the chapters reveal shale gas development in various countries and discuss the key changes and its impact on energy portfolio and security around the world.

Chapter 2 by Sabonis-Helf overviews strategy differences of unconventional shale energy development across countries. The impacts vary in terms of ends, ways, or means. For energy importing countries, the availability of this additional source of energy in their own backyard allows them to lessen the reliance on energy import as an end and to adjust national policy. For energy exporting countries, the role of energy becomes less effective as a way to bargaining with energy importing countries. Energy importing countries can diversify their energy import from alternative unconventional sources. In terms of means, energy importing countries with shale energy may have better trade balances due to decreased energy imports. However, these benefits come with potential risks related to environment and domestic and international transporting passages.

Domestic politics are highly influential on energy policy. Chapter 3 by Keeler illuminates details of fracking "politics" across the English Channel between UK and France. Shale gas development is at its experimental stage in the UK. The development of shale gas is hard to push in local communities with unsatisfactory benefit offered by the government. In France, fracking is banned completely. With the pressure of energy diversification and economic development, it is hard to say the current government would not change its heart in order to boost its low popularity.

An area of potential future shale gas development is in Eastern Europe covering Bulgaria, Romania, and Ukraine. Chapter 4 by Georgiev examines not only geological condition of shale reserve in these countries, but also the potential to develop this new found energy source due to historical and political necessity. In recent years, foreign investments poured into these countries to carry out exploratory shale drilling activities. These countries highly rely on the gas supply from Russia. It is a major hurdle for their energy independence and poses significant geopolitical risk. This new energy source may provide additional bargaining chip for their energy negotiation with their traditional energy supplier, Russia. However, even with the support of foreign investment, it still needs to resolve local political, legislative, and social hurdles.

Chapter 5 by Dodge provides an overview of energy policy of European Union and discussed the current situation of shale gas exploration and its possible future development with special focus on UK, Germany, and Poland. Although the EU has a common energy policy, its member countries are free to pursue their own path of energy independence. Thus, there is hardly "a union" as energy development is concerned. UK, Germany, and Poland all started their shale gas test drilling activities. The development is slow due to various reasons. In the UK, this is due to the resistance from local communities. Becoming carbon-free is the ultimate energy goal in Germany, which indicates that natural gas may not be the top choice on its energy development agenda. Several large foreign companies stopped their exploration of shale gas in Poland including Chevron, Exxon Mobil, etc. due to geological reasons. The developments in these countries indicate there is a long way to go before successful and profitable shale gas exploration in Europe.

Asia is the region of the fastest energy consumption increase in the World. Chapters 6 and 7 shift attention from Europe to the two largest economies in Asia, China and Japan. Chapter 6 by Guo et al. describes the current situation of shale development in China and explains opportunities and challenges. China has the largest shale gas reserve in the World (EIA 2011). It is the only country producing shale gas commercially in Asia. With the heavy reliance on coal in its energy consumption, natural gas is a much better alternative for the environment. The Chinese government considers increasing natural gas in the energy consumption mix as one of the top priorities in energy policy. However, technical difficulties and market structures tempered the incentives of investors, and government incentives for shale development have been reduced. Thus, it may be unlikely to see a US-style shale revolution in China in the near future.

Chapter 7 by Lipscomb et al. discusses the potential impact of shale gas development in Japan. Japan is the third largest economy in the World and is an energy resource scarce country. Securing steady sources of energy supplies is critical for its economy. Japan has had shale gas test exploratory activities. Although it is not successful, the extra supply of natural gas from shale surely provides more choices for its energy consumption. The Great East Japan Earthquake in 2011 completely halted Japanese nuclear energy production for several years. It will take quite some time to recover to its before-disaster level. After the disaster, natural gas increased significantly in its energy mix. Starting in 2017, several LNG terminals in the US will be able to export shale gas to Japan. As the largest LNG importer in the world, Japan plays an important role on the demand side of natural gas market.

The final three chapters look to other regions with an emerging emphasis on unconventional development of their natural gas deposits. There are substantial shale gas reserve in Central and South Asia. It is not as plentiful as those in their eastern neighbor, China, but these resources could bring additional boost to the economy and stability of the countries in the region, e.g., Kazakhstan, Pakistan, and India. Chapter 8 by Murtazashvili provides the reality check about the exploration and exploitation of the newly found shale wealth in these countries. So far, there has not been much activity in these countries on shale gas exploration. There are multiple reasons. First, it is due to technical and natural environmental difficulties. Secondly, there is not a coherent policy framework to support foreign investors on shale gas exploration. Third, countries such as Kazakhstan, Turkmenistan, and Uzbekistan in the region have abundant conventional oil and gas supplies, which reduces the urgency to develop shale gas resources.

The African continent is another active area for shale energy exploration. Chapter 9 by Corrigan and Murtazashvili pays particular attention how the governance of developing countries could impact sustainability of shale gas development in terms of environment and ecology. They designed a governance framework and applied it to South Africa and Botswana where shale gas exploration is most active in Africa. They identified potential areas to be improved in the institutional and regulatory structures in these two countries for a sustainable shale gas development. In addition to the existing strong legislation on mining sectors, the improvement of areas such as information transparency, accountability, monitoring capacity, and effective civil society participation could ensure a sustainable shale development.

Coming back to the American continent where the shale boom originated, it is worth noting the potential of Mexico in shale gas exploration due to its abundant reserve and close proximity to the US. Chapter 10 by Tunstall examines both the potential and challenges for shale exploration in Mexico in details. Although the Mexican government announced energy reform and opened market access to foreign investors, there are yet a plethora of policy details to be determined. Even with the policy in place, natural gas companies do not need to explore the shale gas reserve right away because there is large quantity of conventional natural gas reserve unexploited. With the current low oil and gas price environment and continual supply of natural gas from the US, it is likely that Mexico will take its time in determining its strategy in shale energy development.

Conclusion

The goal of this book was to examine the current and prospective exploration and production of unconventional gas, emphasizing shale gas reserves, around the world. The impacts of these shale plays, as well as the opportunities and challenges regionally and globally, were addressed. These include developmental and environmental impacts, as well as questions of policy and energy security. The ten chapters explored the interactions of economic, political, historical, and cultural factors in the face of growing energy need to support tomorrow's inhabitants of the globe.

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Unconventional Shale Energy and the Strategies of Nations

Theresa Sabonis-Helf

Introduction: Energy and Strategy

A dramatic shift towards unconventional shale gas as an energy source has distinct winners and losers in the international arena. Much of the literature has focused on the extent to which unconventional natural gas is transformative for markets overall, or for the power of particular states.[1] This chapter is more concerned with the question of how unconventional natural gas may come to factor in the grand strategy of nations—how it might become an instrument of power for some states, how it might become a source of either new alliances or new adversarial relationships, and how it might shift the risk calculations of nations as they pursue energy security. This chapter seeks to anticipate how unconventional gas may affect the statecraft of select nations.

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[1]See the following excellent assessments of impacts to specific countries: Michael Levi, *The Power Surge: Energy, Opportunity, and the Battle for America's Future*, Oxford University Press, 2013, David Buchan "Can Shale Gas Transform Europe's Energy Landscape?" Centre for European Reform, July 2013, and Leonardo Maugeri, "The Shale Oil Boom: A US Phenomenon," The Geopolitics of Energy Project, Belfer Center for Science and International Affairs of the Harvard Kennedy School, June 2013.

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Energy security has long been essential to the strategies of many nations, but often lost in the analysis is the extent to which energy figures into the grand strategy of nations variously as an end, a way, a means, or a combination of these. Each of these aspects has decidedly different characteristics. Energy scholar Meghan O'Sullivan has noted that, while consuming states seeking to secure adequate supply at affordable price may pursue energy as an "end," exporting states will find in energy revenues a "means" to resource their national ambitions, and may seek to use energy as a "way" of rewarding allies, and punishing adversaries—using energy as an important vehicle for the promotion of national interests that are not connected to energy directly.[2] Energy also factors into a grand strategy in terms of the risks and costs nations are willing to incur in its pursuit, both at home and abroad. Cost may be understood as what the state expects to incur according the plan, whereas risk is what *might* go wrong—losses that the state may incur if the plan doesn't succeed.[3] In attempting to understand the full potential impact of unconventional shale development on international security, it is useful to distinguish and investigate separately how unconventional gas may serve as the ends, ways and means of various states, what range of risks and costs states are willing to incur, and how nations might perceive this energy shift in terms of their grand security and their power broadly defined. Only by separating these elements of strategy is it possible to see clearly how differently the global shifts in unconventional gas development impact nations.

It is not possible, in one chapter, to address fully the role of emerging energy supply in the strategies of all nations. Rather, this chapter will focus on some key suggestive developments across a range of nations. This analysis will begin with a brief review of the endowments and needs of nations regarding natural gas. It will then examine the energy "ends" of importers, with a particular focus on Israel and the United States as illustrative examples of how unconventional gas success may shift the "ends" of nations in terms of their ability to secure sufficient energy resources. The next section will focus on the energy "ways" of exporting and importing countries. Drawing examples from ASEAN Asia and China, the section will illustrate how each is attempting to use an aspect of unconventional gas to forge new alliances that extend beyond energy. The next section will examine "means" of nations in terms of how new-found wealth associated with natural gas does and does not shape how states understand their interests. Australia and the United States will serve as the key cases in this section. The next section will offer an assessment of some of the risks and costs associated with a large-scale shift towards unconventional gas. The chapter will conclude with remarks on the role of unconventional natural gas in the energy strategies of nations.

[2]O'Sullivan (2013), p. 37.

[3]For an excellent discussion of costs and risk, see Deibel (2007), pp. 322–365.

The Endowments and Needs of Nations: Gas Demand and Supply

Although earlier developments in natural gas markets—most notably the shift towards LNG—seemed to push clearly in the direction of globalizing the gas market and making it more similar to oil markets, unconventional gas does not clearly strengthen this trend. Rather, unconventional gas development simultaneously pushes in both directions, depending on the endowments of nations: while China hopes to reduce exposure to global markets and vulnerable supply chains by producing more gas domestically, Japan seeks to encourage the United States to enter global markets as a new supplier. Endowments drive the impact of the shale revolution on the ends, ways and means of nations as well as their risk and cost preferences with respect to energy.

How one understands the amount of natural gas held by any one nation depends on one’s technological optimism. If a conservative metric—proven reserves—is used, Table 1 shows the nations which hold the most natural gas reserves. As the table suggests, the United States reserves, while among the top five, lag significantly behind the top four. Even so, the US has been the lead producer since 2009. The Table 3 illustrates the extent to which the US embraces technical risk: the reserves-to-production ratio indicates that, without continued new discovery and technical innovation, the US could continue to produce at its present rate for less than 14 years, while Russia (the second largest producer) can maintain at its present rate for over 56 years. The United States' ambitious rate of production is due in part to the favorable economic and political climate, and in part because the US is willing to incur technological (and environmental) risk at home in an effort to reduce political risk abroad.

According to the Congressional Research Service of the United States, proven reserves is not a good metric to use in a field that is changing so rapidly. A recent report recommends, instead, using a measure of proven reserves plus estimated reserves for undiscovered, technically recoverable resources (UTRR)—an estimate of what can be extracted with current technology if price is not a factor. By this metric, the US has a natural gas resource base of 1809 tcf (51,225 BCM) or enough gas for approximately 79 years of production (assuming 2011 production levels). The report argues for using this new measure because, compared with data from 2006, the UTRR for natural gas in the United States has jumped almost 25 %.[4] Regardless of one’s technological optimism, however, it is evident that the United States is producing at ambitious rates while others are lagging. Unsurprisingly, it is nations with slimmer proven reserves that pursue unconventional gas, using more technological innovation and risk to make up for less generous geological endowment.

[4]Congressional Research Service, Ratner et al. (2013), p. 22.

Table 1 Natural Gas World Proven Reserves and Production 2014*

	Reserves (TCM)	% of total 2013 world proven reserves	Reserves to Production Ratio (years)	% of total 2013 world production
Iran	34.0	18.2	>100	5.0
Russia	32.6	17.4	56.4	16.7
Qatar	24.5	13.1	>100	5.1
Turkmenistan	17.5	9.3	>100	2.0
USA	9.8	5.2	13.4	21.4
Saudi Arabia	8.2	4.4	75.4	3.1
UAE	6.1	3.3	>100	1.7

*Excludes gas that is flared or reinjected. Data from *BP Statistical Review of World Energy* June 2015, British Petroleum, tables on Natural Gas Proved Reserves (at end of 2014) and Natural Gas Production (at end of 2014) in trillion cubic meters, pp. 20 and 22

Till date, the United States has had remarkably more success with unconventional gas production than any other state. This success, according to energy scholar Leonardo Maugeri, can be explained by (1) property rights possessed by individuals and companies rather than by the state; (2) US shale formations being concentrated in sparsely populated regions (unlike Europe); (3) private financing forms such as venture capital which make it easier to fund independent companies; and (4) mid-stream and downstream infrastructure and water supply that are adequate (unlike China).[5] Scholar Holly Morrow adds to this list the widespread availability of geological data, which rose from explicit government initiatives, as an additional key factor. Morrow differs with Maugeri on the importance of individually owned mineral rights, noting that most systems find a way to compensate landowners for energy development, regardless of property rights.[6]

The US demand for natural gas is rising, driven by price, environmental advantages of gas relative to other fossil fuels, and the ability of natural gas in electricity generation to balance intermittent renewable supply as well as to meet unpredictable demand in mature grids. Gas in 2013 comprised 27 % of US electricity generation, and 28 % of total primary energy supply (up from 23 % in 2003).[7] Natural gas-fired power plants are expected to account for 73 % of added capacity in the United States between 2013 and 2040.[8] For this and other reasons,

[5]Maugeri (2013), p. 24.

[6]Morrow (2014), p. 7.

[7]IEA, United States Energy Overview 2014, International Energy Agency Member Countries Data, prepared August 2014, access at: http://www.iea.org/media/countries/slt/UnitedStatesOnepagerAugust2014.pdf.

[8]This assumes growing electricity demand as well as retirement of 97 GW of existing capacity. See EIA Annual Energy Outlook 2014, p. MT-17.

the Department of Energy projects that US demand will grow from a 2012 level of 25.6 to 31.6 tcf in 2040.[9]

Historically, natural gas is used near the places where it originates. The cost of moving gas often exceeds the cost of getting it out of the ground. Hence, both natural gas, and natural gas markets have a regional character: pipelines are the most common form of delivery. There is a significant cost difference between natural gas and LNG. According to the World Bank, pipelines remain more economical than LNG up to distances of 3500 km (2175 miles).[10] Despite this history, LNG is growing both in volume and as a share of global trade. LNG met approximately 10 % of world demand for natural gas in 2012.[11] In international natural gas trade, LNG's share constituted 33.4 % of world gas trade in 2014 (up from 31.4 % in 2013).[12]

Because of the trend towards LNG, the cost of moving cheap US natural gas to distant, more lucrative markets is often underestimated. The actual costs of exporting LNG must incorporate delivery to the LNG facility, liquefaction itself, shipping, storage, and regasification. According to *Pipeline and Gas Journal* author D.K. Das, these costs in 2011 added up to an approximate $3.17 per million British thermal units (MMBtu) above the cost of extraction.[13] Das' cost assumptions are optimistic compared to other industry analysis. Margins on gas projects are thin, and construction of new facilities is unlikely to proceed if global prices are low, or if the difference between US and other regional prices is not significant. Assuming a US price of $4–$4.50/MMBtu, recent industry analysis suggests that US exporters would need European natural gas prices around $9/MMBtu and Asian prices around $10.65/MMBtu to attain necessary profits.[14] As Table 2, below, illustrates, German natural gas prices in 2014 were probably not high enough to attract willing suppliers from the United States.

Transport explains part of the difference in price, and yet that difference across the regional markets remains striking. Table 2 shows a price range of $4.35–$16.33 in the same year. Not only did these prices vary dramatically by region, they also varied differently across time. Gas markets are not fully developed, and so the prices paid, especially in Asia, reflect an inability to supply the market reliably at

[9]Based on the reference case: EIA Annual Energy Outlook 2014, Department of Energy, p. MT-21.

[10]Krishnaswamy (2007), p. 17 (*The World Bank has not offered an update to this calculus, in spite of rising LNG trade since 2007*).

[11]NERA 2014 Economic Consulting, (Robert Baron, Paul Bernstein, W. David Montgomery and Sugandha D. Tuladhar, authors) "Updated Macroeconomic Impacts of LNG Exports from the United States," prepared for Cheniere Energy, Inc., by NERA Economic Consulting, March 24, 2014, p. 20.

[12]*BP Statistical Review of World Energy* June 2015, Gas trade tables and map, pp. 28–29.

[13]Das (2011) Das estimates $0.32 for transport if the facility is less than 300 miles from extraction, $1.09–$2.09 for liquefaction, $0.28–$0.61 for shipping, and $0.30–$0.38 for storage and regasification.

[14]Gloystein (2014).

Table 2 Natural gas prices: US$ per Million Btu*

	2008	2009	2010	2011	2012	2013	2014
Japan	$12.55	$9.06	$10.91	$14.73	$16.75	$16.17	$16.33
Germany	$11.56	$8.52	$8.01	$10.49	$10.93	$10.73	$9.11
United States	$8.85	$3.89	$4.39	$4.01	$2.76	$3.71	$4.35

*British Petroleum, *Statistical Review of World Energy* June 2015, Gas price tables, p. 27

the desired level. Asian markets are struggling to meet large and expanding demand: Japan and Korea, which have no domestic capacity and limited other energy options, are willing to pay more for secure supply—incurring greater economic cost in an effort to minimize risk. Because of Qatar's preference (and large role in the market), these states purchase according to long-term oil-based contracts. They are especially eager to diversify suppliers, to gain supply that does not transit the Strait of Malacca, and to negotiate deals with states that do not limit exports in an effort to control price (as does Qatar).[15]

Aiming at 2035, the International Energy Agency (IEA) expects differences in price across regions to narrow, but remain large throughout the time period.[16] This is in spite of the IEA's assumption that global demand for natural gas will experience the fastest rate of growth among fossil fuels, and will become the leading fuel in the OECD energy mix by about 2030. The IEA predicts that gas production will increase almost everywhere (except Europe) and that unconventional gas production will account for nearly 60 % of global supply growth by 2040.[17] An assessment cited by the Congressional Research Service suggests that global capacity to produce LNG will rise by almost 50 % by 2020. Because the study cited only counts projects that are operating, under construction, or have reached final investment decisions, less than 3 BCF/day of US supply is included in their analysis.[18] As global LNG capacity expands, consumers will enjoy more flexibility of supply and prices will (slowly) converge.

The IEA does expect the United States to remain the largest global gas producer out to 2035, but its role in international markets remains unknown (as the largest gas consumer, the US could out-produce all others, but still only engage marginally

[15]NERA 2012 Economic Consulting (W. David Montgomery, Robert Baron, Paul Bernstein, Sugandha D. Tuladhar, Shirley Xiong, and Mei Yuan, Authors) "Macroeconomic Impacts of LNG Exports from the United States." Prepared for US Department of Energy by NERA Economic Consulting, December 3, 2012, p. 34.

[16]International Energy Agency, "World Energy Outlook 2013 Executive Summary," OECD/IEA 2013, Paris, based on the WEO's central scenario for projections to 2035, p. 2 (henceforth "IEA-WEO 2013").

[17]International Energy Agency, "World Energy Outlook 2014 Executive Summary," OECD/IEA 2014, Paris, pp. 2–3.

[18]A PIRA Energy Group Study, cited at length in CRS 2013, CRS 2013, Ratner et al. (2013), p. 16.

in world markets). The key uncertainty is global price, and Qatar's likely behavior in a more competitive market. As the NERA 2012 report notes,

> …if countries like Japan and Korea become convinced that they could obtain secure supplies without long-term oil-based pricing contracts, and ceased paying a premium over margin cost, the entire price structure could shift downward.[19]

Because the US is not a low-cost producer of natural gas compared to Africa and the Middle East regions, the United States' comparative advantage is easily lost. The NERA 2012 study concludes that LNG exports are only economically feasible in a climate of high international demand and/or low US cost of production.[20] However, there are also political reasons why nations may prefer to develop long-term gas relationships with the United States. These will be examined in a later section.

The United States, then, is currently the most successful producer of unconventional natural gas. It does not enjoy the greatest geological endowments, but it has created a favorable climate for exploitation of unconventional gas at a moment in history in which demand for gas is rising rapidly. The production and demand trends noted above set the context within which states craft energy strategies, and use energy as a component in grand strategy. Subsequent sections will examine each of the strategic aspects of energy, beginning with a review of energy security as an "end" of statecraft.

Unconventional Gas and "Ends": The Political Economy of Energy-Importing Consumers

The unconventional gas provides an opportunity for nations that have long imported energy resources to consider the attractive possibility of producing their own gas and either reducing or eliminating their dependence on outside supply. Nations that lack energy self-sufficiency have long sought to create "baskets of risk" whereby they import multiple sources from multiple suppliers to mitigate risk from any single source or supplier. When a state no longer places acquiring sufficient energy supply from abroad as an important security "end" of foreign policy, that state can then decide what to do with surplus. Some states will emphasize the economic benefits of selling surplus, while others will develop the resource more slowly, favoring the prospect of long-term autarky. Among nations, the US and Israel—both nations that have traditionally imported energy—have experienced dramatic, recent shifts in energy fortunes. The two states have chosen to emphasize different benefits of their newfound endowments. Although Israel's change in fortune is associated with offshore natural gas (rather than unconventional), the difference in policy choices between Israel and the United States is instructive.

[19]NERA 2012, p. 13.
[20]NERA 2012, pp. 76–77.

Israel's Experience

Historically energy resource-poor, Israel first discovered gas in 2000, at the Mari-B field. This discovery was followed by offshore discoveries of Tamar Field, discovered in 2009, and Leviathan Field, discovered in 2010, the latter of which was the largest deepwater discovery in ten years. As of 2015, Israel is estimated to have 6.7 tcf (0.2 trillion cubic meters) of proven reserves. Although this is a modest amount compared to major exporters, the current reserves to production ratio suggests that Israel can extract natural gas at the current rate without further discoveries for over 25 years.[21]

How to best use that natural gas in Israel's national interest quickly became a point of debate in Israeli policy circles. The most promising finds were deep offshore, discovered by foreign companies. These companies (led by Noble Energy) wished to develop the gas for export, since Israel's consumption levels were not sufficient to justify investment in developing the offshore gas fields. Meanwhile, the government wished to secure long-term energy security, and was uncertain how domestic demand would develop if gas was more reliably available. Following rapidly on the Leviathan discovery, Israel (which had no Ministry of Energy at the time) offered an international tender for advice on how to establish a gas export policy—one that would best balance Israel's "desire to secure energy self-sufficiency, maintain competition in the gas sector, and make the greatest contribution to the local economy."[22]

In June 2013, after considering its options, the government of Israel adopted a policy limiting natural gas exports to about 40 % of the offshore reserves. Although the companies were hoping for less restrictive limits, the citizens of Israel appeared to support higher restrictions. In making the controversial 40 % announcement, Prime Minister Netanyahu argued "We did the right thing for Israel. Without gas exports, there will not be gas for the domestic market." He went on to note that saving the gas exclusively for Israel would be a populist mistake: 'A number of countries did this, and they saved the gas for themselves. It is still buried under the ground and water, beneath layers of populism and bureaucracy."[23]

Since the Tamar field began producing in 2013, Israel's energy consumption mix has changed significantly. Between 2012 and 2013, oil decreased 22 % and coal decreased 17 % as shares of Israel's primary energy fuels, while natural gas consumption increased 170 %.[24] Israel's Antitrust Authority ruled in December 2014 that development of the Leviathan field would not proceed as expected, due to concerns about the effect of monopolies on Israel's domestic energy market. As a

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[21]British Petroleum, *Statistical Review of World Energy*, June 2015, table of Total Proved Reserves of Natural Gas, p. 20.

[22]Sandler (2011).

[23]Quoted in Reuters, "Israeli Government approves a 40 pct limit on natural gas exports," Reuters Jerusalem, Sunday June 23, 2013.

[24]Congressional Research Service, "Antitrust Case Complicates Israel's Energy Future," CRS In Focus Series, February 27, 2015, p. 1.

newcomer to regulation of export, Israel continues to have difficulty deciding how best to manage international companies. Potential development companies, meanwhile, have significant concerns about the domestic consumption quotas and other aspects of the regulatory regime, which may increase the difficulty of attracting companies to invest in additional prospective fields.[25]

Meanwhile, the Israeli government has been closely involved with decisions on how to export the 40 %. The government has approved plans to supply Egypt via the pipeline through which Israel once used to import gas from Egypt. The government also plans to supply Jordan with natural gas from the Tamar field, and the Palestinian Authority with natural gas once the Leviathan field begins producing.[26]

Israel's choice to limit exports is unsurprising given its national interests, but there was a cost. Israeli law existing at the time of discovery suggested that the foreign operator (Noble Energy) had the right to export at levels of its own choosing. Israel was willing to raise tensions with the developer—and potentially discourage future investment—in its effort to ensure that Israel could successfully become more autarkic in its provision of energy to its own people. The optimal rate of exploitation from the government's viewpoint depended on Israel's present and future natural gas needs. How much natural gas Israel needs per year, how much the price should be reduced if natural gas is produced domestically, and how much government policies should push Israel towards more dependence on natural gas and less dependence on other fuels all become contentious policy questions, as did the question of selecting trade partners. Israel has long been concerned with security of oil supply, due to Arab producer's historical dominance in the world oil markets. Shifts in endowments that have made the market less risky for Israel (discovering gas in its territory) have not persuaded the state that it can rely securely on world markets, and Israel continues to enshrine energy security in its oil policies.[27] Energy security defined as secure (even autarkic) supply remains a clear "end" of Israeli state policy, even as Israel has been found to be energy-rich and able to export, and the state has carefully selected its future trade partners. By contrast to Israel's prioritization of energy security, the United States has placed emphasis clearly on the economic benefit. It is largely US allies who have pushed the agenda of seeking new energy partnerships with the US.

The United States

Like Israel, the United States has reduced its imports of natural gas dramatically in the 2010s. An anticipated shift towards large-scale imports gave way to an

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[25]Congressional Research Service, "Antitrust Case Complicates Israel's Energy Future," CRS In Focus Series, February 27, 2015, p. 2.

[26]US Energy Information Administration, "Israel Country Report and Analysis," Updated July 2015, access at: http://www.eia.gov/beta/international/analysis.cfm?iso=ISR.

[27]Shaffer (2011).

expectation of significant export. As late as 2008, it was expected that the United States was on the verge of becoming a large-scale net importer of natural gas. The leap in production of shale gas, even as it was underway, took the government and industry by surprise. As the 'shale gale' took off in America in 2008–2009, the United States Geological Survey (USGS), the Energy Information Administration (EIA) and the Potential Gas Committee all revised dramatically their estimates of recoverable natural gas reserves, but shale gas production quickly exceeded even the revised assessments.[28]

In 2015, the United States is estimated to have 345 tcf (9.8 trillion cubic meters) proven reserves, ranking fifth in the world in proven reserves. Although this is substantially more than Israel holds, the current US reserves to production ratio suggests that the United States can extract natural gas at its current rate without further discoveries for only 13.4 years.[29] Serious discussion of government limitations on the rate of exploitation are largely absent. Analysis focuses on price and its variable impacts. The US Department of Energy's *Annual Energy Outlook* in 2015 anticipates in its Reference Case that the US will become a net exporter of natural gas by 2017, and a net exporter of overall energy in 2019.[30] All of the cases considered in the *Outlook* predict a continued growth in dry gas production. There is no single focus of debate in the United States, as there was in Israel, on the matter of exports. Although the United States has built some key assumptions into its projections, there is no strong movement to identify an optimal export limit.

Debate in the United States with respect to export of natural gas turns on concerns regarding the impact of export on domestic prices, the environmental impact of shale gas, and the price volatility of export.

To some extent, the difference in natural gas perspectives between Israel and the United States can be accounted for by differences in endowments of natural resources and of the technological means to exploit the resources, but the essential difference between Israel and the United States appears to be the level of confidence in the markets—that price will, and should be, the key determinant of the rate of exploitation, and that market actors will lead over government actors in effectively organizing international trade of gas.

In our typology of ends, then, these two cases illustrate how importing states will differ on the extent to which energy resources should remain the focus of policy if endowments change in that state's favor.

The ends of states will diverge depending on their perceptions of threat and opportunity associated with critical national energy interests. Israel, with limited indigenous capacity to produce, is compelled to export at a level that will keep the producing companies interested in development, but the clear government priority

[28]Maugeri (2012), p. 44.

[29]British Petroleum, *Statistical Review of World Energy*, June 2015, table of Total Proved Reserves of Natural Gas, p. 20.

[30]US Energy Information Administration *Annual Energy Outlook 2015 with projections to 2040*, US Energy Information Administration, US Department of Energy, pp. ES-3 and 4.

remains on energy security and providing long-term self-sufficiency in natural gas for the Israeli consumer. By contrast, the United States is likely to continue its focus on commercial opportunity and overall prosperity.

The key advantage of the shift from being an importer to becoming an exporter of energy is that it allows an energy-endowed state to shift its focus from pursuit of energy as a key "end" of statecraft. In this respect, unconventional natural gas (or any newly discovered energy endowment) contributes significantly to the power and the options of a state. But being an exporter has other advantages as well. Israel, as evidenced by the government's involvement in energy export agreements is aware of the potential leverage power inherent in becoming a significant exporter of energy. The next section will focus on the "ways" in which states incorporate the concept of leverage in their assessments of energy trade.

Unconventional Gas and "Ways": New Weapons, New Alliances

To the extent that energy is used as a foreign policy tool to achieve outcomes that are not directly associated with energy trade itself, energy may be assessed as a "way" of statecraft. O'Sullivan notes that energy can be used either coercively by sellers or buyers in an effort to change behavior, or it can be used cooperatively to strengthen alliances, and build support for foreign policy positions.[31] In the present shift of energy trade's "center of gravity" towards Asia, new statecraft "ways" involving energy are evident on all sides. While Asian states fearing China's potential control of critical energy corridors seek to establish energy trade relationships with the United States, China itself seeks to establish overland corridors (and long-term energy trade partners) to diversify its import risk portfolio. A brief examination of these two cases illustrates the extent to which the potential role of unconventional gas is key to these emerging "ways" of energy statecraft.

Trans-Pacific Partnership (TPP)

The Trans-Pacific Partnership (TPP), even if it does not in the end succeed as a free trade area, is an illustration of the reality that the promise of energy trade dramatically changes how nations view the costs and benefits of a free trade agreement. Under current US law, nations that have a free trade agreement (FTA) with the United States have a clear advantage in establishing an energy trade relationship. The Natural Gas Act as amended provides that exports to FTA

[31]O'Sullivan (2013), pp. 30–47.

countries are "presumptively considered in the national interest."[32] Among the 20 nations with whom the United States has a Free Trade Agreement, only South Korea is a likely customer for LNG (Mexico is a likely long-term partner, via pipeline).[33] The US-Korea trade agreement entered into force on March 15, 2012.[34] The agreement was spurred to conclusion by South Korea, which, as the second-largest importer of LNG globally, was particularly interested in potential US exports of LNG once the United States' endowment became clear.

Although the current administration has looked favorably upon permission to sell LNG to non-FTA countries, contracts for energy export to nations with whom the US does not have a free trade agreement are decided on a case-by-case basis. The TPP (as well as the Transatlantic Trade and Investment Partnership—TTIP) is understood to be desirable for the promise it holds of preferential access to US LNG. This desire isn't about flexibility of markets, since the LNG projects currently being developed will most likely seek 20–30 year long-term supply contracts in order to attract finance.[35] It is, rather, an effort on the part of allies to use energy to further strengthen relationships with the United States through long-term import relationships.

This best explains Japan's May 2013 entry into the Trans-Pacific Partnership negotiations, three years after the original summit which they did not attend.[36] The failure to finish a deal in July 2015 was testament to the complexity of the agreement, which would have included over 40 % of the world economy.[37] Nevertheless, the willingness of Japan to engage the negotiations is a reflection of its concern regarding energy security. This concern was reflected in a meeting on 10 October 2013 of the House of Representatives Subcommittee on Energy and Power. The Committee hosted a forum on the Geopolitical Implications of US Energy Exports, and representatives from Asia—including Japan's Minister of Economy, Trade, Industry and Energy—were very engaged participants. In the words of Ambassador Ashok Kumar Mirpuri, Singapore's Ambassador to the US,

> Increased LNG exports to Asia would further anchor the US economic presence and further contribute to enhancing the region's energy security. In doing so, the US would strengthen its partnerships in the region, serving regional stability and its global interests.[38]

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[32]Congressional Research Service, Ratner et al. (2013), p. 14.

[33]CRS, September 17, 2013 p. 11.

[34]Office of the United States Trade Representative, Resource Center, Executive Office of the President, accessed 7 September 2015, at https://ustr.gov/trade-agreements/free-trade-agreements/korus-fta.

[35]Congressional Research Service, Ratner et al. (2013), p. 15.

[36]The original TPP meetings included Australia, Brunei, Chile, Malaysia, New Zealand, Peru, Singapore, Vietnam and the United States.

[37]Ami Miyazaki and Krista Hughes, "Pacific Rim Free Trade Talks Fail to Seal Deal" Reuters wire service, posted 07/31/2015.

[38]Quoted in "Prosperity at Home and Strengthened Alliances Abroad—A Global Perspective on Natural Gas Exports," Policy Paper Series from the US House of Representatives Committee on Energy and Commerce, Chairman Fred Upton, Vol 2, Issue 10, February 4, 2014, pp. 9–10.

The nations of Asia are seeking more than energy sales. The pivot to Asia, in energy terms, has already occurred. The sheer volume of demand increase in Asia has caused trade patterns to shift, and with that shift came new vulnerabilities.[39] Even if no players act aggressively, stress on the Strait of Malacca has changed significantly. Oil flowing through Malacca has increased from 7 million bbl/day in 1993 to 15 million in 2013, while LNG has more than doubled in just five years, from 1.6 tcf/year in 2009 to 4.2 tcf/year in 2013.[40] More than half of global LNG currently flows through the South China Sea (of which 50 % is destined to Japan). Although the gas comes from a range of sources—Qatar, Malaysia, Indonesia, and Australia—a rising concern about China's future role with respect to the sea lanes has inspired the rest of Asia to seek not only supply, but better yet secure supply that would rely less on the overstressed sea lanes, and perhaps best of all, supply from a power that might engage in ensuring the continued openness of all the sea lanes.

It is not surprising, therefore, that ASEAN Asia is looking to the US as a long-term supplier, and anticipating that US participation will simultaneously lower price, offer non-Malacca routes, and cause the US to keep an eye on Malacca as long as it is engaged in extensive energy trade in the region. For ASEAN Asia, this suggests that enticing the US into energy trade relationships is an important "way" of securing sustained US attention. China sees the potential as well, but draws a different conclusion.

China's Overland Energy Relationships

While ASEAN Asia is pursuing energy relationships with the United States, China is pursuing domestic exploitation of conventional gas, and trying to secure long-term import relationships with land powers that can supply it with additional gas imports. China is seeking gas from many sources, partly in an effort to meet its ambitious energy targets (the 2020 Five Year Plan expects gas to become 10 % of the energy mix, an increase of 6 % from 2010),[41] but it is also seeking routes whereby energy supply cannot be used as a "way" to discipline its behavior. If the US is likely to continue to be highly visible in the sea lanes, China wants to ensure that the sea lanes aren't its only option.

China began developing overland supply in 2007 when it completed a deal with Turkmenistan to export natural gas via Uzbekistan and Kazakhstan. The Central Asia-China Gas pipeline, a 1833 km pipeline connecting Turkmenistan to China is being expanding to four lines, and both Uzbekistan and Kazakhstan are now

[39] Klare (2015), p. 252.

[40] EIA, "World Oil Transit Chokepoints," US Energy Information Administration, November 10, 2014 report, pp. 8–11.

[41] See Holly Morrow for a case study of China: Morrow (2014), pp. 10–13.

contracted to produce natural gas for China's market. Total capacity of the lines will be 85 BCMA, of which Turkmenistan is contracted to supply 65 BCMA.[42] In less than a decade, Turkmenistan will transition from selling all of its gas to Russia, to selling nearly all its gas to China. Although it may seem that China is setting up Turkmenistan to compete with Russia, in fact China is seeking supply from both locations. The "Power of Siberia" pipeline, which broke ground in September 2014, will carry an additional 38 BCMA to China.[43]

Given that China is endowed with what is estimated to be the largest unconventional natural gas reserves in the world, it may seem counterintuitive that China is pursuing imports rather than developing unconventional gas at home. The reality is, China's ability to exploit unconventional gas remains unproven. In her investigation of why China has had little success so far in its efforts to exploit CoalBed Methane (which, in her estimation, should develop more rapidly than shale gas), Holly Morrow identifies several impediments: overlapping license problems; lack of pipeline connectivity, and—most of all—the bias of the state energy companies to invest in huge conventional projects that can leverage their scale.[44] Instead of developing its own resources, China is leveraging its ability to access large-scale conventional projects in nations where it can have a powerful (in the case of Turkmenistan, perhaps even a monopsonistic) relationship with the government that holds the resource.

These examples of ASEAN members and of China seeking new ways of procuring energy that bind energy to larger alliances are illustrative of broader global trends. The increased focus on energy… particularly natural gas… as a "way" of statecraft is a striking development. Energy can be leveraged by consuming countries (such as China) or by producing ones. The emphasis in this section has been on Asia, but the political salience of energy relationships is also strikingly evident in the ongoing Russia-European Union crisis: Europe is continually having to weigh its access to cheap natural gas against support for Ukraine.

Yet another example of energy as a contemporary "way" of statecraft, explored by Robert Manning, is the evidence that surging US oil production made possible oil export sanctions on Iran, since without new US production such action would have destabilized a fragile global economy.[45] In considering "ways," it is evident that indigenous natural gas enhances security of the states endowed with it by reducing the leverage that outside actors can gain through the use of energy as a political weapon. For conventional exporters such as Russia, the diversification of sources will pose a challenge to its monopoly. For importing states such as China,

[42]EIA, "China International Energy Data and Analysis," US Energy Information Administration, Updated May 14, 2015, accessed 17 September 2015 at: http://www.eia.gov/beta/international/analysis_includes/countries_long/China/china.pdf.

[43]Gazprom Export website, "Power of Siberia," accessed 17 September 2015 at: http://www.gazpromexport.ru/en/projects/3/ Also confirmed by EIA "China International Energy Data and Analysis".

[44]Morrow (2014), pp. 10–11.

[45]Manning (2015), p. 120.

diversification will become an increasingly attractive strategic “end,” precisely so that China does not become vulnerable to use of energy as a “way” of shaping its state behavior.

Pursuit of domestic resources is also highly attractive to states because it enables them to benefit from the additional “means” that self-sufficiency in energy can offer a state. Being an exporter is an attractive source of revenue if it is geologically possible, but for most states unconventional gas is most attractive if it reduces the vulnerabilities associated with import of energy. The following section turns to the question of means and the priorities of nations.

Unconventional Gas and “Means”: The Wealth and Priorities of Nations

The literature on the “oil curse” is well-known. No state aspires to destroy its economy with a “Midas touch” that creates Dutch disease, currency instability, and fiscal unpredictability. It is widely understood, however, that the challenges are quite different for developed states which put appropriate mechanisms in place to manage their resource wealth. No oil company enjoys more international admiration than Statoil, and Norway has done quite well with its resource wealth. Because unconventional exploitation requires a sophisticated level of technology in addition to well-developed markets, the “break-through” states in unconventional gas are all developed states, ones which can aspire to use their natural gas to enhance domestic industry and lower the cost of production. Even so, the desire to engage in international markets is almost irresistible. Natural gas is on the rise in demand as much as in supply. World markets for energy are robust, and show no sign of declining in the medium term future. Nations that have the capacity to export energy reap economic benefits on world markets. For this reason, the question of how to enter the market—and thereby best benefit the state—is a burning question for developed states that find themselves with unconventional natural gas resources. In an effort to understand how states might differently perceive the “means” that energy wealth can bring, it is illustrative to contrast Australia and the United States.

Australia

The coalbed methane (CBM) production boom in Australia predated the “shale gale” in the United States. The CBM boom was driven by a 2000 government mandate that 13 % of power generation should come from gas. This led to a spike in domestic demand, and given the guaranteed market, the industry began to succeed, and estimated reserves rose dramatically as companies searched with greater intensity. Australia’s estimated reserves of CBM rose from 5 BCF in 1996 to

15,000 BCF in 2008.[46] CBM accounted for almost 13 % of total natural gas production by 2012, and if technically recoverable reserves estimates are correct, Australia could rank 6th in the world for unconventional gas.[47]

This boom in reserves, coupled with low domestic prices, a history of international gas trade, and proximity to Asian markets, led developers to focus on export of coalbed methane in the form of LNG. In her case study of Australia CBM, Holly Morrow notes the ironic consequence of ambitious CBM-LNG projects—there is now an expected shortage of gas in the domestic market of eastern Australia. As the industry increased the speed of development, companies consolidated or were bought out, until prospective LNG projects came to own ¾ of the CBM reserves. The companies prepared to market that CBM internationally rather than domestically. The realization that export of LNG would indirectly lead to much higher domestic prices led to a deterioration of public support for CBM. In addition, Australia is a high cost producer, and as Asian prices fluctuated downwards, projects slowed down—reducing availability of natural gas for domestic markets even before the companies were able to begin actual LNG export. Public opinion, which did not develop at the outset when the industry had maximum momentum, is now increasingly opposed to fracking. Morrow draws the lesson that, if the government wishes to develop unconventional resources, it will need to identify the risks, regulate them well, and communicate with the public.[48]

Australia has become a cautionary tale to many policymakers in America. The idea that entering the world market may imperil the domestic market is a strong message. The distance from markets, and the undeveloped state of LNG export capacity in the United States made it less possible for an unconventional boom to cause citizens to see their own costs increase before the advantages of unconventional exploitation were fully evident.

The United States

In the United States, the domestic market is established in law as primary. This is illustrated by the Alaska-Japan LNG crisis. In spite of rising demand in Japan for natural gas after the nuclear disaster at Fukushima, the United States' only LNG export terminal, which had traditionally supplied Japan, remained closed for three years. The LNG facility, known as Kenai, in Nikiski, Alaska, was inactive starting in 2011, and its license expired in March 2013. US export rules clearly specify that export cannot be allowed to damage local supply. Declining productivity of the gas field supplying Nikiski was the reason why exports were halted, and exports were

[46]Morrow (2014), p. 13.

[47]EIA Australia Country Analysis, US Energy Information Administration, August 28, 2015, accessed at: http://www.eia.gov/beta/international/analysis.cfm?iso=AUS.

[48]Morrow (2014), pp. 13–16.

resumed only when reinvestment in the field ensured that the region surrounding Nikiski would be fully supplied prior to resumption of export. Kenai received a new license in April 2014.[49]

Most US official documents express the assumption that the US will begin exporting in 2016 and will become a modest net exporter by 2017. The amount that the US will export, however, and how that will be determined remains unclear. The Department of Energy projections assume that US net exports by 2040 will range somewhere between 3.0 and 13.1 tcf. In the DOE reference case, price is expected to more than double during the same period, from the 2015 price of $3.69–$7.85 per million BTU.[50] The Congressional Research Service has criticized available government analysis for its vagueness. The price increase estimates range from 9.6 to 32.5 %, leaving "enough latitude in their results for supporters and opponents of exports to promote their opinions."[51]

Given the uncertainties, some analysts argue that the United States has no obligation to offer its natural gas to world markets at all. On this question, the US is pulled between GATT exemptions for natural resources and the US traditional role as an advocate of free trade. GATT Article XX(g) provides for member countries to take action "relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption." This article is understood to mean that nations may regulate the sale of an exhaustible national resource, taking into account their national interest. The logic is that, since such resources can only be sold once, the national interest may not reside in selling the resource as rapidly as possible.[52] Writing for Congressional Research Service in March 2013, Brandon Murrill raised the specific question of whether a US government-imposed restriction on LNG exports could be considered an actionable subsidy to downstream users of natural gas (users such as the petrochemical industry) under WTO rules. He posits that it cannot, based on the precedent that an actionable subsidy must be specific to a group of enterprises or industries.[53] The precedent of selling natural gas to domestic consumers at prices far below the regional trading price is well-established by Russia, which had to display only that it achieved cost-recovery in natural gas before being admitted to the WTO.[54]

If, however, the US were to invoke GATT XX(g), this would mark a decided change in position for the United States. The US was the main complainant against China in the WTO regarding its limits on the export of rare earths and other metals,

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[49]According to the website of ConocoPhillips, which operates the Kenai facility. See http://alaska.conocophillips.com/what-we-do/natural-gas/lng/Pages/kenai-lng-exports.aspx.

[50]EIA Annual Energy Outlook 2015, p. ES-2.

[51]CRS 2013, Ratner et al. (2013), p. 19.

[52]See Carey (2009), pp. 783–810.

[53]Murrill (2013).

[54]For a detailed discussion of Russian domestic energy policies and Russian trade in energy, see T. Sabonis-Helf, "Russia and Energy Markets," Chapter 2 in *New Realities in Global Energy Security*, Edited by John Deni, Army War College Press, December 2014.

and the WTO found in favor of the complainant in that case, which turned on interpretation of GATT XX.[55] In acknowledgement of this precedent, the Congressional Research Service suggests it may be necessary for the US to restrict its own production (for reasons of conservation or protecting human health) in order to make a successful case that trade must be restricted.[56] More broadly, retreat from open markets in the sale of natural gas would bring into question the US's traditional position as a promoter of free trade.

If the US were to opt to export, estimates of both quantity and percentage of production vary widely, and no clear guidance has been provided in this regard. Based on the parameters provided by DOE, the first NERA (2012) analysis assumed that LNG exports would range between 6 and 9 billion cubic feet/day (BCF/day), between 9 and 18 % of US domestic production at the time of the study.[57] The subsequent NERA (2014) analysis assumed higher export levels—the highest case scenario has exports exceeding 53 BCF/day.[58] The Department of Energy, in its 2014 Annual Energy Outlook, predicts a higher volume, but lower percentage of exports. Their reference case focuses on an export level of 15 %.[59] An examination of actual infrastructure suggests a trend towards relatively high export levels. Although only 2.76 BCF/day of LNG export capacity is currently under construction in the US, a total of 7.26 BCF/day capacity has already been approved, and an additional 18.7 BCF/day has been formally proposed to the appropriate federal licensing authority.[60] If all this capacity were to be built, the US would have infrastructure in place to export 26 BCF/day. At 2013 production levels, this would represent the capacity to export 39 % of US gas produced.[61]

In aggregate economic terms, export of LNG (according to the NERA 2012 and 2014 studies) is a net benefit to the United States even at higher levels. However, those benefits are not distributed evenly. There would be clear losers as well as winners if the United States chose to pursue LNG exports at a significant level. The CRS report notes that economic effects are likely to vary significantly from

[55]World Trade Organization, Dispute DS431, "China—Measures Related to the Exportation of Rare Earths, Tungsten and Molybdenum," final report 29 August 2014, names the US as the key Complainant, with 18 other nations listed as third parties. See: http://www.wto.org/english/tratop_e/dispu_e/cases_e/ds431_e.htm.

[56]CRS 2013, Ratner et al. (2013), pp. 14–15.

[57]NERA 2012 Economic Consulting (W. David Montgomery, Robert Baron, Paul Bernstein, Sugandha D. Tuladhar, Shirley Xiong, and Mei Yuan, Authors) "Macroeconomic Impacts of LNG Exports from the United States." Prepared for US Department of Energy by NERA Economic Consulting, December 3, 2012, p. 3.

[58]NERA 2014, p. 11.

[59]EIA Annual Energy Outlook 2014, p. MT-23.

[60]Data from Federal Energy Regulatory Commission Office of Energy Projects, maps of Existing and Proposed Export and Import Terminals, as of December 3, 2014, access at: http://www.ferc.gov/industries/gas/indus-act/lng.asp Offshore facilities are approved by MARAD, by FERC. See table in the appendix.

[61]In 2013, the US produced 24,282 BCF—66.5 BCF/day. Data from EIA, US Natural Gas production, access at: http://www.eia.gov/countries/country-data.cfm?fips=US&trk=m#ng.

region to region, and that regional impacts "…may diverge from impacts on the nation as a whole."[62] The greatest negative impacts will be felt by regions especially dependent on natural gas inputs to electricity generation, regions that host energy-intensive manufacturing,[63] and those regions in which natural gas makes up a significant part of heating. The greatest positive impacts will be felt by regions involved in natural gas production, and by regions where flaring of associated natural gas will be reduced once the demand for and price of gas rises. NERA 2014 notes that exports of LNG would lead to a shift in sources of income, in that labor income would grow more slowly while capital and net resource income grows more rapidly than in a no-exports scenario. Despite this, the report expects that overall household income would increase. Capital income, resource income, and tax income would all increase more than labor income decreases.[64]

Low gas prices are a comparative advantage for industry in the United States, but American citizens have long enjoyed some of the lowest energy prices in the world, and this would continue even in a high export scenario due to the cost advantages of indigenous gas. It has been argued that current prices are in fact too low. The IMF has described the US as among the top three subsidizers across the world in absolute terms, noting that US subsidies total $502 billion/year, while China totals $279 billion and Russia totals $116 billion.[65] The IMF has stated that, although the US, as a wealthy country, does not spend in excess of 5 % of GDP on energy subsidies, the US (like many developed nations) engages in 'insufficient energy taxation,' and thereby aggravates climate change.[66] Meanwhile, the US government acknowledges energy subsidies, but places the estimate much lower, describing direct federal financial interventions and subsidies in energy as constituting $37.2 billion in 2010.[67]

In comparing Australia to the United States, it appears that Australia, as a nation that traditionally exports commodities and fuels, did not carefully examine or adjust for domestic impacts of export. The United States, by contrast, focuses rather closely on the domestic market. However, as an artifact of seeing itself as a consuming nation (rather than a producing nation), the United States shows few signs of considering the uses of energy to better secure non-energy goals. Instead, the US remains focused to date on the commercial wealth associated with energy

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[62] CRS 2013, Ratner et al. (2013), p. 6.

[63] Defined in the NERA 2012 report as manufacture which "…has energy expenditures greater than 5 % of the value of its output and serious exposure to foreign competition" to include paper and pulp manufacturing, as well as chemical, glass, cement and primary metal manufacturing. See NERA 2012, pp. 17, 64 and 68.

[64] NERA 2014, pp. 8–10.

[65] IMF, "Energy Subsidy Reform: Lessons and Implications," Staff Team led by Benedict Clements, International Monetary Fund, January 28, 2013, p. 13.

[66] IMF Press Release: "IMF Calls for Global Reform of Energy Subsidies: Sees Major Gains for Economic Growth and the Environment," International Monetary Fund Press Release No 13/93, March 27, 2013.

[67] EIA, Information Requests, access at: http://www.eia.gov/analysis/requests/subsidy/.

production. The key debate about unconventional gas export centers more on how much to sell (and with what impact on the domestic economy) rather than to whom to sell LNG.

Australia and the United States focused differently on how energy constitutes the "means" … a critical component of state resources. While Australia allowed its well-developed export sector to focus on the global market to the detriment of its domestic demand, the United States has significant policy focus on ensuring full supply to domestic markets, counting on overall economic growth to produce increased revenue for the state. The two nations have in common a growing concern among the polities about the costs and risks of the development of unconventional gas.

Costs and Risks of a Strategic Shift Towards Unconventional Gas

No strategic assessment is complete without consideration of costs and risks. To the extent that unconventional gas has set new terms of the game in international energy, it is essential to consider the costs and risks of this shift for nations pursuing energy security as an end—as well as for those states which use energy as part of the means and ways of statecraft. Polities of many states are concerned about the environmental risk associated with unconventional gas. This issue is a critical aspect of cost and risk, but one beyond the scope of this chapter on geopolitics. This chapter will instead focus on risks and costs associated with the infrastructure of trade, the risks to conventional gas-rich states, and the implications of natural gas becoming "more like oil" in international markets.

Concentration of Energy Infrastructure

Although unconventional gas is highly distributed, one characteristic of its exploitation in the United States so far is that it has exacerbated an already existing concentration of energy assets in one vulnerable location: the Gulf of Mexico. The industry-led nature of energy development in the United States has allowed companies to default to areas that are "industry friendly" and to emphasize the commercial advantages of clustering of related industries over the potential security disadvantages.

Significant offshore oil and gas infrastructure in the Gulf of Mexico is co-located with the Strategic Petroleum Reserves. Additional energy infrastructure is under construction. The Gulf Coast Pipeline project, commissioned in January 2014 will carry an additional 700,000 barrels of oil a day into the Gulf for shipping. This concentration of energy assets constitutes a significant vulnerability to severe weather events, accidents or terrorist actions.[68] The potential proliferation of LNG facilities complicates this issue further. According to the Federal Energy Regulatory Commission Office of Energy Projects, as of December 3, 2014, 11 proposed export facilities (for a total of 18 BCF/day) and 3 proposed import facilities (for a total of 3.6 BCF/day) are sited in the Gulf of Mexico.[69] An additional 12 facilities, which are at an earlier stage of proposal development, also potentially located in the Gulf of Mexico, are listed as "Potential LNG Export Terminals." These facilities would total an additional 16.25 BCF/day of natural gas throughput if constructed. The Gulf of Mexico is simultaneously more critical and more vulnerable as energy developments progress.

Severe weather events are already in evidence. According to the US Government, extreme weather events are expected to intensify due to climate change, and the "number of Gulf Coast electricity substations exposed to inundation caused by storm surge from Category 1 storms is projected to increase from 225 to 337 by 2030 due to sea-level rise."[70] In 2012, the Gulf of Mexico produced 19.5 % of all US oil, and 6 % of all US natural gas. Production shut-in during the 2012 hurricane season totaled 14 million barrels of oil and 32.1 billion cubic feet of natural gas.[71]

In addition, the concentration of LNG facilities together with other energy infrastructure is sometimes considered a potentially attractive terrorist target. For the 40-year history of LNG use, the safety record has been excellent[72] and no tankers or land-based facilities have been attacked by terrorists. In an age of terror, however, the US government Sandia Laboratory conducted an in-depth analysis of risk of intentional breach of an LNG cargo tank. They concluded that such a breach would likely produce an ignition source and an LNG fire. In such a scenario, they assessed the most significant impacts "on public safety and property" would be within 500 m of the incident itself, and even in the case of very large spills, impacts

[68]Note that, of the three instances in which the International Energy Agency has ordered emergency draw-downs of Strategic Petroleum Reserves of member states, one was in response to Hurricane Katrina. Department of Energy, "International Energy Agency Members release strategic petroleum stocks," June 24, 2011, US Energy Information Administration, access at: http://www.eia.gov/todayinenergy/detail.cfm?id=1950.

[69]Federal Energy Regulatory Commission Office of Energy Projects, maps of Existing and Proposed Export and Import Terminals, as of December 3, 2014, access at: http://www.ferc.gov/industries/gas/indus-act/lng.asp.

[70]US Government, "Quadrennial Energy Review: Energy Transmission, Storage and Distribution Infrastructure: Summary for Policymakers," April 2015, p. S-10.

[71]EIA 2013.

[72]As in the case of compressed gas, LNG is only flammable when the air-natural gas mix is 5–15 %. If there is less air, there isn't sufficient oxygen for a flame. If there is more air, the gas becomes rapidly too diluted to ignite. See FERC, Federal Energy Regulatory Commission, "LNG Overview," can be accessed at: http://www.ferc.gov/for-citizens/citizen-guides/lng.asp.

would be substantially lower only 1600 m away.[73] In their assessment, this means that the zone at highest risk in an intentional LNG spill includes narrow harbors or channels, underpasses of major bridges or tunnels, and times when the tankers are within 500 m of major infrastructure elements. These parameters should influence the siting of energy facilities in the Gulf.

Protection of the Sea Lanes

If US interests in the Gulf of Mexico are more directly at risk in an age of LNG exports, US interests in the Middle East are less so. To the extent that the United States has reduced (and continues to reduce) its reliance on the Middle East to supply energy, the United States' strategic interests in the Strait of Hormuz are reduced. While the United States retains non-energy interests in the Middle East, it is increasingly allies of the US, rather than the US itself that are vulnerable to interruptions of supply. The energy pivot to Asia, however, ensures that other powers will find their interests in the Middle East rising. In particular, China's increasing dependence on free flow of energy from the region has caused its strategists to begin contemplating a shift in responsibility.

The US has acted as the security guarantor in the Persian Gulf since the Carter Doctrine, and secondarily has ensured flow through the Strait of Malacca. Energy Security scholar, Robert Manning, notes that

> This US role has meant other major oil consumers have been largely free-riding on the US provided public good of stability and sea lane security. This is especially true of China, which is in the midst of building a blue water maritime capacity. One key question is whether the combination of redefined US interest, the reality of a growing Middle East-Asian energy nexus, and new or enhanced naval capabilities of China, India, Japan, the Republic of Korea, and other actors results in burden-sharing in regard to the security of sea lanes.[74]

The US is unlikely to give up its strong interest in maintaining free flow of commerce in general and energy in particular on the sea lanes in the medium term. If the US pursues a role as a significant exporter of LNG, it will continue to engage in energy trade routes as an exporter rather than an importer. However, this shift will require some changes: both new routes and improvements to old routes will be necessary. If the US is to provide LNG to Asia competitively, the widening of the Panama Canal is critical.[75] Even if new routes include Panama and the recently completed New Suez, pressure on the existing routes will remain high. The Strait of Malacca remains the primary route—once oil has cleared the Straits of Hormuz—for oil heading to Asia, and LNG from the Middle East will likely follow that route.

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[73] Sandia (2004).

[74] Manning, p. 124.

[75] CRS 2013, Ratner et al. (2013), p. 16.

Even if unconventional gas reduces pressure on the sea lanes in some locations, it will increase energy trade in others, so strategists should watch for a shift in routes rather than a decrease in the tempo of interstate trade.

The Future of Conventional Gas-Rich States

Unconventional gas is likely to impact the routes of trade—but also the players that matter. Although it is possible that Moscow will diversify and modernize, taking advantage of its own considerable shale,[76] it is more likely that shale will be pursued most successfully by states that do not have large conventional endowments. As Holly Murrow's research demonstrates, unconventional resources do not tend to attract the interest of companies or states that have the opportunity to pursue large fields, which are more profitable and require less effort per unit of production. In addition, she notes, "quasi-monopolistic control of the energy sector is poorly suited to unconventionals," which are "still an innovation game."[77] For these reasons, the winners in unconventional gas are not likely to be the traditional major exporters.

A rise in new energy players does suggest a Russia that finds itself falling further behind in energy markets as it fails to innovate.[78] It also suggests a possible weakening of the US-Saudi bond, as Robert Manning predicts.[79] The shift in energy powers that matter to the global economy will produce some significant dislocation. Although there may be evidence to support Tom Friedman's memorable "first law of petropolitics," which holds that "when the price of oil rises, the quality of governance in petrolist states always falls,"[80] it does not follow that a decline in energy prices and/or a diminution of power of the petrostates will lead in any direct path towards better governance at home. Significant shifts in the structure of world energy markets will be associated with instability, as they were in the late 1980s. This may well be a set of risks that the energy-dependent states are willing to incur—making the Middle East less important to US energy is longstanding goal—but such risks need to be addressed in energy strategy. Another risk, which major importing states have long stated their willingness to embrace, is the economic risk of a freer market in natural gas.

[76]Manning, p. 123.

[77]Morrow (2014), p. 12.

[78]For a detailed discussion of Russia, see the author's "Russia and Energy Markets" Chapter 2 in *New Realities: Energy Security in the 2010s and Implications for the US Military*, Edited by John R. Deni, Strategic Studies Institute and U.S. Army War College Press, February 2015.

[79]Manning, p. 124.

[80]Friedman (2006).

Price Stability: If Gas Is More like Oil, Who Wins?

In the late 1980s, it is widely understood that the United States collaborated with Saudi Arabia to depress the price of oil, weakening the Soviet Union and reducing the "means" available to it to engage in proxy conflicts. The price collapse of the 2010s, by contrast, was not done by design. It was, rather, a collision of a highly structured market with disruptive technology. Fracking has destroyed the price stability imposed by OPEC and Russia (which cooperated with OPEC since 2001). The irony, of course, is that the disruption was caused by high-priced producers of oil and natural gas. The break-even price in oil varies widely: Saudi Arabia enjoyed an estimated cost of production and transport per barrel of $7, while tight oil in the United States is estimated to have a cost of production and transport of $85 per barrel.[81]

Although increases in production from shale fields in the past decade are remarkable, fracking in oil and in gas is a relatively expensive process, very sensitive to price fluctuations. Shale oil development, as Leonardo Maugeri notes, takes place on a per-well basis, not on a field basis, and therefore critically depends on short-term oil prices, especially since peak production is achieved early in the well activity, and most production is competed within two years of production.[82] Although such wells can be brought back into production relatively quickly, the industry depends on continuous drilling. At low prices, such drilling is likely to fall off.

The situation for unconventional natural gas is similar: drilling is more intensive and must be continuously developed. Morrow offers the contrast within Australia between conventional and unconventional gas wells, noting that "In Australia, for example, a two-train CBM-based LNG project requires about 6000 wells to be drilled, versus fewer than 100 for two trains of conventional LNG."[83] Unconventional gas requires continuous drilling, which in democratic societies means it would require ongoing strong public support. In addition, high prices in Asia in natural gas have been created in no small measure by Qatar playing the role of "swing producer." If Japan and Korea stop paying a premium to Qatar over the margin cost, the entire price of gas could shift downward. Such a shift would rapidly make US LNG non-competitive.[84]

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[81]Production, Transport and Total are marginal cost, from Swiss National Bank, SNBCHF.com, "Shale and Oil Sands: Market Price Compared to Production Costs, Sept 2014, http://snbchf.com/global-macro/shale-oil-oil-sands/ Transport indicates delivery to major distribution channel.

[82]Maugeri (2013), p. 14.

[83]Morrow (2014), p. 3.

[84]NERA 2012 Economic Consulting (W. David Montgomery, Robert Baron, Paul Bernstein, Sugandha D. Tuladhar, Shirley Xiong, and Mei Yuan, Authors) "Macroeconomic Impacts of LNG Exports from the United States." Prepared for US Department of Energy by NERA Economic Consulting, December 3, 2012, pp. 13 and 76–77.

In the case of unconventionals, the costs of drilling tend to be higher, the need to drill is more continuous. How, then, can unconventional gas compete? What advantage does unconventional production have in the longer term? The key is in what is known as the "fiscal break-even price." While the break-even price denotes the actual cost of production, the fiscal break-even price is a measure of how desperately a petrostate requires oil and gas revenues. While Russia's actual break-even price in 2014 was estimated at $30 for onshore oil, its fiscal break-even price was estimated by the Ministry of Finance at $96 per barrel,[85] meaning that the budget would only balance if oil remained at that rate. Russia was not alone—the IMF estimate for other petrostates in 2014 notes that Saudi Arabia required $84.30, Iran $126.50, and Iraq $117.90.[86] When states rely on oil dollars to balance budgets, the state itself—not just the industry—suffers from price fluctuations, making the states less able to tolerate market shifts. While the United States could simply cease to export and keep low-priced gas at home, states that rely on exports for revenues would suffer more significant impacts.

It is clear, then, that a shift to unconventional fuels is disruptive, yielding new winners and losers. Costs to the new producing states include having to secure new sea lanes (while preserving the old ones), having to harden infrastructure and spend both dollars and policy attention on physical energy security. Risks to those states include a more volatile market, a need to manage relations between the industry and the polity, any unanticipated domestic environmental impacts of unconventional development, and possible political destabilization in nations that are old producers.

Conclusions: Unconventional Energy and the Strategies of Nations

In conclusion, unconventional gas is striking in the extent to which it can have an impact on each of the elements of strategy and therefore it has the potential to change the grand strategy and statecraft of nations. An examination of unconventional energy that disaggregates the elements of strategy demonstrates the extent to which unconventional energy impacts states differently. Table 3 reiterates the distinctions.

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[85]Data from "Record Fall in Oil Prices Threatens Russian Budget" 7 Oct 2014 at http://rbth.com/business/2014/10/07/record_fall_in_oil_prices_threatens_russian_budget_40409.html.

[86]"Fiscal Break-Even Oil Prices for Major OPEC Members" OGFJ 3 April 2014 at http://www.ogfj.com/articles/2014/04/fiscal-break-even-oil-prices-for-major-opec-members.html and IMF Statistical Appendix Regional Economic Outlook Update, at https://www.imf.org/external/pubs/ft/reo/2014/mcd/eng/pdf/menapst0514.pdf.

Table 3 Elements of energy strategy

ENDS Energy Importing States seek to secure adequate supply at affordable price: finding new sources of supply (domestic or new foreign suppliers) enhances their energy security Energy Exporting States seek to maintain their ability to extract and export. They may seek to ensure access to markets as well	**WAYS** Energy Importing States can use their ability to purchase (or boycott) energy from Exporting states as a basis for alliances or effective sanctions Energy Exporting States can use their ability to supply or withhold energy as a tool of statecraft to extract other concessions from importing states
MEANS Energy Importing States seek to maintain favorable balances of trade by not importing too much energy Energy Exporting States have resources as a source of state revenue (and therefore, power). Management of those resources will vary by country	**COSTS AND RISKS** All states incur economic, environmental, political and technological risk in the pursuit of secure energy. States seek to establish a "basket of risk" and are typically willing to incur added cost in some ways that reduce risk. The extent to which states will accept cost to reduce risk varies

In terms of ends, the energy importing states with unconventional gas will be able to produce more gas domestically, and become less reliant on outside supply. This will afford such states the option of reducing the emphasis of energy as an "end" in their international statecraft even if (as in the case of Israel) domestic policy retains a focus on the strategic significance of energy. For energy exporting states, demand for their energy sources is not likely to disappear, but the ability to use such exports as a way—enabling them to extract non-energy concessions from importing states—may diminish as importers diversify into their own backyards. Some importing states, such as the members of ASEAN, will seek to use unconventional LNG energy imports as a "way" to enhance alliances with market-oriented new gas powers such as the United States. In terms of means, unconventional gas may provide some formerly importing states with more favorable balances of trade as they import less. Exporting states, meanwhile, are likely to find continued revenue, but how these resources are spent will vary by country and price may become more, rather than less volatile. In terms of risks, unconventional gas as pursued by formerly importing states represents a shift—accepting environmental risk and potentially higher cost in exchange for reducing the political risk of imports. States seeking to export unconventional gas will also incur costs associated with hardening infrastructure and ensuring free passage on sea lanes.

Examining unconventional gas from a grand strategy perspective suggests some opportunities, but also some limitations on natural gas as a potential instrument of power: Unconventional gas will neither replace conventional, nor allow most states to become autarkic. Given its higher cost, and the price-sensitivity of fracking to volatile markets, it is not likely to take over the market if conventional gas is available. It is a valuable "means" of diversity, but not a replacement.

The US comparative advantage lies in reducing the use of energy as a “way” for other states. Exports of unconventional gas are only likely in a climate of high international demand; lowered production costs; or as an aspect of broader strategic relationships. Only in times of higher price, or times of international instability, will US LNG supply be perceived as essential outside the US. Unconventional gas has the promise of enhancing resilience, but only if the state plays a role in recognizing the security needs and contributions of gas exploitation.

Managed strategically, unconventional natural gas does hold out the potential of changing the grand strategy of nations. Policy analyst Michael Klare has noted, “While energy technology is constantly changing, conflict over energy is likely to recur so long as major consuming states continue to rely on supplies derived from distant and unruly areas.”[87] The real strategic promise of unconventional gas is that it sets out the possibility that a state which choses to prioritize development could fundamentally shift its reliance… and perhaps even come to serve the international community as a reliable supplier. That would redefine energy as a different kind of strategic “end.” To do so effectively, however, would require a strategic approach which takes into account the significance of unconventional gas to each element of grand strategy.

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The Politics of Shale Gas and Anti-fracking Movements in France and the UK

John T.S. Keeler

France and the UK are similar in having substantial reserves of shale gas (Shale Gas Europe 2013) and in possessing legal regimes in which—unlike the USA—mineral rights are owned and controlled by the state. Companies and government officials in both cases have understandably expressed interest in exploiting those reserves as a means of stimulating economic growth and lessening dependence on external providers. However, the debates over the development of shale gas through hydraulic fracturing ("fracking"—for an excellent primer on the technique, see Rao 2012) and horizontal drilling have unfolded in very different trajectories on the two sides of the English Channel.

In the French case, President Nicholas Sarkozy's Center-Right government moved before the UK to authorize exploration for shale gas—but did so through an apparent administrative blunder that would trigger a massive wave of resistance that led in 2011 not to a mere moratorium but to the first ban in the world on utilization of the fracking technique. Political remorse over this hasty move provoked reconsideration by the Socialist government, elected in 2012, until President François Holland firmly stated in July 2013 that the issue would remain off the agenda for the remainder of his presidency. Ironically, that same summer, the Conservative-led coalition government of David Cameron reaffirmed with flourish that it intended to move fast to put the UK "at the heart of the shale gas revolution." Given the degree of centralization of control over such issues in Britain, and the high priority attached to shale gas by the Cameron government, there was every reason to expect that fracking would begin in Britain in relatively short order. As of August 2015, however, not a single drilling site was in operation. As will be discussed below, this has resulted from the development of a British anti-fracking movement raising the same objections that had halted development in France,

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fractures within the governing coalition and the Conservative Party, and surprisingly successful mobilization of opposition to shale gas development within the planning process controlled by county councils.

This paper will address the cases of France and the UK in detail and then, in the conclusion, discuss in comparative perspective seven key variables that play a major role in determining the propensity of governments to pursue—and succeed in—developing shale gas.

France: Governmental Blunders, the Explosion of Protest, and the 2011 Fracking Ban

It was what appeared to be routine administrative decisions of the Ministry of Ecology, Energy and Sustainable Development on March 1, 2010, that, quite remarkably, set in motion the chain of events that would lead to the world's first ban on fracking only fifteen months later. In line with the standard operating procedures of the ministry, MEESD officials approved the requests of corporations for three "exploration authorizations" (or exclusive research permits) related to shale gas in southeastern France—the region affected by these permits is shown in Fig. 1, "les 3 permis abrogés"). Under the Mining Code in force at that time, "no public consultation was required prior to the issuance" of such an authorization. Only at a later stage, if and when exploration indicated that drilling could be profitable and a company applied for an "exploitation authorization" (or concession), were broad public consultation and environmental impact assessments required (Tomasi and Nicolet 2013). As Jean-Louis Borloo (the minister who formally approved the authorizations recommended by his staff) lamented months later during parliamentary debates, the requirement for public consultation related to applications for research permits had been eliminated in 1994 so as to facilitate efforts to "know and understand" the potential value of natural resources. Borloo noted that over the past seventeen years, hundreds of research permits had been authorized in this fashion, but in retrospect the 1994 code revisions had been an "enormous error" since it was now evident that some exploratory research—such as that for shale gas—could entail "extremely grave risks for the environment and health" (Journal Official—or JO—10 mai 2011).

Two other flaws of the traditional Mining Code were also made apparent in the wake of the notorious decisions of March 2010. First, the applications for research permits were not required to declare what exact technique they intended to employ in their exploration; applications were assessed only on the basis of the general financial and technical capacity of the applicants. Thus, the companies requesting permission for exploratory research on shale gas were not required to declare that they planned to employ hydraulic fracturing (Kosciusco-Morizet JO 10 mai 2011). One could well assume that the technocrats of the ministry should have recognized the potential problem, since fracking as developed with horizontal drilling in the

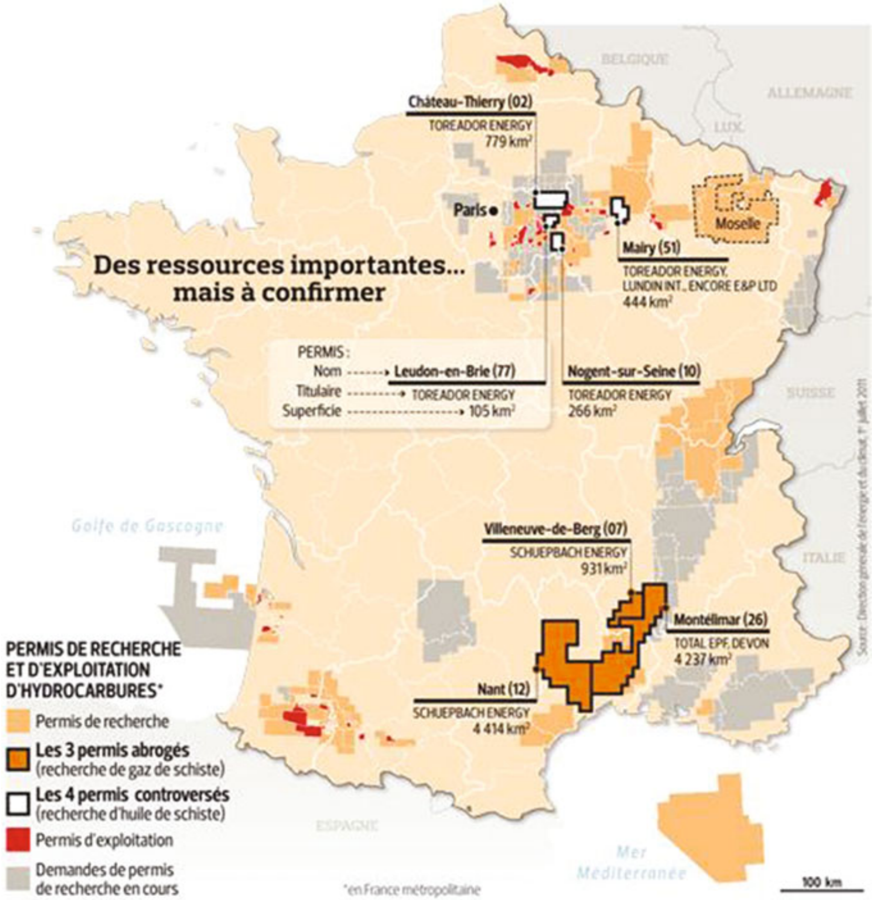

Fig. 1 Shale gas regions in France—Nodé-Langlois (2011)

USA was the only available technique for extracting shale gas; some critics would later charge that they must have known this and looked the other way due to their sympathy for industrialists (Bono JO 29 mars 2011), but a report commissioned by the parliament in 2011 stressed that there had been only minimal understanding of what fracking entailed even in technical entities in France in 2010 (Morel-A-L'Huissier JO 10 mai 2011). Second, the code did not require that information regarding authorizations for exploratory research be quickly and widely disseminated even to elected officials in the regions concerned; the authorizations were simply listed on a Web site of the MEESD and later published in the parliament's *Journal Officiel* (Kosciusco-Morizet JO 10 mail 2011).

It thus took months for the French public, even in the prospective exploration region of the southeast, to learn about the March 2010 authorizations. The only newspaper article that mentioned the authorizations before the fall of 2010 was a brief one in *Le Monde* by Hervé Kempf noting that the parliament's *Journal Officiel* would soon formally announce that permits had been issued and that France would thus soon join many other countries in pursuing shale gas (Kempf 2010). The first highly provocative article appeared only in October 2010 in *Charlie-Hebdo*, where Fabrice Nicolino criticized Borloo for approving the permits "without the least publicity," alluded to the newly released anti-fracking American documentary *Gasland*, mentioned with foreboding that the hydraulic fracturing technique had been perfected by Dick Cheney's Halliburton, and cited environmental activist and European parliament member José Bové on the potential negative impact on the environment (Nicolino 2010). In December, both Kempf and Nicolino appeared at a large public meeting in Aveyron, one of the departments targeted for fracking, and that same month journalist Sylvain Lapoix created the first in-depth French analysis of the issue on the Internet (the website Owni.fr, a sort of "Wikileaks for shale gas"), including animation to demonstrate "the process of hydraulic fracturing and why it is dangerous" (Raoul 2011).

It was in late December 2010 and January 2011 that the word began to spread, through both social media and networks of local activists, and that "the revolt against the extraction of shale gas" began to capture the attention of elected officials in the countryside and then in Paris. As Fig. 2 illustrates with data from Goggle Trends, the term gaz de schiste (shale gas) registered no activity in France until late December, but spiked dramatically over the next two months. New Web sites and blogs produced by activists proliferated with names such as www.stopaugazdeschiste07.org and www.nongazdeschisteinfos.com (Grouef et al. 2012). The Web sites provided scores of links to everything from the exploration permits received by companies to the Web sites produced by other anti-fracking activists around the country and the world. Anti-fracking songs appeared on Youtube (www.chansongazdeschiste.com) with folk singers relating this current struggle to earlier challenges in French or local history, often against a backdrop of the picturesque landscapes now threatened by environmental ruin. For the anti-fracking movement, the "Internet was a powerful tool, a sort of permanent à la carte general assembly in which each could participate when and how he wanted" (Raoul 2011).

A case study of the movement in Ardèche notes that in early 2011—soon after people began to realize that Schuepbach Energy LCC headquartered in Texas had

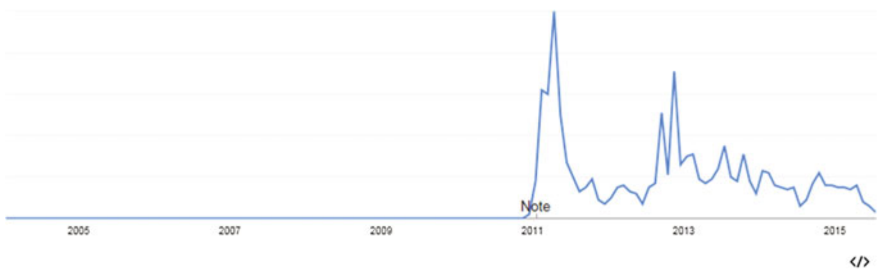

Fig. 2 References to Gaz de Schiste (Shale Gas) in Google Trends for France 2005–2015

obtained a permit for exploration in the department and that the government had imposed this decision on them with no consultation—"many people rose as one bloc to express their radical refusal of such projects. Very quickly, information meetings were being held in packed rooms and collectives arose in each village." The authors observed that the movement unified local residents normally divided by "traditional political cleavages." The revolt began to be organized with "bumper stickers, t-shorts, posters, but also exchanges of reflections." A twenty-minute edited version of highlights from the documentary Gasland was prepared and shown, with subtitles, at meetings attended by more and more people. As mobilization became "explosive," it rekindled memories of historic struggles such as the resistance in World War II. Activists wanted to avoid creating a formal leadership structure for the movement, but they did agree to organize a department-wide Collectif 07 (Ardèche is listed #7 among French departments) to centralize information, manage a principal Web site, and coordinate activities. By February 26, 2011 Collectif 07 and its allies beyond Ardèche succeeded in organizing the largest anti-fracking protest in France as an estimated 20,000 people attended a demonstration in Villeneuve-de-Berg (Grouef et al. 2012).

Even by the standards of France, where anti-government protests are common and may in fact be viewed as a revered tradition (Keeler and Hall 2001), the anti-fracking protest movement of 2011 was extraordinary in its intensity, scope, and ultimate impact. Anger and indignation arose initially, of course, in the southeastern departments such as Ardèche where—as in virtually every country where shale gas drilling has been proposed or undertaken—the NIMBY (Not in My Backyard) effect drove many people to oppose what they perceived to be a threat to their regional environment (Grouef et al. 2012). However, those local movements became a nationwide firestorm of protest as more and more citizens—and elected officials—learned of the process that produced the MEESD's March 2010 authorizations of exploratory research permits. They indignantly demanded to know how such decisions with important implications for the environment could have been made in an opaque manner "en catimini" (on the sly or in secret) when governments of the Center-Right—under both President Jacques Chirac and his successor in 2007, President Nicolas Sarkozy—had recently made apparently solemn, highly publicized commitments never to allow such a thing to happen (see comments by Frédérique Massat, Socialist from Ardèche, in JO 10 mai 2011).

Chirac had placed a high priority on mobilizing support, deflecting predictable opposition from organized business within his coalition, for a Charter for the Environment that was enshrined as an amendment to the constitution in 2005 by a 531-23 vote in a joint session of parliament (French Constitution 2015). France had long been perceived as "a relative laggard in environmental affairs" within Europe, but this charter represented "a qualitative leap in the level of France's publicly avowed commitment to environmental protection" and provided French citizens with "new political and judicial tools to promote transparency and accountability in policies affecting the environment" (Bourg and Whiteside 2007, p. 118). Article 7 of the charter states: "Each person has the right, in the conditions and to the extent provided for by law, to have access to any information pertaining to the environment in the possession of public bodies and to participate in the public decision-making process likely to affect the environment" (Charter for the Environment). And article 5, in language that the main French business organization had warned could "sideline research and harm the French economy," constitutionalized the principle of precaution: "When the occurrence of any damage, albeit unpredictable in the current state of scientific knowledge, may seriously and irreversibly harm the environment, public authorities shall, with due respect for the principle of precaution and the areas within their jurisdiction, ensure the implementation of risk assessment procedures and the adoption of temporary measures commensurate with the risk involved in order to preclude the occurrence of such damage" (Bourg and Whiteside 2007, pp. 125–126). In short, the charter clearly called for a degree of public access to the decision-making process and a degree of precaution by the state that were not respected in the process leading to the authorizations of March 2010.

As if this were not enough to make the Center-Right government seem hypocritical, negligent, and/or underhanded to the protesters of 2011, the problem was exacerbated by the fact that President Sarkozy had championed a lengthy process from 2007 to 2010 known as the Grenelle for the Environment designed to build an "ecological democracy" in France by enhancing public participation and transparency in the making of decisions affecting the environment; the term "Grenelle" (coined originally as a nickname for the process of state–industry–labor negotiations to end labor unrest in May 1968—the Ministry of Labor was situated on the Rue de Grenelle) in France "connotes a set of broad institutional reforms, not simply imposed from above, but agreed to by major actors in civil society after an extensive process of consultation and negotiation with State representatives" (Whiteside et al. 2010, pp. 450, 465). What gave this process an ironic and even farcical appearance in retrospect for the protesters of 2011 was that the Minister of Ecology who managed it was none other than Jean-Louis Borloo, the man who approved the permits of March 2010 (truth is indeed sometimes stranger than fiction!); parliament approved the second package of Grenelle reforms in July 2010, months after the permits were granted, and Borloo stepped down as minister in November 2010 (for reasons unrelated to the permits—which were not yet a focus of controversy).

It was Borloo's successor at the MEESD, Nathalie Kosciusco-Morizet, who was left to deal with the mounting wave of protest in early 2011. Unlike in most such crises in highly partisan France, due to the points noted above, the minister was faced with angry citizens and elected officials from all across the political spectrum. She was inundated with letters and petitions reinforcing the impact of demonstrations across the country. More than fifty municipalities voted to reject fracking in their jurisdictions, and the media produced a cascade of coverage of the many facets of the issue (JO 29 mars 2011). The Center-Right politicians in both Paris and the countryside were clearly embarrassed (no one, even Borloo, attempted to defend the research authorizations) and eager to reestablish their credibility in regard to environmental policy. Politicians on the left rode the wave of anti-government protest and, with national elections due in 2012, seized the opportunity to try to prove that they were the true champions of the environment and the most vigilant guardians of democratic procedures.

The government's first step toward stemming the tide of unrest was to announce, in February 2011, the temporary suspension of the three exploration permits for shale gas. Soon thereafter, it requested that two consultative entities, one focused on industry and energy and the other on the environment and sustainable development, prepare reports investigating and documenting the environmental consequences of extracting shale gas. However, these steps did not serve to mollify the protesters and many elected officials. They expressed distrust of the technocrats charged with preparing the reports and dismissed the government's response as a "snow job" designed simply to dampen their anger (Grouef et al. 2012). Weeks before the commissioned reports were to be completed, five different bills (one sponsored by Borloo!) calling for a ban on hydraulic fracturing or a ban on shale gas extraction under any conditions were submitted to parliament. Originally it appeared—remarkably enough—that there was enough consensus on the issue that the Center-Right government and the Left opposition might be able to agree on a bill to be managed by corapporteurs of the two sides, but ultimately they disagreed on whether it was adequate to ban only the fracking technique or rather shale gas extraction altogether. The government decided to support a bill submitted by Christian Jacob, a Center-Right deputy and former Minister of the Civil Service under President Chirac, that called for a ban on fracking on the grounds that it violated the principle of precaution in the Environmental Charter—but that left the door open for the possibility of shale gas extraction in the future if and when a "clean and safe" alternative technique to fracking were developed. Another feature of the bill opposed by the Left was that it did not immediately abrogate the controversial research permits granted in March 2010 (the government was advised that this would pose legal problems and could lead to litigation by the companies concerned); instead, it stipulated the permit holders would be required to submit reports within two months after the promulgation of the act and that the permits would be formally abrogated if no report were submitted or if a report indicated that the fracking technique was to be employed (Tomasi and Nicolet 2013, pp. 454–459; Kosciuso-Morizet JO, 29 mars 2011).

The stage was now set for debates in parliament over the Jacob Bill in which the Center-Rights' proposal to ban fracking was framed as a reasoned and moderate alternative to the more radical effort to foreclose any possibility of shale gas extraction in the future, regardless of what technical innovations might be developed. In the National Assembly debates of 29 March and 10 May, the deputies of the Left argued that the authorization of the research permits in March 2010 constituted a "crime of *lèse-democratie*" that represented a "violation of the Charter for the Environment" and a "total contradiction of the philosophy of Grenelle" (Geneviève Gaillard, vice president of the Socialist group, JO 29 mars 2011); that in the Marcellus shale area "the landscape has been destroyed in an irreversible manner" by the hydraulic fracturing technique "invented in the USA by Halliburton —which became famous for other reasons in the Iraq War"; that investment in shale gas would also represent a "bad energy model for the future" undermining the development of renewable energy (Yves Cochet, The Greens, JO 10 mai 2011); and that the citizens of France could not be expected to trust the government that now presents itself “as the firefighter after having been the pyromanic,” and they could not trust industrialists promising safe technologies when the Fukushima catastrophe in Japan “just demonstrated that fears expressed were justified” (Germinal Peiro, Socialist, JO 10 mai 2011). With many opposition deputies citing the cinematic evidence in Gasland to clinch their case, they argued that now was the time to forswear the perilous US frenzy for shale gas and ban its development in France forever.

The Minister of Ecology, Nathalie Kosciusco-Morizet, stressed in the March debates that on many issues virtually all of the deputies were in accord. It was “incontestable” that the public was upset and that the deputies reflected their passion to assure that the shale gas issue was addressed. “The documentary Gasland,” she asserted, “has made an impression on all of us, especially the scene where one sees a ball of fire coming out of the faucet in an American home.” Then, she added that “I’m surprised that even more of you haven’t cited it, but I am sure that you all have it in mind” and pledged that “it is out of the question to undertake shale gas extraction in France using a process that can have such a disastrous ecological impact.” To do so “would be a step backward in regard to all that we have done and desired together” (JO 29 mars 2011). The minister returned to this theme in the debates in May, noting that deputies of all parties had been understandably disturbed by “the American experience with powerful images of devastated countryside” and exclaiming: “We do not want to experience that in France” (JO 10 mai 2011).

For an American citizen, especially one living in the shale gas producing state of Pennsylvania where most of Josh Fox’s documentary was filmed, this “Gasland consensus” is perhaps the most striking feature of the parliamentary debates on the Jacob Bill. Not a single deputy, even within the business-oriented Center-Right, raised a question about the extent to which the portrayal of fracking as the cause of all of the negative environmental impacts depicted in the film could be deemed legitimate, i.e., supported by available scientific research. Not one even raised the question of whether some of the scenes might be atypical in cases in which the drilling companies followed industrial “best practices.” This is curious in light of the fact that a number of critiques of allegations in the film had been published before the French parliamentary debates began in March 2011 and even those sympathetic to Fox’s message had to acknowledge that some legitimate questions could be raised—perhaps especially about the flaming faucet scene cited by Kosciusco-Morizet (Walsh 2011; Soraghan 2011).

The uncritical reception of Gasland in the French parliament underscores a major political factor that explains how France, despite possessing the second largest shale gas reserves in Europe and suffering from economic stagnation that could have been at least partly mitigated by exploiting that resource, could become the first country in the world to ban fracking: the relatively small size of its domestic oil and gas industry, which results in an oil and gas industry with far less lobbying clout—and a far weaker voice in the legislature—than in the UK or, to cite the starkest contrast, the USA. As Fig. 3 below shows, according to the most current statistics, France ranks only number 73 in the world in natural gas production, while the USA ranks number 1 and the UK number 24; the USA produces more than 2000 times as much

Energy Type	Natural Gas Production in cubic meters 2013	Crude Oil Production in barrels per day 2013
France	339,000,000 #73 in world	25,260 #67 in world
United Kingdom	38,470,000,000 #24 in world	857,200 #24 in world
United States	687,600,000,000 #1 in world	11,270,000 #2 in world

Fig. 3 Natural gas and oil production in France, the UK and the USA

natural gas as France, and the UK produces more than 100 times as much. France ranks only number 67 in the world in crude oil production, while the USA ranks number 2 and the UK number 24; the USA produces more than 440 times as much oil as France, and the UK produces more than 30 times as much (Central Intelligence Agency 2015). Left opposition deputies on the floor of parliament expressed concern during the Jacob Bill debates about the influence of the oil and gas industry lobby on the Center-Right government (Pascal Terasse, JO 11 mai 2011), but the unanimity of opinion on Gasland reflected how different their political context was from that of the USA: Nowhere in the room were the equivalent of congressmen from Texas, Oklahoma, or Pennsylvania (on the power of the oil and gas lobby in the USA, see Browning and Kaplan 2011).

Ultimately, the only thing to which the French opposition could point as evidence of effective lobbying by the oil and gas industry was the insistence by Minister Kosciusco-Morizet that the door should be left open for the future extraction of shale gas—if and only if the industry could demonstrate that it could be done with a “clean and safe” procedure, something “different than in the film Gasland” (JO 29 mars 2011). After all, she asserted, “there are arguments in favor of the exploitation of shale gas, notably energy independence” (JO 10 mai 2011). It is noteworthy that, in this sensitive political context, the minister did not explicitly mention the potential economic gains that were to be eschewed—France ranks second in Europe in technically recoverable shale gas reserves with an estimated 5.1 trillion cubic meters (Shale Gas Europe 2013). Kosciusco-Morizet assured parliament that the principle of precaution from the Environmental Charter would be respected in future decisions regarding procedures to tap that potential and that the Mining Code—flaws in which had triggered the unrest of 2011—would be reformed to be consistent with both the Charter and the Grenelle for the Environment. The government pledged to prepare a reform of the Mining Code separate from the Jacob Bill and present it for debate at a later date (JO 10 mai 2011).

When the National Assembly moved to vote on May 11, the Jacob Bill was passed with a majority of 287-186 (JO 11 mai 2011; Badkar 2011). On June 30, it received a majority of 176-151 in the Senate and the law was promulgated on July 13, 2011. In both houses of parliament, the “no” votes virtually all came from those on the Left who believed that the bill did not go far enough—that shale gas development should have been banned “pure and simple” (Gaz de schiste 2011). “For once, political activists, elected officials and industrialists are in agreement,” wrote a *Le Monde* journalist after the Senate vote. “We have never seen such a thing before. It is difficult to believe what’s happened”—“in a fever pitch the executive had banned that which it had authorized only a year before” (Raoul 2011).

In the aftermath, the three research exploration permits that had triggered the chain of political events were—despite the skepticism of deputies on the Left expressed repeatedly in the parliamentary debates—abrogated by the government on October 3, 2011. The two permits for Schuepbach Energy LLC were abrogated on the grounds that the company explicitly declared that it intended to use hydraulic fracturing. Interestingly enough, the permit held by Total E&P France and Devon Energie Montélimar SAS was abrogated even though the companies stated that they did not plan to use the banned technique; the government argued that the report was “not credible” and failed to adequately explain the alternative method it envisioned using (Tomasi and Nicolet 2013, p. 459). In December 2012, the reform of the Mining Code was finally promulgated and, as promised in the parliamentary debates of 2011, public consultation was now to be required “prior to the issuance of any hydrocarbons exploration authorizations” (Tomasi and Nicolet 2013, p. 462).

The final stage of the Jacob Law process was reached on October 11, 2013, when the French Constitutional Council, ruling on an appeal filed by Schuepbach charging that the adoption of this law constituted an “excessively rigorous” application of the principle of precaution, upheld the ban on hydraulic fracturing (Schaub 2013). The Council argued that the legislature’s “restriction imposed on both research and extraction of hydrocarbons”—that is, the ban on hydraulic fracturing—“was not, given the current state of scientific knowledge, a disproportionate means of pursuing a goal of the general interest for the protection of the environment.” It also argued, contrary to the allegation by the company’s attorney, that it was not unjustly discriminatory to ban fracking for shale oil and gas, but not for geothermal energy given that the latter entailed less drilling, a different kind of rock and less objectionable products added to the water (Baudet 2013a, b; Conseil Constitutionnel 2013).

While the Jacob Law case has thus been closed, events that have occurred during the Hollande presidency indicate that the temptation to seek the economic benefits from exploiting France’s extensive shale gas reserves is likely to be difficult to keep off the agenda. Not long after coming to office in 2012, Hollande commissioned Louis Gallois, the former chief at aerospace company EADS and state-owned railway company SNCF, to “prepare a report with the intention of reversing the languishing competitiveness of French companies.” When Gallois presented the report—“The Pact for the Competitiveness of French Industry”—in November 2012, it listed 22 proposals to boost French competitiveness. (Micaleff 2012). The fifth proposal was “to support research on techniques of extracting shale gas,” perhaps in conjunction with European partners; this was presented as especially compelling since shale gas had led to reindustrialization in the USA and France’s need for natural gas was expected to increase in the medium term (Gallois 2012, p. 25).

In short order, the Prime Minister's office released a statement that this proposal would not be pursued (Bertrand 2012). However, signs of division within the government—whose sensitivities were heightened by the fact that its majority had been elected through an alliance between the Socialists and the Greens, and two Greens were in the cabinet (Hayes 2013)—on this issue have continued to emerge periodically from 2012 onward. In November 2012, Arnaud Montebourg, the Minister for Economic Recovery, stated: "We don't accept hydraulic fracturing but we are working to imagine a new generation of clean technologies that would permit extraction without damage" (Gradt 2012). At a press conference that same month, President Hollande stated that he would "discharge his responsibility if a technique" proven safe were developed by industry. In January 2013, Socialist deputy Christian Bataille supported a study of alternatives to fracking and stated that "Hollande has left the door open" on the question. On July 2, 2013, Delphine Batho was dismissed as Minister of Ecology and soon thereafter told the press that she had heard rumors that it was in part because she was staunchly opposed to reopening the issue of shale gas development (Dupin 2013). On July 9, 2013, Montebourg testified to the Commission on Economic Affairs of the National Assembly that, in his personal opinion, it would be a good idea to create a national public entity to pursue the extraction of shale gas if and when an acceptable technique became available; he added that he thought it was possible to convince "reasonable ecologists" to go along with the idea (Baudet 2013a, b); based on a report commissioned by Montebourg in 2012 that was in preparation at that time but not finalized until 2014, it appears that the minister may have been enthused by the fact that a new alternative to fracking—"stimulation with pure propane"—was being acclaimed by some as an acceptable alternative because it required neither water nor chemical additives (Le Hir 2015).

However the debate may have been evolving behind closed doors, Prime Minister Jean-Marc Ayrault publicly responded to questions about Montebourg's proposal in a dismissive fashion: "There is only one government policy," and it is to "exclude the exploitation of shale gas in France." And when asked to comment on the seeming imbroglio within the government in his 14 July press conference, Hollande attempted to put the issue to rest by affirming that "as long as I am president, there will be no exploration for shale gas in France" (Hollande 2013).

However, French politicians of both Left and Right have remained divided on the issue. In September 2014, the Socialist Minister of Ecology (also ex-partner of Hollande and mother of his four children), Ségolène Royal, asserted "I am not dogmatic and if new technologies that are not dangerous appear, why not" reconsider developing shale gas? That same month, former president Nicolas Sarkozy, who had presided over the banning of fracking, went even further. He asserted that "I cannot accept that France should not profit from this new energy while unemployment ravages so much of our territory and so many of our families" and added that he preferred a "principle of responsibility" to the "principle of precaution" (Vaillant 2014). What does the future hold in store? One intriguing possibility—that provides a perfect segue to the next section of this paper—was raised in 2014 by a senior European gas analyst for a bank in Paris, Thierry Bros:

"My guess is that we are going to wait for the UK to see how they're doing it. If the UK can do this in a profitable and environmentally efficient way, then France will have few options. If you have companies leaving your country because of energy prices, you have to look at a Plan B" (Chu 2014).

UK: Cameron's "Drive for Gas," Protest Mobilization, and the Planning Roadblock

Shale gas development was not on the agenda for the first two years of the Conservative–Liberal Democrat coalition government headed by Prime Minister David Cameron. The issue did not appear in the coalition parties' 2010 election manifestos, and in June 2011—the year that the French government banned fracking—the UK government imposed a moratorium on fracking after the country's first drilling trials near Blackpool, Lancashire, were viewed as the likely cause of a 2.3 magnitude earthquake. However, a hint that policy change might be coming emerged in June 2012 when a joint report published by the Royal Society and the Royal Academy of Engineering argued that "the risks associated with fracking can be effectively managed in the UK, provided operational best practices are implemented and enforced through effective regulation." A conservative journalist noted that this could be a "heaven-sent opportunity" for Cameron to boost the fortunes of his troubled government and the stagnating economy by tilting away from the green lobby (including many Liberal Democrats) and taking advantage of "the best thing that has happened to Britain since the discovery of North Sea oil: shale gas" (Delingpole 2012). Another signal of a change in course came in September 2012 when, in a reshuffle of his cabinet, Cameron named an advocate of shale gas fracking, Owen Paterson, as the new Environment Secretary (Schaps 2012).

It was thus not a great surprise when Energy Secretary Ed Davey announced the end of the fracking moratorium in December 2012, stating that it "could resume in Britain subject to new controls which aim to reduce the risk of seismic activity." That same month, the two top officials in the government indicated that shale gas development was now, for the first time, to be made a priority. On December 5, Chancellor of the Exchequer George Osborne unveiled the creation of a new Office for Unconventional Shale Gas and Oil "to simplify regulation of the sector and speed up production" (UK government lifts ban 2012; see also Harvey and Vaughan 2012). A few days later Prime Minister Cameron proclaimed: "Britain must be at the heart of the shale gas revolution," as it could help reindustrialize the economy and might bring energy prices down (Wright et al. 2012). A new era for shale gas policy had begun. As the Google Trends data in Fig. 4 demonstrate, references to "shale gas" spiked upward at this time and would remain at a higher level than ever before for most of the next two years.

From 2013 through 2015, David Cameron would become arguably the greatest champion of shale gas fracking among heads of government worldwide. To those

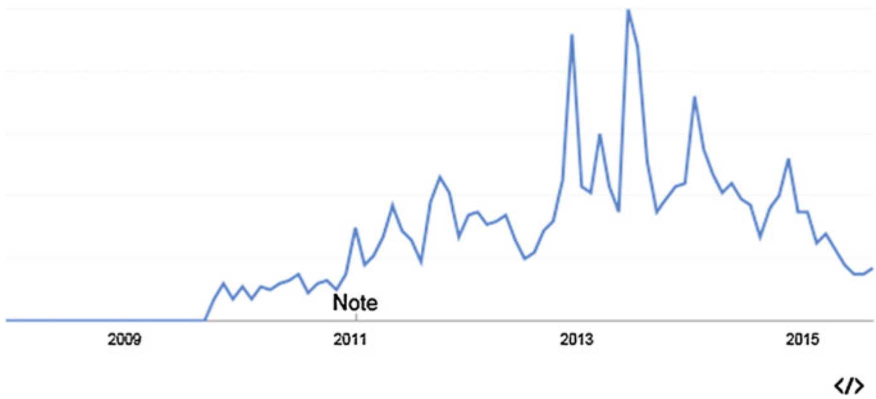

Fig. 4 Reference to shale gas in Google Trends for the UK 2009–2015

familiar with the politics of Marcellus shale, he almost seemed to be reading the script originally prepared by Republican Governor Thomas Corbett, who in his March 2011 budget address exclaimed: "Let's make Pennsylvania the hub of this [drilling] boom. Just as the oil companies decided to headquarter in one of a dozen states with oil, let's make Pennsylvania the Texas of the natural gas boom. I'm determined that Pennsylvania not lose this moment. We have the chance to get it" (Meet Corbett undated). Corbett would achieve his goal of making Pennsylvania a major center of the shale gas boom (Cusick 2014), only to be defeated for reelection in 2014 with strong opposition from those who felt his gung-ho-for-fracking policy had been insensitive to environmental concerns, overly generous in the terms offered to the gas industry, and dismissive of the traditional rights of municipalities to control drilling in their jurisdictions—a state supreme court ruling overturned Corbett-sponsored legislation depriving local governments of the power to ban fracking (Buford 2013). Only time will tell whether David Cameron's shale gas policy will flourish or suffer a similar fate. As the discussion below will make clear, he could well prove vulnerable on precisely the same dimensions of his policy that undermined support for Corbett (Fig. 5).

In May of 2013, Energy Minister Michael Fallon informed the House of Commons that the government had been avidly promoting shale development and had approved more than 300 licenses for onshore oil and natural gas exploration since the lifting of the fracking moratorium. He also explained that the government was committed to "robust regulation" that would assure safe fracking and to managing development "in partnership with communities," so his ministry was "working hard with industry on a package of community benefits" to be offered to affected localities (Britain 2013). The next month a report issued by the British Geological Survey reinforced the government's eagerness to finalize its new policies as it doubled the estimate of British shale gas resources to approximately 37 trillion cubic meters; only a small fraction (less than 10 %) of this would actually be recoverable, but it was noted that the US Energy Information Administration had

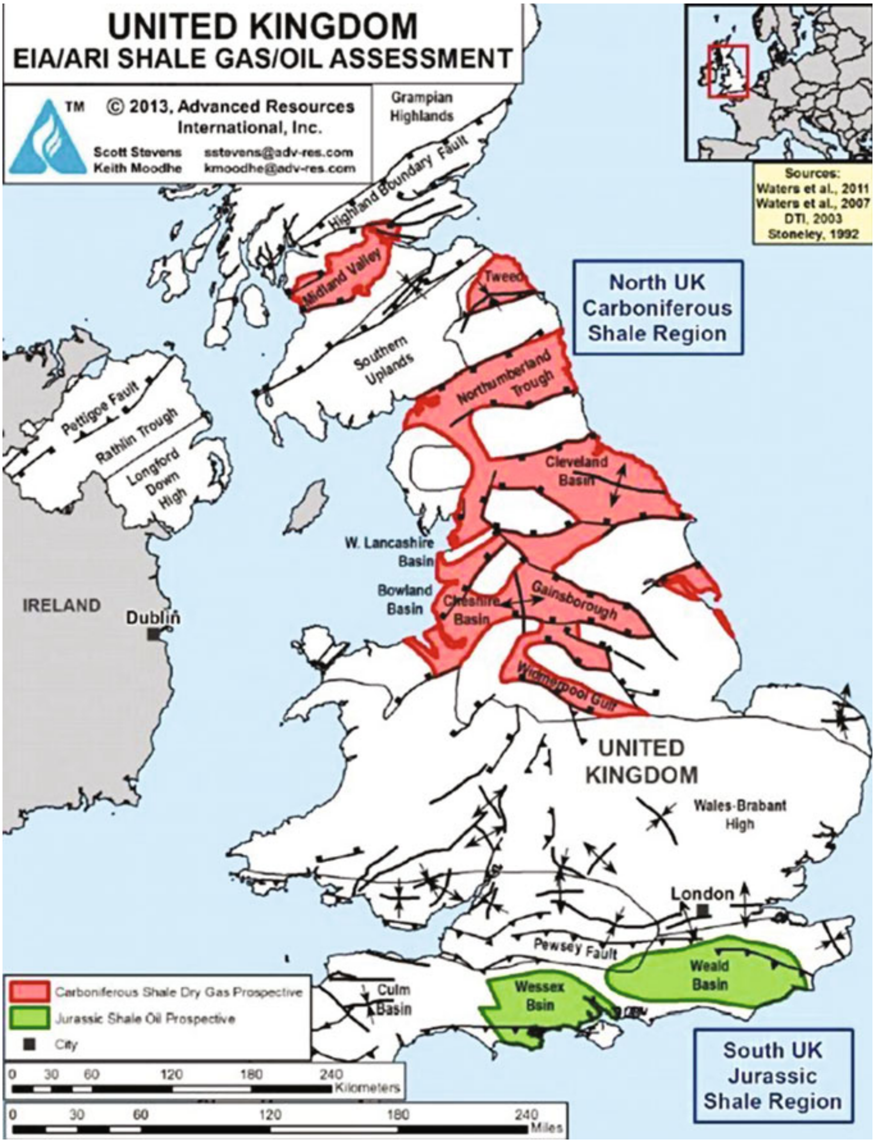

Fig. 5 Shale gas regions in the UK—West (2013)

also recently increased its estimates for "technically recoverable" UK shale gas to 0.7 trillion m^3 (UK Shale Gas 2013).

In late June, the Department of Energy and Climate Change announced details of the "community benefits package" to be offered to localities hosting shale gas drilling. Through negotiations with the oil and gas industry, it was agreed that communities would receive "£100,000 [roughly $150,000] and 1 % of revenues from every production site." Companies would also be bound by a community engagement charter entailing a commitment to "consult openly and honestly with communities at all stages, including in advance of planning permission applications," and operators would be "required to publish annual evidence of how community commitments had been met." At the same time, the Environment Agency produced guidelines to make the process for approving developments more "streamlined" so that it would "not impose unnecessary costs or delays on industry" (Reece 2013). Whereas news of the community benefits was welcomed by many in the regions potentially to be affected, parliamentary debates in July underscored that the amount offered did not seem generous to all (one Conservative MP suggested that 5 % would be much better) and a Labor MP from Blackpool, which had suffered the 2011 earthquake, stressed a theme that would be raised repeatedly by other critics over the next two years: The focus of regulation needs to be on "robust," not on "streamlining" (Hansard 2013). For obvious reasons, the government stressed the former when dealing with the public and the latter when addressing industry. MP Caroline Lucas (Green) caustically asserted that "it is clear that Ministers and fracking firms, which are, sadly, increasingly indistinguishable, are keen to press on rapidly, but it is "pretty appalling" that the government did not consult localities in writing "new planning guidance aimed at making it easier for developers to cast aside community concerns" (Hansard Debates—House of Commons 2013).

Chancellor of the Exchequer Osborne followed up in July with the dramatic announcement that the government's new tax regime would be "the most generous for shale in the world." The shale gas revolution in Britain was to be kick-started with a 30 % tax rate for onshore shale gas production, less than half the rate (62 %) paid by new North Sea oil operations. "I want Britain to be a leader of the shale gas revolution," said Osborne, "because it has the potential to create thousands of jobs and keep energy bills low for millions of people." While the industry and many government supporters applauded the move, Osborne's tax breaks were condemned by environmental groups concerned about the effects of fracking and "fearful that burning more gas will make it impossible to hit carbon reduction targets designed to mitigate climate change" (Macalister and Harvey 2013).

A week after Osborne's tax breaks were announced, the government discovered that its shale gas plans would not be immune from the sort of NIMBY-triggered anti-fracking disruptions that had emerged in France in 2011. On July 25, dozens of protesters blockaded a site in the West Sussex village of Balcombe, less than an hour's train ride from London, where Cuadrilla had just been granted a permit for exploratory drilling. In this case, the exploration was not for shale gas but oil, and at least initially the company was engaging in conventional drilling, but it had not ruled out the potential use of fracking if that proved necessary. In a "seven-hour standoff between Cuadrilla and a group of environmentalists and local opponents," the protesters blocked a truck from hauling equipment to the drilling site, despite repeated warnings from police. The protesters charged that the government was moving too fast to approve drilling licenses and ignoring local opposition (more than 80 % of Balcombe residents surveyed opposed the drilling), so much so that they had "lost faith in the agencies that are meant to protect us" (Booth 2013).

Protests continued on July 26 and 27 with the locals reinforced by activists in organizations such as Friends of the Earth bused in for the occasion, and amidst a heavy police presence, dozens of protesters were arrested. The "battle of Balcombe," as it came to be called, attracted national and even international attention (Henley 2013). What made the protests especially unsettling for the government was that Balcombe was "no hotbed of radicalism"—it was "in the Conservative Party's heartland" and was represented in parliament by a Conservative cabinet minister (Reed 2013a). Doubly unsettling was the fact that the protesters triumphed: Cuadrilla announced in mid-August that it had decided to suspend drilling in Balcombe on the advice of the local police in Sussex following "threats of direct action against the exploration site" (Reed 2013c).

More broadly, the battle of Balcombe signaled "a major shift in the public consciousness" of the fracking issue and created "a major headache for the government." The anti-fracking movement was now more vocal and visible and had managed to mobilize a cross-party coalition—as in France earlier—including both "Daily Mail [pro-Tory] readers" and Left-oriented "Guardianistas." An opinion poll in August showed that, despite the government's well-publicized community benefits proposal, the public was now evenly divided (40 % to 40 % with 20 % undecided) on the issue of whether they would support shale gas fracking in their area (Harvey 2013). Another survey by a University of Nottingham team that had been polling attitudes on shale gas since 2012 showed that, in the wake of the Balcombe protests, "the previously reported steady increase in support for shale gas in the UK had reversed somewhat." From July 2013 to September 2013, the number of people associating shale gas with water contamination increased by more than 6 %, the number who did not view shale gas as clean energy increased more than 5 %, and the number who favored allowing extraction of shale gas in the UK decreased by more than 4 %—though a majority of 54.1 % still supported it (O'Hara and Humphrey 2013).

Against the backdrop of the increasingly intense national debate over fracking, verbal gaffes by two prominent Conservatives in the summer of 2013 did anything but help the government's position. On July 30, Lord Howell, former Energy Secretary under Margaret Thatcher and father-in-law of Chancellor Osborne, "provoked a storm of criticism" when he commented in the House of Lords that perhaps it was unwise to engage in fracking in the south of England but that "there are large, uninhabited and desolate areas…in parts of the north-east, where there is plenty of room for fracking, well away from anybody's residence." Not only was the comment taken as a slur on the north (even the Archbishop of Canterbury tweeted his disagreement), but it was also viewed as politically charged since the north was the region of the country least inclined to support the Conservative Party (Martin 2013; Reed 2013b). Even more embarrassing was a comment made in a private meeting by Energy Secretary Michael Fallon on August 3 as protesters were still carrying placards in Balcombe: "All these people writing leaders saying 'why don't they get on with shale?'—we are going to see how thick their rectory walls are, whether they like the flaring at the end of the drive!" "Doomsday alert over fracking as minister warns of rectory walls quaking across Middle England if drilling continues" blared the headline in the *Daily Mail* (Carlin 2013). The next day Fallon told the BBC that his comments had been intended as "light hearted" (BBC 2013).

On the defensive and urged to speak out, Prime Minister Cameron himself attempted to quell the multilayered controversy and rally support with an article in the *Telegraph* entitled "We cannot afford to miss out on shale." Fracking has become "a national debate in Britain," he acknowledged, "and it's one that I'm determined to win." He summarized the economic rationale for fracking, pledged that it would be done safely and through a "transparent planning process," and then attempted to counter "the worst of the myths" about it—"that fracking damages our countryside." The "huge benefits" of shale, he insisted, would "outweigh any very minor change to the landscape." In an obvious allusion to the Lord Howell affair, he also stressed that it was a myth that "we want fracking to be confined to certain parts of the country." What the government wanted, he said, was for "all parts of our nation to share in the benefits: north or south, Conservative or Labour" (Cameron 2013).

Some months later it became clear that Cameron did not expect to "win" through rhetoric alone. In what one journalist deemed "a new pitch to shore up support for fracking," the prime minister announced that the government was "going all out for shale" and would enhance the community benefits package unveiled earlier by doubling from 50 to 100 % the amount that local councils could keep from the business rates (taxes to help pay for local services) raised from shale gas sites. This new plan, which had been proposed in 2013 by the Institute of Directors, a business lobby, was projected to be worth up to £1.7 million (roughly $2.6 million) for a typical site (Watt 2014). Cameron also asserted, for the first time, that the government was considering whether "because of the disturbance in the early part of a well being dug, there should be cash payments to householders and I'm quite in favor of that" (Dominiczak 2014). Environmental groups predictably responded negatively to the proposal. A spokesperson for Friends of the Earth equated the new offer to a "bribe" and said that it marked "a new low in the government's attempts to curry fracking favor with local people" (Watt 2014). A Labor MP whose constituency included a potential drilling site in which anti-fracking protests were taking place complained that the business rates proposal would undermine trust in local councils by giving them a financial incentive to slacken in their "protective role" via-a-vis energy companies (Vaughan 2014).

However critical the opponents were, Cameron could be encouraged by new evidence that his accelerated drive for shale gas was catching the attention of industry. On the same day as his speech, the French energy group Total—spurned in its efforts to develop shale gas in France, as discussed earlier—became "the first global oil company to invest in a shale gas exploration project in Britain" (Watt 2014). This was very important for Cameron because his speeches made clear that he envisioned a virtuous circle in which the government's business-friendly policy would hasten the commencement of drilling projects, those projects would prove that fracking was safer and less repugnant than critics charged, and mitigation of the NIMBY problem would then facilitate more drilling elsewhere. "I think one of the best ways of addressing" people's worries, he asserted, was "to get some shale gas wells up and running so people can go and see them and you can hear more directly from local people about what it has meant for their communities" and then "the enthusiasm for it will grow" (Fracking "good for the UK" 2014). He expected that some unconventional gas wells would be in operation by the end of 2014 and that soon everyone but the "irrational" people who were "religiously opposed" to fracking would be won over (Dominiczak 2014).

When the Queen's speech (laying out the principal objectives of the government for the coming year) was delivered in June 2014, the issue of shale was included for the first time: The government was to "introduce a bill to bolster investment in infrastructure and reform planning law to improve economic competitiveness," and it would "enhance the United Kingdom's energy independence and security by opening up access to shale…sites" (Queen's speech 2014). Official government briefing notes accompanying the speech explained that this brief and vague passage would actually entail legislation destined to become quite controversial: a change in the "trespass laws" allowing "fracking companies to drill under people's homes without their permission." After weeks of public consultation which yielded 40,647 responses, 99 % of which opposed the change, the government announced that "we believe that the proposed policy remains the right approach to underground access"; fracking companies had argued that the change was necessary to avoid blockage or delays of plans due to resistance by even a single homeowner. The argument of both the government and industry was that a law granting "automatic access for gas and oil development" would not inconvenience homeowners since the horizontal drilling proposed would need to take place at least 300 meters beneath the surface. A Greenpeace spokesman proclaimed that "the roar of opposition to this arrogant policy is deafening" and warned that "there will be a hefty political price to pay for this massive sell-out to the narrow interests of the shale lobby" (Carrington 2014).

In January 2015, the massive Infrastructure Bill, including a host of measures for the governance of shale gas development, reached the crucial stage for voting in the House of Commons after an eight month legislative process. At this point, the government was forced to reckon with growing concerns about fracking not only on the part of the opposition but also within its own majority. The House of Commons Environmental Audit Committee—9 of whose 16 members belonged to the governing coalition—published a report on the morning of the debate arguing that shale gas development would be "inconsistent with the UK's climate change emissions reduction targets" and calling for a 30-month moratorium on fracking for shale gas to allow "uncertainty surrounding environmental risks to be resolved" (Brown 2015). Former Tory Environment Secretary Caroline Spelman supported this proposal and Conservative MP Anne McIntosh, whose constituency included a proposed drilling site, proposed a variety of amendments, including one "to retain the right of people to block fracking under their homes." Labor Party leaders generally opposed the moratorium but strongly criticized many elements of the bill and argued that fracking should not be allowed to go forward unless 13 regulatory "loopholes" were closed (Carrington 2015a).

In the voting on January 26, the amendment to impose a moratorium on fracking received the support of only 52 MPs, including 6 Conservatives and 14 Liberal Democrats. The UK was not France—but it was not Texas, either. With protesters outside of Westminster and around every potential drilling site, even many Conservative MPs were hearing from angry constituents that the government seemed less devoted to the "robust regulation" they promised than to "streamlining" fracking approvals for industry. The anxieties of MPs were exacerbated by the embarrassing leak, on the day of the vote, of a September 2014 letter from Chancellor Osborne urging ministers to make "rapid progress" on "reducing risks and delays to drilling" by, for example, responding to certain "asks from Cuadrilla" (Carrington 2015b). Under considerable pressure, Prime Minster Cameron grudgingly agreed to incorporate into the bill an amendment proposed by Labor that required thirteen conditions to be met before "any hydraulic fracturing activity" could proceed in Britain (Brown 2015; Crichton 2015). The most important of the conditions extended the depth at which fracking could take place without the consent of homeowners from 300 to 1000 m, prohibited except in "exceptional circumstances" drilling in "protected areas" such as national parks and areas of outstanding natural beauty, prohibited drilling in "protected groundwater source areas," required methane levels in groundwater to be monitored for 12 months before fracking could begin, and required "well integrity inspections" by the Health and Safety Executive (Infrastructure bill 2015). All in all, the amendments represented a setback for Cameron's "drive for gas"; an oil and gas industry spokesman stated that the amended bill meant "the outlook for the sector is uncertain as we go into the general election [due in May]" and "investors loathe this sort of uncertainty" (Edie Newsroom 2015).

The concerns of investors and the government became even greater with two political blows delivered only days after the Infrastructure Bill vote. On January 28, the Scottish government—which was set to acquire full power over energy development decisions after the May elections—announced a moratorium on all planning assents for oil and gas extraction until the government had completed a full public consultation (Brooks 2015). A week later the Welsh Assembly voted 37-16 to impose a moratorium on fracking until it was proven safe for health and the environment (Fulton 2015). "The drive by UK Prime Mister David Cameron … to spur a shale-gas revolution," wrote a Bloomberg Business reporter, "is foundering before it's even started." A year and a half after Energy Minister Michael Fallon said he "expected as many as 40 new wells over two years, none has been drilled amid opposition from campaigners and resident near planned sites" (Morales 2015). With the two moratoriums and the presumptive ban on drilling in protected areas of England, commented another journalist, the prospects for fracking in Britain had "lost an awful lot of ground—literally as well as figuratively" (Lean 2015).

It appeared throughout the spring of 2015 that the May elections were unlikely to improve the prospects for shale gas development, since most projections envisioned a decline in support for Cameron's Conservative Party and a possible victory by a Labour-led coalition government. However, confounding the pollsters, the Conservatives won a "resounding victory" by gaining 24 seats in the House of Commons and securing a single-party majority (Erlanger and Castle 2015). Just a few days later, Cameron delighted oil and gas industry lobbyists by appointing Amber Rudd, a shale gas enthusiast, as Secretary of State for the Department of

Energy and Climate Change. "Fracking wells will be popping like champagne corks across Britain during the next five years" predicted one analyst (Mandel 2015). In one of her first interviews after assuming her new office, Rudd pledged that she would "deliver shale" now that the impediment of the Liberal Democrat coalition partner has been removed (Mathiesen 2015). She said she would work to "kick-start a shale gas revolution" and, manifesting the power of the new Conservative majority, made clear that the government would now interpret one of the key elements of the Infrastructure Act in the sort of elastic manner that the anti-fracking movement had feared: While fracking wells would not be allowed *inside* national parks, they were to be allowed to drill horizontally *under* them (Mandel 2015). Critics now conjured up images of fracking rigs surrounding national parks and as a coalition of environmental groups argued: "While the wells may be just outside protected areas, pollution—and visual, noise and light disturbance—won't respect those boundaries" (Gosden 2015b).

However empowered the new government may have been in institutional terms, evidence emerged at this time that that the public—already a source of concern at the time of the vote on the Infrastructure Bill—was not responding well to the persistent drive for gas. A poll taken by YouGov in mid-May 2015 revealed that support for the extraction of shale gas had fallen from 44 to 32 % over the past eighteen months; meanwhile, the number opposing shale gas had risen during that time from 29 to 43 %. Moreover, the poll showed that 49 % said they would oppose—and only 27 % would support—"fracking in a town or village near you." When asked if they would support fracking near them *with community benefits 100 times higher than the government promised*, opponents still outnumbered supporters among the respondents by 40 to 36 %. The pro-government *Sunday Times*, which had commissioned the poll, chose not to report the findings (Evans 2015).

A concrete illustration of such local opposition was delivered to the government in late June when, after months of delay, the Lancashire county council rejected two applications from Cuadrilla for what many had expected to be Britain's first experiences with fracking for shale gas. The application for drilling at Roseacre was unanimously rejected, in line with the recommendation of the county planning officer, on the basis that it would cause excessive traffic congestion (Gosden 2015a). That was bad enough from the government's perspective, but even worse was the announcement a few days later that, by a vote of 9-3 with 2 abstentions, the Lancashire councillors had rejected a separate Cuadrilla application to drill at Preston New Road, near Blackpool, on grounds of visual impact and unacceptable noise—despite the fact that the planning officer had recommended support and legal counsel said refusal would be "unreasonable," was likely to be appealed by Cuadrilla, and could lead to heavy legal costs for the council if the ruling on appeal went in favor of the company (Vaughan 2015).

Since the Lancashire decisions had long been seen as a "make-or-break test case for fracking in Britain," the result was "major blow" for the government (Lean 2015). "Hundreds of anti-fracking campaigners outside the county hall in Preston… reacted with delights and cheers, and people in the council chamber applauded" when the verdict was announced. A leader of Friends of the Earth said the atmosphere was "absolutely electric" and a Greenpeace spokeswoman deemed the decision "a Waterloo for the fracking industry and a triumph for local democracy." Green Party MP Caroline Lucas asserted that this "fantastic victory" proved that, in spite of all the government's efforts to "force through fracking, local communities can prevent it from going ahead" (Vaughan 2015). As one journalist speculated: "The consequences are likely to be profound. Other councils are now likely to be emboldened to reject fracking in their areas, thus adding to a growing feeling among potential investors that exploiting British shale gas and oil is just too risky a project" (Lean 2015).

Business lobbyists responded defensively, with a British Chambers of Commerce spokesman branding the councillors' decision as "perverse, short-sighted, and timid" (Bawden 2015). A shale industry executive lamented: "This after 15 months of a long, drawn-out process cannot be right, and I urge the government to urgently review the process of decision-making" (Vaughan 2015). The UK Onshore Oil and Gas (UKOOG) lobby urged the government to take a "strategic review" of how the planning system deals with these applications. Prime Minister Cameron's initial response, in parliament on July 1, was rather timid and did not send a signal that the system would soon be changed: "Those decisions must be made by local authorities in the proper way, under the planning regime we have" (Bowes 2015). Soon thereafter, however, a journal for planning professionals noted that "calls are growing to consider whether applications could progress via a national process rather than being decided locally" (Sell 2015). And Reuters reported that "pressure is mounting on Britain's pro-shale government" to change the planning system —"discussions have already taken place between the government and shale gas developers in which industry representatives have urged politicians to adjust policies, industry sources said." The shale gas industry was "desperate for a change" to the planning rules. "Government just needs to step up," said the managing director of Hutton Energy. "They can't sit back and say 'we support this industry' but have a process in place which is clearly not working" (Schaps and Twidale 2015).

The next month, the government did step up, doubtless reflecting the pressure of the industry lobby as well as its own frustrations. On 9 August, Energy Secretary Amber Rudd published an article in *The Sunday Times* entitled "Our country needs shale gas, so let's go get it." She noted that the Conservative Party's election manifesto had promised to "support the safe development of shale gas—and that is what we will do." At present, proposed projects were tied up in the planning system for too long, so the government would in the coming week unveil plans to "fast-track" planning applications for shale gas development (Peiser 2015). On 13 August, Rudd and Greg Clark, the Secretary of State for the Department for Communities and Local Government, jointly announced details of the new fast-track process: (1) the Communities Secretary would begin "actively considering calling in" [that is, intervening to make a decision at the central government level]," on a case by case basis, shale planning applications and considering recovering appeals; (2) county councils that "repeatedly fail to determine oil and gas applications within the 16-week statutory time frame requirement" would be identified and the "underperforming" councils' oil and gas applications could be determined by the Communities Secretary; (3) an application's focus on shale gas would be added "as a specific criterion for recovery of appeals," to ensure no application can "fall through the cracks"; and (4) planning "call ins and appeals involving shale gas applications" would be "prioritized by the Planning Inspectorate" [the central government officials who process planning appeals]. Along with the many sticks to be deployed to accelerate planning decisions and assure a higher rate of approvals for shale gas applications, the government offered a carrot as well—yet another "sweetener" to the evolving package of community benefits: A new "sovereign wealth fund" would be developed later in the year so that communities could share more fully "in the financial returns they generate" (Faster Decision Making on Shale Gas 2015).

The government had "fired a warning shot across the bow of local authorities," one analyst commented. Ministers already had the power to take over the decision on controversial planning issues, but they had loudly proclaimed that they would "now consider applying this power routinely to every bid to drill for shale gas" (Harrabin 2015). The initial reaction from anti-fracking forces has been as harsh as the government must have expected. A Friends of the Earth spokesman condemned the fast-tracking plans as "signs of utter desperation" and predicted that they "would fail in the face of overwhelming public opposition" (Vowles 2015). "With public support for shale at an all-time low," asserted Daisy Sands of Greenpeace, "ministers are now having to bulldoze their unpopular fracking plans through. There will be a high political price to pay for putting the interest of the fossil fuel lobby before those of local residents, the environment and the climate." She added that the government's claim to care for the environment now appeared more dubious than ever since county councils were to be stripped of "their right to say no to risky and polluting fracking" only a short time after they had been "given more powers…to oppose wind farms, the cheapest source of clean energy" (Beattie 2015).

The Cameron government clearly calculated it held a strong enough political hand, with a renewed and reinforced mandate and nearly five years to kick-start the "drive for gas" before facing the next election, to cope with the inevitable barrage of criticism. And as noted earlier, Cameron had repeatedly expressed his conviction that if only shale gas drilling could begin, the public would discover that the effects of fracking were less problematic in reality than they seemed in the abstract. That remains to be seen. Unlike Governor Tom Corbett's effort to accelerate fracking in Pennsylvania by stripping municipalities of their power to ban fracking, the Cameron government in Britain need not fear that its initiative might be overturned in the courts. For the next several years, it will only have to fear the court of public opinion, the anti-fracking movement, and the prospect that angry citizens will recreate the trepidation felt by Conservative MPs at the time of the vote on the Infrastructure Bill.

Conclusion

What are the "takeaway" generalizations that this paper can offer comparative analysts of the politics of shale gas and anti-fracking movements? The reflections here will focus on the key variables of the mineral rights legal regime, the size of known shale gas resources, the status of the economy (which will tend to make political officials more or less eager to pursue shale gas), the power of the shale gas lobby, the power of the green lobby (which will in part determine the efficacy of the anti-fracking movement), the degree of commitment by elected officials to "deliver" shale gas, and the relevant governmental institutions (which may or may not provide "veto points" for those seeking to block fracking).

It has often been argued that the *mineral rights legal regime* in the USA, where landowners generally own the rights to minerals beneath their soil, has been a huge factor in making the development of shale gas more politically feasible than in European countries, where (as in virtually all other countries) mineral rights are held by the state. For example, a Shell executive said "don't hold your breath" when asked a few years ago if the shale gas boom was likely to spread soon to Europe. "In places like North America, the landowners love to see a drilling rig because it means money in the pocket," whereas in Europe "the only thing as a landowner you have is inconvenience" (Shell Executive 2011). There is something to this contention, as it has been well documented that in US states such as Pennsylvania, many landowners have eagerly sold their mineral rights to "landmen" representing energy companies, thus accepting the negative effects of fracking in return for cash (Wilbur 2012, especially Chap. 3).

However, as our cases and other comparative research have shown, it is misleading to assume that the mineral rights legal regime alone is a powerful independent variable. One reason is that in Pennsylvania and elsewhere in the USA, landowners proved less eager over time to sell their mineral rights the more they learned about the potential negative impacts of fracking and the often disappointing financial benefits that early sellers were receiving—even before the recent dramatic decline in the price of natural gas (Wilbur 2012, especially Chap. 4). A second reason is that the reputed force of the mineral rights legal regime *presumes* a permissive regulatory regime. As the case of New York state—contiguous to Pennsylvania—illustrates vividly, landowners eager to sell their mineral rights can be prevented from doing so in the USA by a state government that wishes to impose a moratorium on fracking (Wilbur 2012, especially Chaps. 6 and 7; Murtazashvili 2015). A third reason is that, as our two cases demonstrate, a country in which mineral rights are held by the state can choose to offer community benefits in an effort to generate enthusiasm for fracking on the part of residents in a shale gas region. Surveys have shown that, as one would expect, the propensity of people to express willingness to accept fracking in their locality increases as the community benefits to be offered are enhanced (Evans 2015). As we have demonstrated, the Cameron government has embraced this logic by offering ever-sweeter community benefits packages over the past few years. It has not yet succeeded in generating local enthusiasm for fracking through this "carrot" technique and has thus felt compelled to threaten to use the sticks of central control, but this reflects the fact that the carrots offered have widely been viewed as less generous than they should be—and Cameron has to date not delivered on the idea he once floated of providing special benefits to individual property owners as well as the broader community. In the case of France, the fate of fracking was determined, due to an inadvertent administrative blunder that triggered a storm of protest, before any government had a chance to affect the outcome of debates by developing and offering a package of community benefits. Given the apparent eagerness of Sarkozy and others on the Center-Right to pursue shale gas if and when they replace the current Socialist government under a deeply unpopular President Hollande, one may well see such community benefits as part of future deliberations on shale gas development in France.

Our two cases illustrate, as one would expect, the importance of *the size of known shale gas reserves* as an important variable determining in part the chances that shale gas will be developed. In the French case, the ban on fracking led quickly to expressions of remorse from both the Left and the Right in large part due to the fact that France is said to rank number two behind only Poland in the extent of shale gas resources. In a widely cited quote, former Socialist Prime Minister Michel Rocard told an interviewer in 2012 that he was very committed to the environment, but that he did not think France should deprive itself of the opportunity to be "for shale gas what Qatar is for oil"—"France is blessed by the gods" (Guélaud and Wieder 2012). In the British case, as we have shown, the Cameron government's enthusiasm for the "drive for gas" was bolstered substantially by scientific studies indicating that recoverable shale gas resources in the UK were twice what had been estimated earlier. Critics have attempted to counter this by arguing that Cameron has oversold the potential "bonanza" in store, but it is revealing that the Labour opposition has—even if more guardedly—supported shale gas development along with the Conservatives.

As for *the status of the economy*, our two cases demonstrate clearly that politicians will be more inclined to push for shale gas development in the context of a sluggish economy where fracking may be one of the few available options to stimulate growth. Both France and Britain have been hit hard by the Great Recession, harder than the USA, and this has been evident in the debates in both countries. This fact certainly has contributed to the zeal of the Cameron government, and it has fueled much of the remorse and rethinking in France. In the USA, the Great Recession tilted the Obama Administration away from embracing the arguments of liberal environmentalists against fracking and it facilitated Corbett's drive to overcome environmental objections in Pennsylvania (Wilbur 2012).

It was argued earlier that natural gas and oil production could be used as a proxy for the *power of the energy lobby*, and when our cases are set in a broader comparative context, there appears to be substantial evidence that this variable has a pronounced effect on the chances of shale gas development gaining acceptance. France has the smallest current levels of production, the weakest energy lobby, and to date has maintained a ban on fracking—to the chagrin of French companies which have moved across the channel to invest in shale gas development. Britain has far larger current levels of production, a far stronger energy lobby whose pressure on the Cameron government is documented above, and seems on the verge of launching fracking. The USA has extraordinarily high current levels of production, the strongest energy lobby in the world, and was the first country to celebrate the "shale gas revolution."

One would certainly expect the *power of the green lobby* and the resulting overall national commitment to environmental protection to play an important role in affecting the degree of shale gas development, and our two cases demonstrate this fact when set in a comparative context. In general, since 1990, the European Union has "more stringently regulated a number of health, safety, and environmental risks caused by business than the USA" and the EU's "adoption of the precautionary principle" has led European governments to "impose restrictions on commercial activities whose risks are uncertain, unproven, or disputed"—with American firms and officials complaining that European regulations are too often based on "phantom risks" rather than "sound science" (Vogel 2012, pp. 2–9). The variance between the handling of the fracking issue in the USA and both France and Britain is a perfect example of this trend. In addition, the European Union has been far more committed than the USA to efforts to "tackle climate change" and has "set itself targets for reducing its greenhouse gas emissions progressively up to 2050." Within the context of the European Climate Change Program (ECCP), France and the UK have developed national action plans detailing their own commitments (Climate Action 2015). It is important to note that national climate change targets, and the concern that shale gas development would undermine efforts to reach them, have been cited frequently by opponents of fracking in both France and the UK.

One useful measure of the degree of national commitment to environmental protection that allows us to compare our two European cases with the USA is the ranking that countries receive in the Yale Environmental Performance Index or YEPI (Emerson et al. 2012; Hsu et al. 2014). Taking the averages of the rankings form the 2012 and 2014 YEPI reports, the UK ranks number 10 in the world, France number 16, and the USA number 41. It is often argued that concern for the environment is generally higher in more densely populated areas, and these rankings reflect that the population density of the UK is 267 people per square kilometer and that for France is 121—both far higher than the USA figure of 35 (Population Density 2015). It is also worth noting how huge the variance in total land area is across these three cases: the UK is only 2.6 % as large as the USA and France 6 % (Land Area 2015). These data help to explain why opponents of fracking in both France and the UK have gained traction with the argument that shale gas development might be acceptable in the vast open spaces of the USA, but is simply not suited to densely populated countries with very few unspoiled landscapes that require vigilant protection.

The best available direct measure of the power of the green lobbies in France and the UK is electoral statistics. Whereas no green party has achieved a significant national presence in the USA, such parties have in France and the UK—and in both cases they have gained momentum at the most recent elections. From the 2007 to the 2012 elections, the French Greens increased their first-ballot vote from 3.3 to

5.5 % (1.4 million) and their seats from 4 to 17 (Hayes 2013). From the 2010 to the 2015 elections, the UK Greens increased their vote from 0.9 to 3.8 % (1.2 million) and their candidates from 310 to 575. Though they won only one seat at each election, that was mainly a function of the first-past-the-post electoral system, as Green MP Caroline Lucas lamented in May 2015 (Walker 2015). She may be the only Green voice in the House of Commons, but Lucas played a substantial role in the "battle of Balcombe" (she made headlines when she was arrested in 2013 for helping to block a road near the Cuadrilla drilling site) and has been a forceful participant in parliamentary debates on the fracking issue (Davies 2014). One assumes that David Cameron is well aware that support for Lucas' party has grown impressively as the "drive for gas" has proceeded and opposition to fracking has increased in the opinion polls.

Our two cases and others show clearly that the *degree of commitment by elected officials* to push for shale gas development can, as one would expect, play a substantial role in determining outcomes. Neither before nor since the 2011 ban has a current French politician, aware of the obstacles to be overcome, championed shale gas development unreservedly—to date Montebourg on the Left and Sarkozy (only recently) on the Center-Right have perhaps come closest. It was easy for Michel Rocard to sound courageous on the issue—he is retired. In the case of Britain, Cameron has pursued his "drive for gas" in a relentless manner. Many more fainthearted leaders would have curtailed the effort when faced with the mobilized opposition and falling public support for fracking he has endured, and a good number of commentators expected this to be his tack after the planning rejections in Lancashire—but instead he doubled down with the controversial resort to regulatory sticks and the new "sovereign wealth fund" carrot. Across the Atlantic, all it takes to appreciate the importance of this variable is to contrast the outcomes in Governor Tom Corbett's Pennsylvania and Governor Andrew Cuomo's New York, where a fracking ban is still in place.

Finally, our two cases and others illustrate the crucial way in which *governmental institutions* can affect shale gas outcomes. It was France's outdated Mining Code, not yet reformed to be compatible with the Charter for the Environment, that allowed for the "opaque" MEESD decisions on exploratory research permits in 2010, triggering angry protests and compelling an embarrassed government to make amends through legislation. In Britain, the first-past-the-post electoral system enabled Cameron's Conservative Party to win 51 % of the seats in the House of Commons in 2015 with only 37 % of the vote and enabled a renewed push for fracking. Although he controlled a national majority, county councils such as those in Lancashire still had the capacity to stymie the "dash for gas" through the planning process—but they were soon reminded that UK governments wield the central power of a unitary state and that this was not truly a "veto point." Emboldened by his new five-year mandate, Cameron was willing to take the political risk of threatening to have his Communities Secretary overturn such local decisions—despite the Conservatives' putative commitment to empowering local officials. Unlike Governor Corbett, whose legislation prohibiting municipalities from constraining fracking was overturned by the Pennsylvania Supreme Court, Cameron had no such judicial authority to fear. As noted above, he has only the court of public opinion to fear. But in that regard, he may find it troubling to know that *even in Texas* fracking has been unpopular enough in some localities to compel the state government to pass a law prohibiting cities and towns from banning fracking—and that similar laws are under consideration in Oklahoma, Colorado, and New Mexico (Phillips 2015).

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Shale and Eastern Europe—Bulgaria, Romania, and Ukraine

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Abstract This study uses data from diverse scientific and government sources in order to evaluate the impact of unconventional shale gas development on Bulgaria, Romania, and Ukraine in terms of economics, policy, and interdependence. In addition, the study is exploring a number of factors, related to shale gas controversies in the three countries, as well as the future potential of shale gas development in Eastern Europe.

Introduction

Following the rapid development of shale gas in North America, US-based companies explored the possibility to develop shale gas resources in the rest of the world, focusing on Europe as well. Several preliminary studies of the Energy Information Administration of the US Department of Energy showed substantial resources in Bulgaria, Denmark, France, Germany, the Netherlands, Poland, Romania, Russia, Ukraine, and the United Kingdom. Some of these countries have a well-developed natural gas market, supplied by both Russia and external sources (Nigeria, Norway, Qatar, etc.), while others are entirely dependent on the long-term contracts with Gazprom. The closest neighbors to Russia, situated on the Black Sea shores, are Bulgaria, Romania, and Ukraine. Their gas imports currently are almost entirely dependent on Russia, while they also may hold substantial shale gas and other unconventional hydrocarbon resources. Both their offshore Black Sea conventional and unconventional resources, as well as shale gas deposits, are

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underexplored and underdeveloped. If the three countries embrace shale gas as a viable option, and if the geological, political, economic, legal, regulatory, and technical conditions are at place, unconventional gas could play a major role in the three countries' energy balances, energy import dependence, fiscal positions, unemployment, and GDP growth.

General Information About Bulgaria, Romania, and Ukraine

Bulgaria, Romania, and Ukraine are situated in Eastern Europe. As of 2014, Bulgaria has a territory of 110,879 km^2 (42,811 mi^2) and a population of 7.2 million. Romania's territory is 238,391 km^2 (92,043 mi^2) and its population is 19.9 million. Ukraine's territory is 603,500 km^2 (233,000 mi^2), excluding Crimea (27,000 km^2 or 10,000 mi^2), which is de facto controlled by Russia. Ukraine is the largest country wholly situated in Europe and its population is 45.4 million, excluding Crimea with its 2.3 million.

Bulgaria and Romania are ranked as "upper-middle-income" countries, and Ukraine is a "lower-middle-income" country (World Bank 2015). In 2014, the GDP per capita (constant 2005 US$) for Bulgaria, Romania, and Ukraine was, respectively, 4916 USD, 6196 USD, and 2081 USD. The World Bank data show that energy use in Bulgaria, Romania, and Ukraine is, respectively, 162.6, 99.5, and 323.4 kg of oil equivalent per 1000 USD of GDP (constant 2011 PPP). Bulgaria and Romania rank, respectively, first and fifth in the EU by lowest energy efficiency, measured through the same indicator (Eurostat 2015b).

All three countries are net importers of oil and gas, and this affects negatively their trade balances. An analysis of the Directorate-General for Economic and Financial Affairs of the European Commission shows that Bulgaria has the third largest total energy trade deficit in the period 2009–2013, amounting to about 6.4 % of GDP, while the share of energy in total trade is 19.4 % (European Commission 2014). Romania has a better total energy trade deficit—only about 2.3 % of GDP and the share of energy in its trade is 7.8 % for the period 2009–2013. Regarding gas trade balance, it is negative for all member-states of the EU, and the largest deficit for the same period is in Lithuania, Slovakia, Hungary, and Bulgaria. In Bulgaria, its value is 2.3 % of GDP and in Romania is 0.5 % of GDP. In Ukraine, the rising gas prices in the period 2005–2012 have led to a rapid increase in the annual cost of gas imports: from less than 4 bn USD in 2005–2014 bn USD in 2011–2012 (Sarna 2013), which accounts to about 4.7 % of GDP.

Energy Portfolio and Natural Gas Usage in Bulgaria, Romania, and Ukraine

Being situated at one of the important crossroads between the East and the West, Bulgaria, Romania, and Ukraine are usually seen as countries that could help to improve the European Union's overall energy security. Energy security in Eastern and Southeastern Europe has always been an issue in the East–West foreign relations, but became a more pressing matter after the natural gas supply crisis in January 2009, when Russian supplies through Ukraine stopped for about a month for the first time in more than 30 years.

Most of the countries in the region are heavily dependent on Russian gas supplies with no alternatives: Ukraine—for up to 80 % of its consumption, Romania—up to 25 % in the last decade, and Bulgaria—for over 90 % of its consumption. The 2009 crisis prompted the EU to vote specific legislation for ensuring better security of gas supplies (European Parliament 2010), including specific financial instruments for developing gas supply infrastructure (European Commission 2013). However, still not enough is done in terms of promoting indigenous production of gas from both conventional and unconventional sources in this region of Europe.

Bulgaria

Bulgaria is the most promising energy transit route for both Russian and alternative gas deliveries to Europe. Currently, the country transits Russian gas to its neighbors Turkey, Greece, and Macedonia. It was the landing point for the offshore gas pipeline South Stream, which was intended to supply with 63 Bcm (about 2.22 Tcf) of gas per year Italy and Austria, as well as the other transit and adjacent countries: Croatia, Greece, Hungary, Macedonia, Romania, Serbia, Slovakia, Slovenia, etc. The alternative "Southern Gas Corridor," which has to bring gas supplies from the Caspian Region, the Middle East, and the Mediterranean, has two alternative routes on the Balkans—through Bulgaria and through Greece. Bulgaria itself has a potential for natural gas production: onshore, offshore, and unconventional (shale gas and coalbed methane).

Bulgaria and Romania were the fifth and sixth largest exporters of electricity in the European Union in 2014, after France, Germany, Sweden, and the Czech Republic (ENTSO-E 2015). Bulgaria's net physical exports were 9451 GWh, and Romania's net exports were 7130 GWh in 2014. The energy balances of Ukraine show that in 2013 the country had net electricity exports of 854 ktoe or about 9932 GWh (State Statistics Service of Ukraine 2015).

There is currently only one underground gas storage in Bulgaria—"Chiren," operated by Bulgartransgaz EAD. The total working capacity of the storage is 500 mcm (17.7 Bcf) and its maximum daily withdrawal rate is about 4–5 mcm (141–177 MMcf). According to "stress tests" by the European Commission, the capacity and the withdrawal rate would not be enough to cover the winter daily demand of about 12 mcm (424 MMcf) during a new gas supply cut. In order to increase the security of gas supply, Bulgartransgaz intends to increase the working capacity of the storage to 1 Bcm (about 35.3 Bcf) and its daily withdrawal rate to 8–10 mcm (0.28–0.35 Bcf). There is also an option for a second gas storage at "Galata"—a depleting shallow offshore gas field, operated by Petroceltic. Its working capacity may be up to 800 mcm (28.2 Bcf), but as of August 2015 there is still no decision on the future of the gas field.

According to Bulgarian government's data, Bulgaria had an overall dependence on energy imports for 37.8 % of its consumption in 2013—a better position than the average for the EU, which is dependent for 53.2 % of its imports (Ministry of Energy of Bulgaria 2015). However, nuclear energy, which has a 21.0 % share in primary energy use, is considered as local according to Eurostat methodology. In Bulgaria, there are 4 nuclear units under decommissioning (a total of 1760 MW) and 2 operational units with a total capacity of 2000 MW. All of the above are Russian design and the latter are still supplied only with Russian nuclear fuel. Also, the only oil refinery in Bulgaria, Lukoil Neftochim, which holds almost 50 % of the local fuels market, is 100 % subsidiary of the Russian energy company Lukoil. Thus, Bulgaria is dependent on Russia for about half of its oil and fuels, for more than 90 % of its gas consumption and for 100 % of its nuclear fuel imports. The largest local energy resource is lignite coal, which is used for power production, but is also subject to stricter carbon, sulfur, and nitrogen emissions regulations. There is a Russian influence in gas distribution as well, where Overgas Inc. AD, 50 % owned by Gazprom, is responsible for 59 % of the gas retail market.

The majority of power generation in Bulgaria is owned by the state through the 100 %-owned Bulgarian Energy Holding EAD (BEH). BEH is the 100 % shareholder in the following companies: NPP Kozloduy (2000 MW), the lignite-fired TPP Maritsa East 2 (1600 MW), the public supplier NEK EAD (with hydro capacities of 2700 MW, including all the pumped storage hydro power plants with a total capacity of 940 MW), and the whole transmission network and TSO under the subsidiary company ESO EAD. NEK EAD also has two PPA contracts with two US-owned lignite thermal power plants for 100 % of their production—TPP AES Galabovo (670 MW) and TPP ContourGlobal Maritsa East 3 (908 MW). BEH is also the 100 % shareholder of the public supplier for natural gas Bulgargaz EAD and the national gas transmission system operator Bulgartransgaz EAD.

The Bulgarian power sector has been diversified with a rapid growth of renewable energy sources in the period 2011–2012. The poorly structured supporting scheme for renewable energy through feed-in tariffs has initially led to applications for 12,000 MW of new RES capacities in a market with a minimum consumption of about 2500 MWh/h and peak at about 7500 MWh/h. Currently, there are 1040 MW of photovoltaic power plants, 701 MW of wind, and 47 MW of biomass power plants (Georgiev 2015).

NEK EAD has concluded a contract with Rosatom for the construction of a new NPP—"Belene," but later canceled the project and is being sued by the Russian company for a compensation of 1 bn EUR (1.11 bn USD). As of August 2015, the arbitration case is expected to be resolved in the autumn of 2015, without clear signs of who will win it.

Data from the national incumbent wholesale supplier (Bulgargaz 2015) show that Bulgaria consumed 2.485 Bcm (87.7 Bcf) of natural gas in 2014, and 91.99 % of this gas was imported from the Russian Federation. In 2013, the country used 2.539 Bcm (89.6 Bcf) and the imports were 89.13 %. The rest of the consumed gas is produced locally—right offshore the Black Sea coast, from a small field at the end of its life, operated by the British company Petroceltic. The share of natural gas in the national gross energy consumption was only 14.2 % in 2013 (Eurostat 2015a). However, about 38 % of this gas is used for district heating services in the large towns of Bulgaria, including the capital city of Sofia. Leaving these plants without gas in the coldest days of the winter could cause not only discomfort for the households and businesses, but also a crisis with the electricity supplies, if all homeowners switch at once to backup electric heating devices. Another large consumer of gas in Bulgaria is the industrial sector—it used 760 ktoe (about 32.3 Bcf) for energy purposes in 2013 and 207 ktoe (8.8 Bcf) for non-energy petrochemical products such as fertilizers. Most of the industry is not able to quickly switch to a reserve fuel and needs security of energy supplies as well.

Currently, there is no real gas market in Bulgaria. The country buys all the gas it needs from Gazprom and receives it via one pipeline (through Ukraine, Moldova, and Romania), and this gas is sold internally by the incumbent Bulgargaz EAD—a subsidiary of the state-owned Bulgarian Energy Holding EAD and by the largest owner of local gas distribution companies—Overgas Inc. The remaining 7–8 % of gas supplies are also delivered to Bulgargaz, which wants to include alternative sources in the mix in order to keep end user prices down. Bulgargaz sells the gas at regulated prices to industrial consumers, power companies, and households. There is no diversification in the national gas market and this makes business and household consumers extremely vulnerable to supply crises and price changes. The gas is purchased via long-term contracts, dependent on oil price swings and with no real connection to the gas spot markets in Central and Western Europe.

Natural gas has a lot of growth potential in Bulgaria. Currently, only about 3 % of households use natural gas, as this market segment was not developed until the 1990s, but the Energy Strategy of Bulgaria until 2020, which was adopted in 2011 (Ministry of Economy, Energy, and Tourism of Bulgaria 2011), envisions a further development of gas use in households. About 75 % of municipalities in the country are not connected to the gas transmission network, leaving businesses and households without the possibility to use natural gas. The document also puts as a priority the replacement of the electric energy with natural gas for domestic heating and for housekeeping needs, which would “contribute to three times higher saving of primary energy” and “should be viewed as one of the methods for improvement of the energy security.”

According to the strategy’s text, in order to guarantee the state’s energy independence “with strict adherence to the environmental requirements,” there would be development of new natural gas fields “including, without being limited to, shale gas and deep water wells in the Black Sea,” which will be “actively supported.”

One of the 11 priority actions in the strategical document is the “priority investment in geological exploration of new oil and gas fields, including those of shale gas, and deep water drilling in the Black Sea.”

There are also about decade-old plans for building gas interconnectors to Romania, Greece, Serbia, and Turkey. And last but not least, gas transmission projects such as the EU-supported Nabucco and the Russian South Stream, if they are ever built, would cross the country, promising the possibility of new connections to the gas network, for instance for some of the municipalities that now have no access to gas and no distribution networks. All of these developments augur well for gas consumption in the coming years.

With these developments of national consumption, the issue of diversification through additional import sources and local production becomes even more pressing.

Romania

Romania is also dependent for its gas consumption on imports, but only for 11.9 % of its supplies in 2013 (Eurostat 2015a). Its gross annual consumption of natural gas is 32,346 ktoe (about 1.37 Tcf) and the local production ensured the larger part in the last several years. Data from the national incumbent wholesale supplier (Transgaz 2015) show that Romania stopped importing gas during the spring of 2015 as a result of higher local conventional gas production. Imports were as low as 2 % from the needed gas quantities during the second half of 2014, improving the overall energy security of Romania during the political crisis between Russia and Ukraine in 2014 and 2015.

The final energy consumption in Romania is distributed more evenly between the energy sector, the industrial consumption, and the residential sector. In 2013, about 25 % of the energy was used for direct consumption by households and about 24.4 % was used by the industry for its energy needs. About 34.1 % was used by the energy sector for transformation—in cogeneration or heating-only power plants.

According to the national report of the Romanian energy regulatory agency, the country had a total of 4349 MW installed renewable energy capacities in the end of 2013. There are 2594 MW of wind, 531 MW of hydro power plants; 66 MW of biomass, and 1158 MW of photovoltaic capacities. The total installed generating capacity of the Romanian power system is 20,082 MW. The maximum gross consumption in 2013 was 9158 MWh/h and the minimum consumption for the same year was 3648 MWh/h (Romanian Energy Regulatory Authority 2014). The market development progress report for Romania (European Commission 2015b) shows that in 2013 the electricity generation was distributed between thermal power plants (46.2 %), hydro power plants (25.9 %), nuclear energy (19.9 %), and renewables (8 %). According to the data in the report, the state-owned companies Energy Complex Oltenia (operating lignite thermal power plants), Hidroelectrica, and Nuclearelectrica (operating the NPP Cernavoda) are the three largest generators in Romania with a total market share of 69.7 % in 2013.

The gas market in Romania provides consumers with choice of supplier, and in 2013, there were almost 3000 consumers who bought gas at non-regulated prices. According to data from the draft Romanian Energy Strategy (Ministry of Energy of Romania 2015), the share of non-regulated gas market was 54.2 % of the total gas consumption in 2013. In the same year, about 85 % of the gas consumed in Romania was produced locally and imports from Russia and Hungary accounted for 15 % of the total quantities. The national gas transmission network, operated by Transgaz, has a total length of 13,127 km, including 553 km of transit pipelines. The link to Bulgaria is able to transport up to 883 Bcf p.a. and is currently supplying Bulgaria, Macedonia, Greece, and Turkey via the "Transbalkan pipeline."

Romania's gas production and trading company Romgaz operates six underground gas storage facilities with a total active capacity of 2.77 Bcm (97.8 Bcf). Their current maximum flow is about 22 mcm/day (0.78 Bcf/day), and Romgaz intends to invest in its increase up to 30 mcm/day (1.06 Bcf/day). About 70 % of the shares of the company are owned by the Romanian state and the rest are traded on the Bucharest Stock Exchange and the London Stock Exchange.

Ukraine

Ukraine's gas transmission network is an integral part of the gas transport system, connecting producing fields in Russia and the Caspian Region with the consumers in Europe. The most important pipelines are "Druzhba" ("Friendship" in Russian language) and "Urengoy–Pomary–Uzhgorod." About half of Russia's gas exports to Europe are delivered via Ukraine and some of the countries supplied through these routes are Austria, Bulgaria, Croatia, the Czech Republic, France, Greece, Germany, Hungary, Italy, Macedonia, Moldova, Poland, Slovakia, Slovenia, and Turkey.

Data from the national transmission system operator (Ukrtransgaz 2015) show that the country has the potential to transport up to 140 Bcm p.a. (about 4.9 Tcf) and has 12 underground gas storage facilities with a total working capacity of 31 Bcm (1.1 Tcf). This network is an important part of the logistics for supplying the fluctuating seasonal demand with a steady flow of gas from the producing fields. The total length of pipelines is 38,500 km, with 22,160 km of them for transit purposes.

Foreign gas companies, as well as Gazprom, have expressed their interest in owning and/or operating the country's extensive gas infrastructure, which includes pipelines and strategic gas storage facilities. However, the latest developments in Crimea and Eastern Ukraine pose a threat to both the country's unity and its gas sector development. The potential gas production will depend on future developments in the Russia–Ukraine conflict.

According to the Energy Strategy of Ukraine (Ministerial Council of Ukraine 2013), the country consumed between 76 Bcm (2.68 Tcf) in 2005 and 50 Bcm (1.77 Tcf) in 2009 of natural gas per year during the last decade. In 2010, the total national consumption amounted to 57 Bcm (2.01 Tcf), making Ukraine one of the largest consumers of natural gas in Europe. Of these quantities, in 2010 about 18

Bcm (0.64 Tcf) were consumed directly by households and 11 Bcm (0.39 Tcf) were used for supplying the central heating systems in the large towns of the country. The second largest consumer of gas in 2010 was the industrial sector with about 40 % of the total quantity, and the largest industrial consumer was the steel industry. The latest data by the national statistics (State Statistics Service of Ukraine 2015) show a total primary energy supply of gas in 2013 amounting to 39,444 ktoe, equal to about 1.68 Tcf. About 57.3 % of this gas has been imported. The Energy Strategy predicts a stable consumption in the country until 2030—varying from 47 Bcm (1.66 Tcf) p.a. in the pessimistic scenario to 53 Bcm (1.87 Tcf) p.a. in the optimistic one.

The gas market in Ukraine is still not deregulated and does not provide for choice of gas supplier. However, the Energy Strategy until 2030 envisages a gradual deregulation and liberalization of the gas market at two stages—the first one will preserve the state regulation over wholesale supplies while ensuring diversification, while the second stage will include deregulation of prices, privatization of gas distribution grid companies, and the state would keep control over some of the gas imports.

Almost 48 % of Ukraine's power is produced in nuclear power plants by 15 operating reactors. There are five NPPs in Ukraine: "Chernobyl" (4000 MW, stopped), "Khmelnytsky" (2000 MW), "Rivne" (2800 MW), "South Ukraine" (3000 MW), and "Zaporizhia" (6000 MW, the largest nuclear power plant in Europe). Until 2008, Ukraine was supplied with nuclear fuel and nuclear services entirely by Russian companies. Then, the country made several attempts to diversify its nuclear fuel supplies through additional contracts with "Westinghouse" and intensified these efforts after the crisis in Crimea and Eastern Ukraine (World Nuclear Association 2015). The second largest share in the power generation mix is held by coal with about 35–40 %.

Cultural, Economic, and Political Connections Among the Three Countries

Bulgaria, Romania, and Ukraine share a similar post-WWII history. They were part of the Eastern Bloc—Ukraine as part of the USSR, while Bulgaria and Romania had their de jure independence, but were close allies of the Soviet Union in both the Warsaw Pact and the Comecon.

In the end of 1989, after the fall of the Berlin Wall, both Bulgaria and Romania overthrew their Communist regimes and started a process of democratization together with a westernization of their economies. Then, Ukraine seceded from the USSR in 1991, but did not follow the exact example of the other former members of the Eastern Bloc.

Bulgaria and Romania (together with Estonia, Latvia, Lithuania, Slovenia, and Slovakia) joined NATO on March 29, 2004. Five years earlier, in 1999, Hungary, the Czech Republic, and Poland also joined the North Atlantic Treaty. Then, in April 2009, Albania and Croatia followed, while Ukraine and Georgia were told that they could eventually become members. The latter has been criticized by the leaders of the Russian Federation and is seen as one of the reasons for the Crimea crisis and the War in Eastern Ukraine, which started in 2014. Even though Ukraine is still not a part of NATO, it has developed an Individual Partnership Action Plan (IPAP) with the organization. Such IPAPs have also been signed between NATO and several other East European countries: Armenia, Azerbaijan, Bosnia and Herzegovina, Georgia, Kazakhstan, Moldova, Montenegro, and Serbia in the period 2004–2015. All these developments are seen by the leaders of the Russian Federation as a threat to its geopolitical and economic position in Europe and in its closest vicinity, as these countries have been part of either the Eastern Bloc or the USSR.

Even a quarter of a century after the transition started, Bulgaria, Romania, and Ukraine have deep economic (including energy-related) and political ties to Russia. Some of the connections are based on the contacts between the KGB and the former secret services of Bulgaria, Romania, and Ukraine. Thus, any attempts to change the balance of interests in the three countries in political or economic terms lead to an internal opposition, which is usually pro-Russian. Some of the latest events are the Euromaidan and the successive crisis in Ukraine, the internal support for the Russian South Stream pipeline in Bulgaria, and the anti-shale gas protests in both Romania and Bulgaria.

Bulgaria and Romania are the poorest nations among the 28 members in the European Union. They both joined the EU in 2007 and are still struggling to improve the rule of law, the economy, and the overall living standard of their citizens. On May 7, 2009, Ukraine, among other East European countries (Armenia, Azerbaijan, Belarus, Georgia, and Moldova), signed a Joint Declaration with the member-states of the European Union, with the main goal "to create the necessary conditions to accelerate political association and further economic integration between the European Union and interested partner countries" (European Commission 2009). The initiative is known as the "Eastern Partnership."

Both Romania and Bulgaria have been very active in seeking alternative options for gas supplies—originating in Russia or the Caspian. The Nabucco gas pipeline project would have crossed both countries, if constructed, and would bring gas from Azerbaijan, Turkmenistan, and eventually Iran to Southeastern and Central Europe. Russia was considering landing points of South Stream in the EU both in Romania and Bulgaria. In addition, there are several other potential gas projects—a successor of Nabucco, called Eastring, as well as a CNG option for transport trough the Black Sea, called AGRI (abbreviation for Azerbaijan, Georgia, Romania Interconnector).

Ukraine has been exploring diverse options in order to improve the security of its gas supplies. The common trait of all scenarios is the attempt to diversify imports away from Gazprom. Some of the alternatives are reverse flows on existing pipelines (the one with Slovakia has already been implemented), new pipeline routes, LNG imports through the Black Sea, and increased local production of conventional and unconventional gas. However, gas supplies from Slovakia are dependent on supplies from Russia through a different route, new pipelines to the Caspian region could not bypass Russia, Turkey most probably would not allow LNG supplies through the Bosphorus, and local production could not be increased substantially in the short term. The most viable of all options proved to be the reverse flow from Slovakia, and it supplied up to 12.7 % of the Ukrainian consumption in 2014 with the additional benefit of lower spot prices as a result of oversupply in Central and Western Europe (Bochkarev 2015).

History of Shale Gas Development and Its Present Situation in Each Country

According to an analysis by the Energy Information Administration of the US Department of Energy, Bulgaria, Romania, and Ukraine have "significant prospective shale gas and oil resources." The EIA has analyzed three potential sedimentary basins: "Dniepr-Donets," "Carpathian Foreland," and "Moesian Platform" (Energy Information Administration 2013). The same report aggregates data from different studies and estimates for the potential of shale gas deposits and claims that there could be technically recoverable shale gas deposits of 195 Tcf and 1.6 billion barrels of shale oil and condensate in the three countries.

Bulgaria

The EIA estimates that Bulgaria has technically recoverable unproved resources from wet shale gas amounting to 17 Tcf.

However, Bulgaria was the second member-state of the EU to enact a moratorium and a ban on hydraulic fracturing in January, 2012. The Bulgarian government was initially extremely enthusiastic about the prospects of shale gas. The Energy Minister Traycho Traykov (2009–2012) has even said in 2011 that 1 trillion cubic meters of gas (35.3 Tcf) could be found in Bulgaria, which would cover the country's consumption for 300 years (Tsolova 2011). The government believed that shale gas production would improve diversification of supplies and bring various economic benefits: domestic gas supply at reasonable prices, revenue from royalties and taxes, increased employment, investments in infrastructure and improved geological knowledge.

After the rise of shale gas exploration and production in the USA and the start of exploration in Poland, American companies turned their attention on Bulgaria. In June 2011, Chevron became the first company to receive a 5-year exploration license. Eventually, the organized protests against shale gas have led to the company's pulling out of active development of this project. One of the reasons for the government to stop shale gas development in Bulgaria with a moratorium, voted by the Bulgarian Parliament in January 2012, may be the lack of enough information regarding the exploration and production activities.

A national survey, conducted by Estat on the request of the Bulgarian government, actually showed that 72.1 % of the respondents did not know the company Chevron and 10.2 % could not answer the same question about its reputation (Estat 2012). The study concluded that "there is a serious information deficit regarding the topic of shale gas exploration and production, which leads to a high level of anxiety among the population." Also, the lack of official information about the environmental effects has led to multiplying of the fears of the population and left free space for alternative information sources, the study says. The first question of the survey, "Do you know what shale gas is?" actually received 28.3 % answers of "I do not know anything about it" and 57.1 % answers of "Partially." The lack of information and awareness about the issue, almost a year after the license of Chevron had started, could be attributed to communication mistakes made by the Bulgarian government and the company itself. While the government was communicating mainly the final effects of local gas production—energy independence and lower prices of natural gas, the company was not present enough in the public space: both nation-wide and locally, where shale gas deposits would have been developed.

Later in 2012, a consortium of the French company Total, the Austrian company OMV, and the Spanish company Repsol signed a contract with the Bulgarian government for exploration of one of the most promising conventional gas fields in the offshore Black Sea—"Khan Asparuh." The initial studies show potential reserves between 1.5 and 3 Bcf. The three companies paid an advance of 40 million EUR (44.44 million USD) and the exploratory drilling costs are expected to be over 100 million EUR (111.11 million USD). In April 2015, the Bulgarian government published additional tenders for two additional blocks in the Black Sea: "Silistar" and "Teres." The three Black Sea blocks are seen by the government as the only current viable option for local gas production.

Romania

Romania is both a transit country for Russian gas and a gas producer for part of its energy consumption. The country has stepped up in developing its shale gas potential in the last couple of years, managing to permit exploration activities despite opposition of environmentalist groups. According to EIA data, Romania has an unproved wet shale gas potential of 51 Tcf. As a gas producer, the country has a tradition and sustained know-how in exploration and production activities, as well as technical resources for fossil fuels production. The country is exploring all available options for improving its energy security—gas exploration and production offshore and onshore, as well as new possible routes for non-Russian gas supplies—through the Black Sea and through the newly built interconnector with Bulgaria.

The draft Romanian Energy Strategy (Ministry of Energy of Romania 2015) evaluates current natural gas proved reserves at 150 Bcm (5.3 Tcf). About 93 % of the reserves are located onshore and the current annual production is about 11 Bcm (0.39 Tcf). However, the document suggests that the use of new technologies may increase the volume of reserves in the coming years. One of the undergoing conventional gas projects offshore the Black Sea is "Neptun"—a 50-50 joint venture of ExxonMobil E&P Romania Ltd. and OMV Petrom S.A., which may increase Romania's proved reserves by 40–80 % and the country's annual production by up to 60 % if its potential is proved by the exploratory drilling activities. The document does not give its own estimate of unconventional shale gas resources, but quotes the numbers of the EIA.

Romania experienced similar to Bulgaria tensions and protests, related to shale gas exploration. The main target for anti-shale protesters was the US company Chevron, which had licenses in both countries. Right after the moratorium against shale gas exploration was enacted in 2012 in Bulgaria, as a result of a strong public campaign, similar protests took place in Romania as well. The campaigns had not only similar goals, but also the same organizers. According to analyses by researchers on this topic, activists from both countries merged their campaigns in border towns and brought the motto "Two Countries, Same Water—Two Nations, One Fight" (Devey et al. 2014). Other analyses connected the anti-shale campaign with Russian interests and financing (Labelle and Goldthau 2014). The blame that Russia was financing anti-shale protests in Southeastern Europe was also voiced by the NATO Secretary General Anders Fogh Rasmussen, who said that "…Russia, as part of their sophisticated information and disinformation operations, engaged actively with so-called non-governmental organisations—environmental organisations working against shale gas—to maintain European dependence on imported Russian gas" (Jones and Chazan 2014). Despite all suspicion, there are no hard evidences that the protests were financed externally. The conclusion that there should have been a Russian connection to the anti-shale protests was only based on the analysis of who wins and who loses if local shale option is not developed. An analysis in NY Times suggests (Yardley and Becker 2014) that "with the death of shale gas, South Stream's rationale was stronger than ever"—after Nabucco's cancelation, South Stream was the only option for a large natural gas project in Bulgaria and Romania.

Even if there may be an influence from abroad regarding the protests in Romania, local referenda in December 2012 showed a strong opposition to shale gas drilling near the Black Sea resorts of the country. The referenda were not considered legally binding due to the low activity, but even so about 86 % of the voters were against shale gas development (Visan 2013). According to the policy brief of the Romania Energy Center, overall public support for shale gas development is low because of the unknown factors and the lack of information regarding the production of this resource. The same report quotes a public opinion poll from April 2013, which showed that 41.5 % believed "shale gas drilling is a danger to both the environment and humans," while 16 % of the respondents did not know details and could not comment and other 20 % have never heard of the issue.

Ukraine

Ukraine is one of the countries with the highest potential for shale gas production, according to the EIA—128 Tcf of unproved wet shale gas technically recoverable reserves and 39 Tcf of proved natural gas reserves. The International Energy Agency estimates the coalbed methane resources at almost 3 Tcm (105.9 Tcf) and the technically recoverable shale gas resources at 1.2 Tcm (42.4 Tcf). According to the IEA, these resources are "around one-third less than remaining recoverable resources of conventional gas" (International Energy Agency 2012).

Currently, Ukraine ranks fifth in Europe in terms of gas production and local production is 20 Bcm (0.71 Tcf) p.a. on average for the last several years. According to the national Energy Strategy (Ministerial Council of Ukraine 2013), the potential resources of conventional gas in Ukraine are 5.4 Tcm (190.6 Tcf), 80 % of them being in the Eastern part of the country. Eastern Ukraine is also responsible for about 90 % of the country's gas production. The energy ministry of Ukraine evaluates the total unconventional resource potential of the country, including tight gas, coalbed methane gas, shale gas, and deep Black Sea offshore deposits somewhere between 20 and 50 Tcm (706–1765 Tcf). Full-scale production of shale gas alone may reach 11.6 Bcm (0.41 Tcf) p.a. by 2030, but would need 35–45 bn USD of investments, the report says. Under the pessimistic scenario of the strategic document, gas production would reach 30 Bcm (1.06 Tcf) p.a. between 2020 and 2030, while the optimistic scenario, which includes shale gas and other unconventional gas developments, puts the production of Ukraine at 47 Bcm (1.66 Tcf) p.a. during the same period.

Policy Similarities and Differences Across the Three Countries

The European Union's Energy Policy relies on three main pillars: competitiveness and affordability, sustainability, and security of supply (European Commission 2010). While electricity and natural gas are considered common markets within the borders of the European Union, still the choice of energy resources is left up to each country's policy. Individual member-states can choose whether or not to develop nuclear energy, unconventional oil and gas resources, and other energy options. There is a common environmental legislation, which focused until now mainly on wastewater disposal and carbon emissions as part of energy production and consumption. There is also no joint effort on energy diplomacy issues, including negotiation of energy transit routes, prices of energy resources, etc. Each country is responsible for its own energy supplies and energy security. These conclusions are valid for both Bulgaria and Romania as members of the EU, but also for Ukraine, which is bringing its policies closer to the EU ones as part of the Eastern Partnership process.

The current centerpiece of European energy policies is the initiative for creating an "Energy Union." The "Energy Union Strategy" was announced by the Vice-President of the European Commission Maroš Šefčovič on February 25, 2015. He defined it as "the most ambitious European energy project since the Coal and Steel Community" (European Commission 2015a), the latter being a cornerstone for the founding of the European Union.

The term "Energy Union" has been introduced by the current President of the European Council Donald Tusk, while he was still prime minister of Poland, in March 2014 (Premier.gov.pl 2014). He said that the European Union should "demonstrate more solidarity between member-states" in terms of energy, and proposed 6 main priorities:

1. Creation of an effective gas solidarity mechanism in case of supply crises.
2. Increased financing from the European Union's (EU) funds of infrastructure ensuring energy solidarity, in particular in the east of the EU—even up to 75 % of projects' value.
3. Collective energy purchasing.
4. Rehabilitation of coal as a source of energy.
5. Shale gas extraction.
6. Radical diversification of gas supply to the EU.

The Energy Union Strategy implementation will create new possibilities for member-states of the EU to diversify their energy resources and to increase their energy security. Even if the current version of the strategy has softened some of the six priorities above, it shows the strong will of the European leaders to tackle the energy security vulnerabilities of the EU members and even of the countries in the Eastern Partnership.

With regard to environmental regulations in the EU—they have a mixed effect on natural gas exploration and production. On the one hand, natural gas should have gained a momentum with carbon regulations across the EU and should have replaced a considerable part of coal for electricity and heat production, as stipulated by the European Commission's 2050 Energy Roadmap (European Commission 2011). Also, gas-fired power plants were considered the best solution for balancing intermittent wind and solar power.

However, there are a number of environmental regulations that limit the industrial activities in Europe, and they could be a hinder for both conventional and unconventional oil and gas drillings. A special report by the International Energy Agency, published in the World Energy Outlook 2012 (International Energy Agency 2012), presents some of the policy challenges, related to unconventional oil and gas production. The report considers that "there are above-ground factors that are likely to impede rapid growth in unconventional gas production, the most significant of which is the high population density in many of the prospective areas." In addition, the report summarizes the specific regulations in the EU in five groups: (1) water protection, enforced through the Water Framework Directive, the Groundwater Directive, and the Mining Waste Directive; (2) chemicals use, limited by the REACH regulation; (3) protection of natural habitats and wildlife; (4) the required environmental impact assessments for new investment projects; and (5) the liability for operators with large penalties for environmental damage.

The specific environmental legislation in the European Union also includes the "Natura 2000 network" territories. This is an EU-wide network of nature protection areas, established under the 1992 Habitats Directive of the European Union. The aim of this network is to assure the long-term survival of Europe's most valuable and threatened species and habitats. About 33.9 % of Bulgaria's territory and about 17.9 % of Romania's territory are designated for the "Natura 2000 network" and may be off-limits for shale gas drilling and production. This network could diminish substantially the ultimately recoverable resources for both countries (ICF GHK 2014). Additional territories may be excluded because of their proximity to population centers. For Bulgaria's territory, they are estimated at 8 % of the country's total area, and for Romania, the share of the territory is 10 %. Thus, the ultimately recoverable resources vary in the minimum and maximum scenarios between 183 and 1000 Bcm for Bulgaria (6.48–35.3 Tcf) and between 172 and 1445 Bcm for Romania (6.07–51.01 Tcf).

There are other specific factors for shale gas development in Bulgaria, Romania, and Ukraine, which are different from the policies and regulations in the USA and could have quite different effects on exploration and production. While there is private ownership of mineral rights in the USA, in Europe the mineral rights are owned by the state. This means that even if there are large quantities of gas on private and municipal lands, still the central government will be the one to negotiate and lease mineral rights and then will be the one to receive the larger chunk of payments for the extracted resources. This makes private owners, especially in agricultural regions, anxious and reluctant to shale gas development. Also, these communities are not used to such industrial activities. Exploring and producing shale gas in Pennsylvania, Texas, or Oklahoma has its traditions, while the local population in shale-rich regions of Eastern Europe would face an entirely new experience.

Another difference between the USA and the three countries is the entrepreneurship and financial infrastructure. While the independent oil and gas producers in the USA are able to collect capital from the financial markets, the situation in Eastern Europe in not the same. If shale gas is developed, it will be done mostly by foreign companies with the respective experience and access to finance. The growth of this sector would be based primarily on foreign capitals and entrepreneurship and not on local independent producers.

And last, but not least, exploring for shale gas and producing it would require specific human capital and technologies on site. There is no personnel with experience for shale gas exploration and hydraulic fracturing in Bulgaria, Romania, and Ukraine. Also, there are not enough modern drilling rigs in place that could be used for the exploration and production stages of shale gas fields. Data from the "International Rig Count" (Baker Hughes 2015) show that between January and July 2015 there have been a total of 108–128 rigs in Europe, most of them based on traditional technology. The latest data for Bulgaria from June 2014 show only 1 operating rig and Romania had between 8 and 11 rigs in the first 7 months of 2015.

A team under the leadership of the Institute for Energy and Transport at the Joint Research Centre of the European Commission has aggregated the challenges mentioned above into a matrix, combining two sets of factors (Pearson et al. 2012) (Table 1).

All the summarized challenges above show the disparities between Europe and the USA in terms of economic, legal, regulatory, environmental, social, and logistical factors. These differences mean that the shale gas revolution could not be "exported" without being adapted to local factors.

In addition to this, the gas infrastructure in the three countries is designed and constructed mainly as a system for transporting natural gas from the East (from

Table 1 Summary of the main challenges for accessing land for shale gas development in Europe

	Regulatory	Environmental	Social	Technical/Logistical
Environmental	• Water management • Natural/protected sites			
Social	• No subsurface property rights • Duration/intensity of drillings • Proximity to residential areas • Noise/visual impacts	• NIMBYism • Community impacts		
Technical/Logistical	• Well size, spacing and density • Zoning restrictions • Multi-well pad permitting • Smaller land parcels	• Inaccessible terrain • Force majeure • Obligation to conduct environmental impact assessment	• Population density • Utility line placement	
Economic/market	• Royalties for the state • Permitting costs • Licensing/concessions	• Waste disposal • Site protection	• Lack of financial incentives for land-owners/local communities • Higher labor costs	• Equipment/rig transport • Access to distribution/ transmission system • Service availability

Source Pearson et al. (2012)

USSR and later from the Russian Federation) to Southern and Western Europe and is still primarily owned, operated, and used by the incumbent state-owned integrated gas companies of Bulgaria, Romania, and Ukraine. The entrance of new producers both for conventional and unconventional resources would require a higher level of liberalization and third-party access to the gas transmission grids as well as investing in new branches of the national gas infrastructures.

Future Potential of Shale Gas Development in the Three Countries and the Region

An analysis on the socioeconomic impacts of shale gas for Bulgaria (KC 2 Ltd. 2014) indicates that the country may see between 7.0 and 23.2 bn EUR (7.78–25.78 bn USD) direct investment for the "low-shale" and "full-potential" scenarios, if shale gas is developed. The analysis predicts an annual production between 4.8 and 16 Bcm (169.5–565 Bcf) for a period of 30 years and the new jobs created would be between 26,000 and 39,000. The total fiscal effects for the period according to the pessimistic and optimistic scenarios are between 8.2 bn EUR and 18.1 bn EUR (9.11–20.11 bn USD) and the share of shale gas's value added in the GDP would be between 1.7 and 5.1 %. The two scenarios show an additional growth of GDP as a result of shale gas development between 0.59 and 0.83 % per year leading to an accumulated GDP growth for the whole 40-year period of the project between 18.3 and 26.6 %.

A similar socioeconomic impact study for Romania (Romanian National Committee of World Energy Council 2013) predicts the creation of 4517 new direct and 13,552 new indirect jobs (a total of 18,069) at the national level in addition to 4800 new direct and 14,400 new indirect jobs (a total of 19,200) at the regional level. Thus, the total effect of shale gas development on the Romanian job market would be over 37 thousand new direct and indirect jobs. The report also considers that natural gas prices in Romania could be reduced by up to 30 % with shale gas development, while the new exports of gas could bring up revenues accounting for up to 0.5 % of GDP each year between 2023 and 2030. The report is covering the period between 2013 and 2030 with extraction starting in 2023. According to the authors of the study, "Romania has to explore and exploit new conventional and particularly unconventional oil and natural gas fields in order to meet the requirements in domestic consumption and maybe an additional quantity for export" considering the reduced production of oil and gas from the current conventional sources.

A report prepared for the Ministry of Energy and Coal Industry of Ukraine (IHS CERA 2012) predicts that Ukraine's gas potential would be developed from several sources: advanced recovery from producing fields; development of marginal discoveries; exploration within existing conventional plays or in new areas of Southern Ukraine, including the offshore Black Sea; tight gas sands; and unconventional gas resources, including both shale gas and coalbed methane. In the base-case scenario of IHS CERA, unconventional gas production could reach a plateau of about

25 Bcm (882.8 Bcf) p.a. by 2030. The optimistic scenario predicts a plateau of at least 30 Bcm (1059.3 Bcf) p.a. for the same period. Thus, the total production of gas in Ukraine, including the development of existing conventional resources, could increase from the 2010s' levels of below 20 Bcm (706.2 Bcf) p.a. to at least 70 Bcm (2741.7 Bcf) p.a. in the first half of the 2030s. The report also envisages that the capital costs for shale gas and coalbed methane development could reach between 2 and 3.5 bn USD (in 2011 dollars) annually if and when unconventional development takes off, while the total investments needed for the upstream gas sector may reach 10 bn USD p.a. for some of the years between 2012 and 2035, without taking into account the investments needed for the related support infrastructure. However, IHS CERA predicts "unconventional gas will emerge more gradually in Europe than in North America" for reasons related to cost and politics.

Currently, there is also a great insecurity of shale gas development in Ukraine, related to the War in Eastern Ukraine. This is where the "Dniepr-Donets" Basin is located and it accounts for most of Ukraine's onshore hydrocarbon reserves (Energy Information Administration 2013). In the beginning of 2013, Shell has been awarded Ukraine's first formal shale gas exploration license in the "Dniepr-Donets" basin—the Yuzovska field with an area of 7800 km^2 (3012 mi^2) under a PSA. Chevron has negotiated a PSA for the Oleska field in Western Ukraine near the border with Poland. The military conflict in Eastern Ukraine eventually has canceled both investments. In mid-2015, Shell notified Ukraine that it will pull out of its project due to force majeure (Olearchyk 2015). In the beginning of 2015, Chevron also pulled out of its Oleska project in Western Ukraine.

The other shale basin in Ukraine under risk is in Crimea's Black Sea shores. It is part of the Silurian belt. After a tender in 2012, a consortium of ExxonMobil Exploration and Production Ukraine B.V. (40 % of the shares, operator of the block), Shell (35 %), OMV/Petrom (15 %) and NJSC Nadra Ukrainy (10 %) won the Skifska offshore field in the Black Sea. In June 2015, a year after the accession of Crimea by Russia, the US Ambassador to Ukraine announced that ExxonMobil is not going to develop the field. Shell had announced its exit from the project earlier. As a final cancelation step, ExxonMobil Exploration and Production Ukraine B.V., a Netherlands-based company, announced the closing of its Kyiv office in the beginning of August 2015 (Interfax-Ukraine 2015).

The Italian oil and gas company Eni, the French company EDF, and two Ukrainian companies (Vody Ukrainy and ChornomorNaftogaz) also have a PSA agreement offshore the southeastern coast of Crimea for a 540 mi^2 block. In March 2014, the Eni management was still not aware of the new Crimea government's intentions over the PSA, but the project had not started. Another venture of the Houston-based Vanco Energy Company with Russia's Lukoil and the Ukrainian businessman Rinat Akhmetov for the Prykerchenska block is also on the hold in the same area. ChornomorNaftogaz itself operates 17 blocks in the Sea of Azov and the Black Sea offshore Crimea. The company announced in March 2014 that it would seek compensation for the confiscation of its assets in Crimea "by targeting the assets of Gazprom and other Russian companies globally" (Platts 2014).

Potential threats for the development of shale gas in Europe and in Eastern Europe in particular include the difference in the legislative bases in comparison with the USA (in terms of mineral rights ownership), lower dynamics of entrepreneurship and venture capital, lack of enough knowledge and technologies for unconventional oil and gas production, as well as higher environmental sensitiveness in comparison with other parts of the world. These threats have the potential to delay or even stop indefinitely the exploration and production of shale gas in Eastern Europe.

On February 20, 2015, Chevron announced its decision to stop shale gas exploration in Romania after the exploration activities performed in 2014. According to an analyst (Mihalache 2015), the business decision of Chevron is based on several factors: the unsatisfactory results from exploration activities, the anti-shale protests, and public perception in general against shale gas, as well as the oil price drop in the last year. The expert also considers that the "Chevron experience" could bring positive change to Romania, if the government concentrates on the Black Sea offshore projects, where additional pipeline infrastructure is needed. The Black Sea offshore has become the new oil and gas "frontier" in the region with concessions granted to international companies in Bulgaria, Romania, and Ukraine.

There are a number of uncertainties, related to shale gas development not only in Southeastern Europe, but in general in Europe, a report by the European Parliamentary Research Service says (Erbach 2014). According to the experts, quoted in the same report, "more exploratory drilling is needed to assess the real extent of technically and commercially recoverable resources in Europe."

Another risk factor is time. The time needed for licensing and exploration may delay the first gas to be produced with almost a decade. In addition, the report says, shale gas in Europe would be neither cheaper, nor more abundant than in the USA. Its effects on the energy situation of Europe would be only marginal, even if it reduces the gas import dependency of the member-states, but there would be other positive effects such as economic growth and job creation. The report also predicts that potential imports of shale gas to Europe would take several years, and thus, the shale gas development both in the USA and in Europe would not have short-term effects on EU's energy security.

Conclusion

In terms of geology, the prospects for shale gas development in Bulgaria, Romania, and Ukraine are promising. However, they still seem premature because of the lack of exploratory drilling activities in order to prove the exact volumes of ultimately recoverable reserves. The interest of foreign investors for concessions in the three countries in the last 5 years indicates that both oil majors and independent US producers are ready to risk their capital and invest in shale gas development.

Studies for all the three countries show that the development of local unconventional gas resources would be beneficial in terms of thousands of new jobs, income for the local and national governments, as well as for reducing the energy import dependence and the negative energy trade balances. Moreover, all three countries are eager to break their dependence on one external source of gas, Russia, and the local production of gas is one of the most preferred options.

The main hurdles for shale gas development in this region of Europe are not the geological conditions, but the other specific local factors in place. There are significant differences between the USA and Europe in terms of legislation, regulation, social acceptance of this business, environmental requirements, logistical implications, etc. The shale gas revolution could not be easily "exported" from its birthplace in North America to Eastern Europe. In order to develop the potential shale gas deposits, investors will need to accommodate themselves under the specific factors, present in Europe.

The geopolitical situation may be even more significant for the further development of shale gas in Eastern Europe. Local production in Bulgaria, Romania, and Ukraine would make these countries and maybe even some of their neighbors more independent from their historical supplier—the Russian Federation. The current dependent state of all the three countries, for example, makes them more eager to participate in Russian pipeline projects, crossing the region. A change in the energy balances of any of them would provide a new bargaining chip in the regional geopolitical game. Thus, a future of shale gas in Eastern Europe may prove to be possible only under a wider geopolitical accord between the contemporary global players in the world gas market.

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Unconventional Drilling for Natural Gas in Europe

Robert Dodge

Abstract In the European countries' quest to combat global warming and becoming less dependent on Russia for energy, they have been inspired by the natural gas boom in the USA brought about by the production of natural gas extracted from shale formations. Although relatively poor in natural gas that can be extracted by conventional means, vertical drilling, the existence of shale formations throughout much of Europe has spurred interest in unconventional drilling using hydraulic fracturing. The exploratory results up until now have been disappointing. This study includes three country-focused case studies, Poland, the United Kingdom, and Germany, which appear to be close to shale gas production, but to the extent of making them energy self-sufficient, or secure in their energy needs, that will never be realized.

Introduction

Since 2010, the quest for energy independence from Russia and exploiting an in situ energy source that is qualitatively environmentally friendly and quantitatively commercially viable has accelerated Europe's exploration for shale gas deposits. These shale gas formations contain seams of natural gas that can be tapped only by unconventional drilling that requires hydraulic fracturing (aka: "fracking" or "fraccing"). This effort has been spurred on by the fact that natural gas, among the conventional fossil fuels, generates the least amount of CO_2 emissions compared to coal and oil.[1]

[1]Cremonese, Lorenzo, Ferrari, Michele, Flynn, Marianne P., and Guseve, Alexander, "Shale Gas and Fracking in Europe," IASS (Institute for Advanced Sustainability Studies) Fact Sheet 1/2015 (Potsdam, Germany: 2015). Due to its chemistry, methane, the main component of shale gas, produces less CO_2 per unit of energy than other fossil fuels. For example, coal combustion gives rise to about twice as many CO_2 emissions as shale gas.

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Thus, concerns for lowering carbon emissions to reduce global warming and achieving energy independence from Russia are the two primary goals that have caused this uptick in interest during the first decade and a half of the twenty-first century. That effort has been expedited by the discovery and eventual production of natural gas from two vast shale formations in the USA, the Barnett Shale in Texas, and the Marcellus Shale in western Pennsylvania since 2000. This has resulted in an energy boom in the USA and has gone a long way to ensure relative independence for years to come. This report examines the question of just how self-sufficient Europe can become during this century because of the existence of shale gas formations. The emphasis here is on the estimate of natural gas reserves believed to be recoverable from shale rock formations onshore and does not include oil, which is often found in the same formations.

Europe's Dependency on Russian Energy

Since the Russian Federation's annexation of the Crimean Peninsula in March 2014, and its continued support of ethnic Russian separatists in eastern Ukraine, adjacent to the Russian border, the European Union (EU) has enhanced its effort to make its 28 member states less dependent on Russian energy, especially natural gas. However, 15 months after the beginning of the most recent Russian–Ukrainian crisis, and following several rounds of Western sanctions against Russia, primarily against its international banking and financial services, Russian natural gas exports to East-Central and Western Europe are still in place. Since the late 1960s and early 1970s, East-Central and Western Europe have become increasingly dependent on Soviet/Russian exports of natural gas.

Recently, that dependency has weakened from its high point in the middle of the first decade of the twenty-first century as a result of the 2009 world recession. Globally, there has been a glut of energy due to a decrease in demand, which has been reflective of the slow recovery from the recession. Additionally, the greater availability of liquefied natural gas (LNG) and some success in replacing carbon fossil fuels with solar and wind have reduced European dependence on Russia. However, *The New York Times* printed a graphic as recently as Thursday, April 22, 2015, indicating the percentage of energy that the EU member states still import from Russia, especially the big states: Poland, 88 %; Germany, 46 %; the Netherlands, 34 %; Italy, 27 %; and France, 18 %.[2] In addition to Poland, the

[2]Kramer, Andrew E., "Weakened Gazprom Is Target," *The New York Times* (Thursday, April 22, 2015) B1. Graphic entitled "How Russian Energy Flows to Europe," source: Global Trade Atlas—IHS.

smaller EU member states that were formerly constituent republics or satellite states of the former U.S.S.R. import a large percentage of their energy from Russia. Estonia imports 66 %; Latvia, 71 %; Lithuania, 85 %; Czech Republic, 64 %; Slovakia, 100 %; Hungary 90 %; Bulgaria, 85 %; and Romania, 42 %.[3]

The European Economic Community's (EEC's) and its successor, the European Union's (EU's) dependency on Soviet, and after 1991, the Russian Federation's energy exports, has been a slow-moving, conscious development by both Western Europe and Moscow. This story is told well by Professor Per Högselius in his account *Red Gas, Russia and the Origins of European Energy Dependence* (2013).[4] Austria became the first capitalist country to receive deliveries of Soviet natural gas in 1968, just a few weeks after the Soviet invasion of Czechoslovakia in order to put down the "Prague Spring." West Germany followed in 1973, and Italy and Finland in 1974.[5] Högselius refers to this process as the "hidden integration" of Europe during the Cold War era.[6] When the Soviet Union imploded in 1991, the former Soviet Ministry of Gas Industry (*Mingazprom*) transformed itself into a private enterprise, simply called *Gazprom*.[7] Today it is more than 80 % owned by the Russian state to which it pays taxes equivalent to approximately 15 % of the Russian government's total budget.[8]

Gazprom produces 80 % of Russia's total natural gas output.[9] It has a monopoly over gas transportation within Russia as well as over all natural gas exports. *Gazprom* has been striving to become a globally diversified energy company, which began with a joint marketing company in Germany, Wintershall (joint venture was called "Wingas") in 1993.[10] However, the continued building of new

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[3]Ibid.

[4]Högselius, Per, *Red Gas*, *Russia and the Origins of European Energy Dependence* (New York: Palgrave Macmillan, 2013) *passim*.

[5]Ibid., 3 and 227.

[6]Ibid., 3.

[7]Yergin, Daniel, *The Quest*, *Energy, Security, and the Remaking of the Modern World* (New York: The Penguin Press, 2011) 335. *Gazprom* eventually had private shareholders all around the world as well as in Russia. According to Yergin, it became a bell-weather for the overall performance of the Russian stock market and economy. In mid-2008, *Gazprom*'s stock market capitalization had increased to more than $300 billion, and it ranked as the third largest company in the world, behind Exxon Mobil and PetroChina.

[8]Ibid.

[9]Ibid., 336.

[10]Ibid. Also, see Högselius, Ibid., 206. Högselius claims that this joint venture between *Gazprom* and Wintershall was in place as early as 1991, when Ruhrgas, a former West German entity, had managed to acquire a large ownership stake in the former East German transmission operator VNG, in 1990, in order to extend its influence from western to eastern Germany. Initially, the joint venture Wingas announced a sharp increase in the amount of gas sold to VNG (now under Ruhrgas control) if it continued to pay the pre-1991 price, and if VNG refused, *Gazprom* would cut off the supply of natural gas. This was the first intentional disruption of natural gas deliveries from the Russian Federation, and its basis was economic, not political. A temporary one-year contract was concluded, but a year later both Ruhrgas and Wintershall had built new pipelines linking eastern Germany (referred to as the *Neueländer*) with the West. Thus, the former East Germany was geographically

inter-connecting pipelines in East-Central Europe throughout the 1990s did reduce *Gazprom*'s monopoly. Furthermore, Russia's, and therefore *Gazprom*'s, ace-in-the-hole was the existence of long-term contracts with Western Europe, which Russia assumed to be still in existence after the breakup of the former Soviet Union. The problem was that there were no contractual relations on gas flows and transit fees through the former constituent republics of the former Soviet Union, especially Estonia, Ukraine, and Belarus. The governments of these states wished to negotiate new contracts based on their newly adopted currencies vis-à-vis the ruble for natural gas imports for their own use, and with respect to Ukraine for transmission to Western Europe.[11] The Ruhrgas-VNG-Wingas dispute in 1991–1992, referred to above, was economic, not political.[12] Even with this new dimension of newly independent states asserting their sovereignty vis-à-vis Moscow, to include new language laws directed against ethnic Russians resident in their countries; and insisting that Russia not be allowed to extort them for energy; they muddled through to a point whereby Daniel Yergin claims that by 2005 a European natural gas supply appeared to be in political balance insofar as a kind of *modus vivendi* existed between Europe and Russia in which the former's dependence on Russia remained.[13] In terms of natural gas, Western and East-Central Europe produced 39 % of its own needs by conventional drilling, while Russia supplied 26 %; Norway, 16 %; Algeria, 10 %; and other sources, approximately 10 %.[14]

However, with the election of Vladimir Putin as president of the Russian Federation in 2000, and an uptick in energy prices, political factors became increasingly dominant in East-Central Europe. From Moscow's perspective, the enlargement of the EU in 2004, which included the three Baltic States, all former U.S.S.R. constituent republics, plus five former satellite states, was perceived as being anti-Russian.[15] Of more concern to Putin's regime was the enlargement of the North Atlantic Treaty Organization (NATO) beginning as early as 1999, when the Czech Republic, Hungary, and Poland became full members, followed by Bulgaria, Estonia, Latvia, Lithuania, Romania, Slovakia, and Slovenia in 2004. Albania and

(Footnote 10 continued)

and logistically able to import not only Russian, but also Dutch and Norwegian gas, thus making the East Germans less vulnerable to future supply disruptions from Russia.

[11]Högselius, 207.

[12]Ibid., 205.

[13]Yergin, 336.

[14]Ibid.

[15]Former East Germany, i.e., the German Democratic Republic, was absorbed into the German Federal Republic, former West Germany, in 1990, and West Germany had been a founding member of the EEC in 1958, and the Czech and Slovak Republics formed two separate states in 1993.

Croatia became NATO members in 2009. Comparatively, from a chronological point of view, NATO and EU enlargement paralleled each other.[16]

The appearance of a political European balance of gas supply in 2005, suggested by Yergin, actually had begun to fray dramatically with the "Orange Revolution" in Ukraine in late 2004. The nullification of the election of Viktor Yanukovich, a Moscow favorite in November, and a new election, which became known as the "Orange Revolution", that resulted in the victory of Viktor Yushchenko, a pro-Western political figure, to the Ukrainian presidency, exacerbated the political tension between Kyiv and Moscow, and Europe and Moscow. This resulted in charge and counter-charge between Ukraine and Russia concerning Kyiv being in default of payments for natural gas and siphoning off gas transported by pipeline though Ukraine to be distributed to Central and Western Europe. This culminated in a Russian cutoff of natural gas to and through Ukraine on January 1, 2006. Three years later, in January 2009, another more serious cutoff occurred, which affected nearly all European countries.

Although Russia's favorite, Viktor Yanukovich, was elected president of Ukraine in 2010, a EU plan, called the "Eastern Partnership," was to be implemented in late November 2013, whereby six former Soviet republics were to sign on formally for eventual membership in the EU. These states included Armenia, Azerbaijan, and Georgia in the Caucasus and Belarus, Moldova, and Ukraine in Eastern Europe. Because of its size, the importance of its economy, and its geo-political and geo-strategic location vis-à-vis Russia, Ukraine was the biggest prize in this deal. At first, the Yanukovich government supported signing such a European Agreement with Brussels, but then backed away when Putin provided a better deal, including cheaper prices for natural gas. Russia saw these European Agreements as a first step toward further NATO enlargement eastward in the Eurasian continent, and thus inimical to Russia's security. The result of this turn-around on the part of the Yanukovich government was a popular uprising in Kyiv against Yanukovich. This uprising had considerable external support both by the

[16]Bulgaria and Romania joined the EU in 2007, while Croatia did not join until 2013, and Albania is still not a EU member. EU and NATO enlargements have not been viewed by Moscow as separate developments, but rather as two sides of the same coin, and are perceived by Russia as being inimical to its geo-political and geo-strategic interests. In April 2008, at a NATO summit in Bucharest, Romania, the US President George W. Bush administration supported admitting Georgia and Ukraine to NATO, but France and Germany opposed the move believing that it would unduly antagonize Russia. At the conclusion of that summit, the Alliance did not begin the formal process leading to their membership, but it still issued a statement endorsing the aspiration of Georgia and Ukraine, boldly declaring that "These countries will become members of NATO." See Mearsheimer, John J., "Why the Ukraine Crisis Is the West's Fault," The Liberal Delusions that Provoked Putin, *Foreign Affairs* (vol. 93, no. 5, September/October 2014) 78–79.

EU member states and the USA. In February 2014, Yanukovich fled to Russia, Russia seized the Crimean Peninsula, and provided military support for ethnic Russian separatists in the Donetsk, Luhansk, and Mariupol areas in eastern Ukraine, abutting a large sector of Russia's western frontier. The Ukrainian–Crimean crisis accelerated, at least rhetorically, the process of Eastern, Central, and Western Europe, i.e., the EU, wishing to become less dependent on Russian energy.

The natural gas produced by Russia and exported to Europe is extracted by conventional methods of vertical drilling, which is also the case of what Europe produces itself, as well as that imported from Norway, Algeria, and Qatar as Liquified Natural Gas (LNG). However, beginning in the first decade of the twenty-first century, a major attempt has been underway to explore the possibility of shale gas development by so-called unconventional means. This gas is accessed by angular and horizontal drilling into shale formations and the use of hydraulic fracturing in order to stimulate the flow of natural gas found trapped in the shale seams. The success in finding and producing natural gas by this method has been perceived by some as the panacea for Europe's energy independence based on the experiences in the Barnett formation in the Dallas/Ft. Worth area of Texas, and in the Marcellus shale formation in western Pennsylvania.

Potentially, there are 11 major shale gas formations in six European countries, including Russia (Fig. 1), that could produce commercially sufficient energy over an extended period of time. Those shale gas deposits are: the Baltic, Podlasie, and Lublin Basins in Poland; the Northern Petroleum and Southern Petroleum provinces in the United Kingdom; the Lower Saxony Basin in Germany; the Paris and South Eastern basins in France; the Lviv Depression and Donetsk Basin in Ukraine (Fig. 2); and the West Siberian Basin, Bazhenov Shale in Russia (Fig. 3). What unconventional drilling that has occurred, or is currently taking place in these areas, is only in the exploratory stage of development. Such exploratory unconventional drilling, using hydraulic fracturing, has occurred in Poland, the United Kingdom, and Germany.

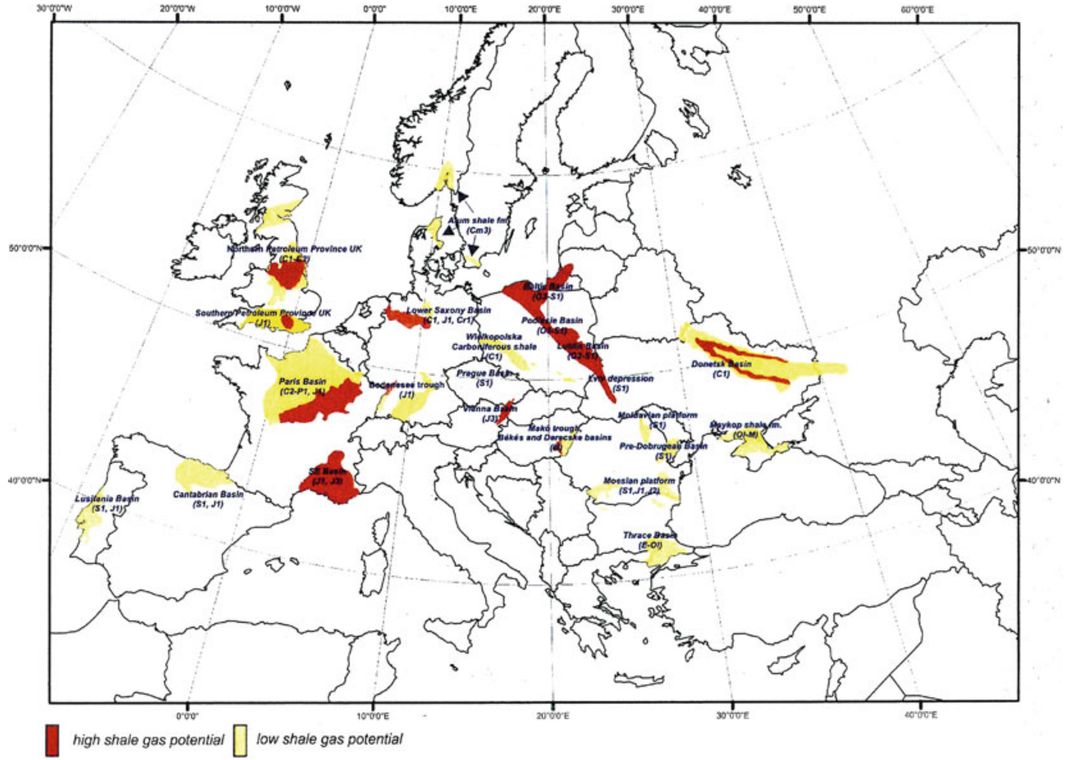

Fig. 1 Major shale formation in Europe. *Source* Polish shale gas deposits in relation to selected shale gas prospective areas in Central and Eastern Europe, Geological review (Przeglad Geologiczny) vol.61, no. 11/1, 2013, 609. This is a composite map. Permission for use was granted by Dr. Mariz Waksmundzka, Head of Energy Security Program, polish Geological Institute, National Research Institute, in a letter recevied on August 5, 2015

At this time, it is fair to state that the EU member states' policies toward the development of shale gas is still in its exploratory stage and will remain at that level for some time. No EU member country has completed the exploratory stage for shale gas according to the generally accepted chronological process of five years for exploration, another five-year period for appraisal and development of the infrastructure, and if deemed viable, 20–30 years of production.[17] Furthermore, France, Bulgaria, and Romania have imposed moratoria on fracking even in the exploratory phase for shale gas, basically for environmental and economic reasons, and Germany is considering an all-out ban.[18] In Germany, seven of the 16 *Länder* (states) have banned fracking.[19] Exploration for unconventional shale gas is ongoing but at a much slower pace than envisaged at the beginning of the first half of the second decade of the twenty-first century, and the Russian–Ukrainian war over the past 15 months, ironically, has not noticeably enhanced any urgency in this

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[17]Skea, James, "Shale Development in the UK." Presentation at conference hosted by the University of Pittsburgh, Pittsburgh, Pennsylvania, on March 18, 2015, entitled "Managing Risks in the Shale Industry: A Comparison of Policies Worldwide." Professor Skea is Professor Sustainable Energy in the Centre for Environmental Policy, Imperial College London and Research Councils UK Energy Program Strategy Fellow.

[18]Geoffron, Patrice, "France's Ban on Shale Development." Presented at conference hosted by the University of Pittsburgh, Pittsburgh, Pennsylvania, on March 19, 2015, entitled "Managing Risks in the Shale Industry: A Comparison of Policies Worldwide." Professor Geoffron is the Director of the Centre of Geopolitics of Energy and Raw Materials (CGEMP) and Professor of Economics at University of Paris Dauphine. The French ban was imposed by a parliamentary statute in 2011, and reaffirmed subsequently in a strong statement by President Francois Hollande, following his election in 2012, that there would be no exploration for shale gas. Bulgaria placed a moratorium on fracking in 2011, and withdrew Chevron's five-year exploration license. See Grinmal, James V. and Ballhaus, Rebecca, "Clinton's Corporate Ties," *The Wall Street Journal* (Friday, February 20, 2015) A6. As Secretary of State, Hillary Clinton flew to Sofia in 2012 to urge the Bulgarian parliament to reconsider its moratorium on fracking and its withdrawal of Chevron's exploration license. The Bulgarian government relented to the extent of permitting conventional exploration for gas, but not fracking, and Chevron pulled out of Bulgaria in 2012. Secretary Clinton's efforts in this instance were to promote shale gas development by unconventional means worldwide. This was under the rubric of the US State Department's Global Shale Gas Initiative, which was established in 2010. In another instance, during her first year as Secretary of State, Mrs. Clinton met with EU leaders in March 2009, urging them to emphasize energy as a priority for action. According to her own account, Secretary Clinton worked with the EU's High Representative for Foreign Affairs and Security Policy, Catherine Ashton, to create the USA–EU Energy Council. Teams of US energy experts, under the auspices of the US Department of Energy's Energy Information Administration (EIA), fanned out across Europe to help countries explore alternative to Russian gas. She writes: "When I visited Poland in July 2010, Foreign Minister Sikorski and I announced Polish-American cooperation on a global shale gas initiative to capitalize on new extraction technologies in a safe environmentally sustainable manner…." See Clinton, Hillary Rodham, *Hard Choices* (New York: Simon & Schuster, 2014) 241. Exploration did begin, but the two biggest companies, Exxon Mobil and Chevron, have subsequently pulled out. Secretary Clinton mentions her February 2012 visit to Bulgaria, but says nothing about pressuring Bulgaria to remove its ban on fracking.

[19]Schreurs, Miranda, "Germany's Moratorium on Shale Development." Presentation at a conference hosted by the University of Pittsburgh, Pittsburgh, Pennsylvania, on March 19, 2015, entitled "Managing Risks in the Shale Industry: A Comparison of Policies Worldwide." Professor Schreurs is the Director of the Environmental Policy Research Centre and the Professor of Comparative Politics at the *Freie Universität Berlin*.

matter. With respect to Russia, natural shale gas formations are moot for the near- and long-term future in that Russia will remain primarily a producer of natural gas by conventional means, i.e., by conventional vertical drilling.

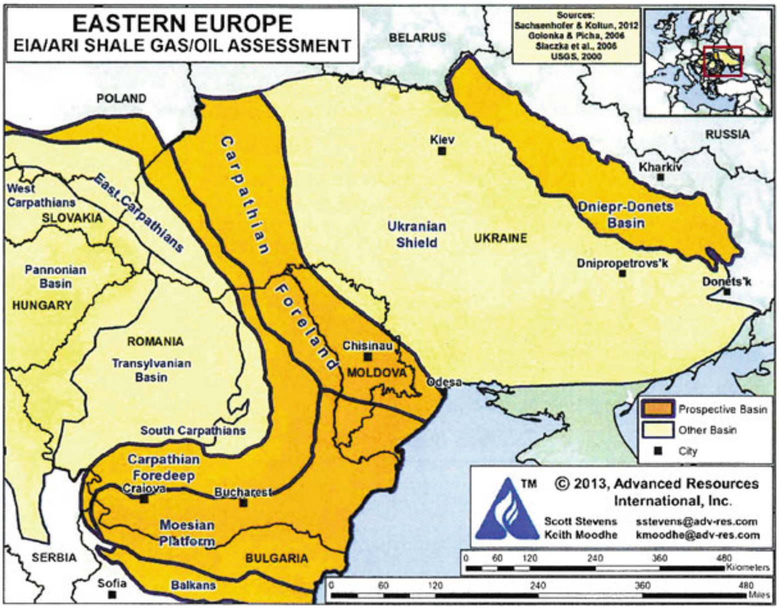

Fig. 2 Eastern Europe to include Ukraine. *Source* U.S Energy Information Agency (EIA) May 17, 2013

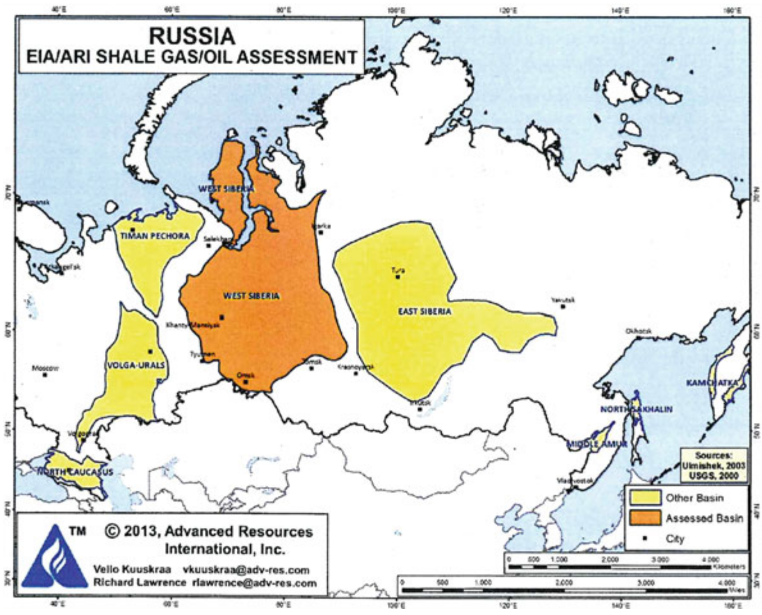

Fig. 3 Russia. *Source* U.S Energy Information Agency (EIA) May 17, 2013

The EU's Energy Policy

The European Commission released its *Energy Union Package* (EUP) proposals on February 25, 2015, designed to point out ways to find long-term relief from dependence on Russian energy. While these proposals are designed to continue developing the bloc's energy market and energy security, they are more a continuation of already-existing EU energy policies and not a radical departure from them. As discussed above, these proposals will not substantially decrease energy supplies flowing from Russia. However, these proposals will continue to erode Moscow's ability to dictate prices in European markets, a tool that Russia has often used to achieve political ends. To accomplish this lessening of dependence on Russian energy, the EUP proposals place a premium on the Southern Gas Corridor in order to enable Central Asian countries, notably Azerbaijan and Turkmenistan, and Turkey, to export their gas to Europe, thus bypassing Russia altogether.[20] With respect to Northern Europe, the *Package* claims that "the establishment of liquid gas hubs with multiple supplies is greatly enhancing supply security" in that LNG facilities provide storage capacity in the case of gas shutoffs.[21]

There are only two references to Russia in this report, one direct and the other indirect. The direct reference states that "…When the conditions are right, the EU will consider reframing the energy relationship with Russia based on a level playing field in terms of market opening, fair competition, environmental protection and safety, for the mutual benefit of both sides…."[22] The phrase "[W]hen the conditions are right…" suggests that for the foreseeable future, the EU member states will continue to depend significantly on Russian gas.[23]

The indirect reference to Russia and Eastern Europe appears under the heading of "The internal market's hardware: connecting markets through interconnection." It states that "Work on infrastructure projects has accelerated in recent years, even more so in light of recent events at the European Union's Eastern border….,"[24] an obvious reference to the Russo-Ukrainian war. The report claims that in 2013, the EU identified 248 energy infrastructure Projects of Common Interest (PCIs).[25] In 2014, European Energy Security Strategy identified 33 infrastructure projects,

[20]*Energy Union Package*. Communication from the Commission to the European Parliament, the Council of the European Economic and Social Committee of the Regions, and the European Investment Bank (Brussels: 25.2.2015) COM (2015) 80 final, 4 and 6. This also included the Mediterranean area to include Turkey, Cyprus, Israel, and Algeria. Hereafter cited as *European Energy Package*.

[21]Ibid., 4.

[22]Ibid., 7.

[23]STRATFOR (Strategic Forecasts), "The European Commission Unveils Its Energy Union Plan," February 27, 2015.

[24]*Energy Union Package*, 8.

[25]Ibid.

which are essential to improve the security of supply and better connect energy markets.[26] However, these references have more to do with the modernization of the electricity markets and little to do with Russia.[27]

The legacy of Europe's dependency, first on Soviet energy and then, after 1991, on the Russian Federation's energy, is still *defacto* and psychologically in place, and somewhat tolerable and comfortable insofar as the consumers of Russia's energy largesse are concerned, and it is difficult to break away from this habit. This is emphasized in the EU *Package*'s claim that the EU has energy rules set at the European level, but it has 28 national regulatory frameworks, and that this contradiction cannot continue.[28] Despite what many Euroskeptics have referred to as the "homogenization" of Europe and Europeans, that is not what has occurred up to this time with respect to energy policy, where it has tended to be every EU member state for itself.

In a list of EU legal tools vis-à-vis energy self-sufficiency, as yet there are no "regulations," the most powerful of EU laws, which are directly and immediately binding in their entirety on all member states. The highest category that applies to energy legislation is the "directive," which is binding on all member states in terms of goals, but member states are left to decide how best to achieve these goals and must make changes to their respective national laws, if in violation of the "directive" within a specified period of time. Most "directives" focus on outlining general policy objectives, which has been and still is the case with energy policies in the EU.[29] Thus, the *Energy Union Package* constitutes a set of "recommendations" or "action points" and has no binding force.[30]

Similarly, the European Parliament and the Council of Ministers issued Directive 2001/42/EC on June 27, 2001, recommending an environmental impact assessment of "certain plans and programmes, which are likely to have significant effects on the environment."[31] This was formulated and adopted when the EU consisted of 15 member states, but subsequently it applied to those states that became members between 2004 and 2013. Presumably, an environmental impact study would appear to be a common sense procedure for an EU member state without a "directive" from Brussels. However, Articles 6 and 174 of the Treaty on European Union

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[26]Ibid.

[27]The STRATFOR analysis of February 27, 2015, concerning the EU *Package*, emphasizes that this "modernization" is a reiteration of the EU's "Third Energy Package," going back to an EU Commission proposal in September 2007, and adopted by the European Parliament and the Council in July 2009, and entered into force on September 3, 2009.

[28]*Energy Union Package*, 3.

[29]McCormick, John, *European Union Politics* (New York: Palgrave McMillan, 2011) 179. Energy policy, at least up to now, has been the essence of "subsidiarity," the principle that the EU should limit itself in policy terms to undertaking tasks better dealt with at the level of the member states.

[30]Ibid., 179. See also *Energy Union Package*, 19–21.

[31]Directive 2001/42/EC of the European Parliament and the Council on the Assessment of the Effects of Certain Plans and Programmes on the Environment (Luxembourg, June 27, 2001). PE-Cons3619/3/oi,REV3, ENV135, CODEC260; 1996/0304(COD), C5-0118/2001, LEX271., 7.

(TEU) provide that "environmental protection requirements are to be integrated into the definition of Community policies and activities…," and "that Community policy on the environment is to contribute to, inter alia, the preservation, protection and improvement of the quality of the environment, the protection of human health and the prudent and national utilization of natural resources and that it is to be based on the precautionary principle …"[32]

Specifically, the European Commission issued a "recommendation" on January 22, 2014, the proverbial "green light," to proceed with unconventional drilling. Minimum principles were established for the exploration and production of hydrocarbons (such as shale gas) using high-volume hydraulic fracturing.[33] Among several provisions, it provides a definition of "high-volume hydraulic fracturing" as "injecting 1000 m^3 or more of water per fracturing stage or 10,000 m^3 or more of water during the entire fracturing process into the well…." as well as a baseline study to include quality and flow characteristics of surface and ground water; water quality at drinking water abstraction points; air quality; soil conditions; presence of methane and other volatile organic compounds in water; seismicity; land use; biodiversity; status of infrastructure and buildings; and existing wells and abandoned structures.[34] The focus on baseline studies by the EU has grown out of the experiences with the Barnette and Marcellus Shale formations in the USA.

In addition, the United Nations Economic Commission for Europe's (UNECE's) Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters was adopted on June 25, 1998, in the Danish city of Aarhus (thus the Aarhus Convention) at the Fourth Ministerial Conference as part of the "Environment for Europe" process. It entered into force on October 30, 2001.[35] Subsequently, the EU has implemented and supported the Aarhus Convention by four EU directives. They are: Directives 2003/4/EC, Public Access to Environmental Information; 2003/35/EC, Public Participation and Access to Justice; 2003/98/EC, Re-use of Public Sector Information; and 2007/2/EC, Infrastructure for Spatial Information.[36]

As the title of the Aarhus Convention suggests, the emphasis is on environmental concerns. This includes the energy sector, the production and processing of

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[32]Ibid., 2.

[33]Commission Recommendation of January 22, 2014, on minimum principles for the exploration and production of hydrocarbons (such as shale gas) using high-volume hydraulic fracturing (2014/70/EU). L39/72.8.2.2014; http://eur.lex.europa.eu/LexUriServ.do?uri=OJ:L2014:039:0072:00/8:EN=PDF.

[34]Ibid.

[35]Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (done at Aarhus, Denmark, on June 25, 1998). Hereafter cited as the Aarhus Convention. www.unece.org/fileadmin/DAM/env/pp/documents/cep43e.pdf.

[36]Strategy for Implementing the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters—The Aarhus Conveiton. www.osce.org/Serbia/89086?download-true. See Sect. 2. "International and European Context of the Aarhus Convention," 17.

metals, the mineral industry, the chemical industry, waste management, wastewater treatment plants, industrial plans, transport to include railway, motorways and express roads, dams and other installations designed for the holding-back or permanent storage of water, pipelines for the transport of gas, oil, or chemicals with a diameter of more than 800 mm and a length of more than 40 km.[37] The formulation and adoption of these provisions predated the interest in unconventional drilling using hydraulic fracturing for shale gas. However, the formulators of these provisions manifested prescience in anticipating many of the specific problems associated with the exploration and the eventual production of shale gas.

The EU and its founding member states have emphasized the prevention of environmental damage or disaster rather than repairing it after the fact. Still, each member state's government is responsible for implementing the EU directives. Most of the visiting delegations to the Barnett and Marcellus shale formations in the USA from EU member states, usually consisting of legislators, geologists, geophysicists, hydraulic engineers, avowed environmentalists, and conservationists, as well as journalists, have been primarily interested in environmentally related issues associated with unconventional drilling and hydraulic fracturing.

Finally, making the EU member states less dependent on Russian natural gas or importation of natural gas from elsewhere will be difficult in the short- and long term. Because of Russia's proximity, and a pipeline network already in place, Moscow most likely will continue to play a significant role, if not a dominating one. To this point in time, the EU member states are not likely to allow Brussels to make a deal with Russia or any other country with respect to an all-EU energy policy. And neither Russia nor *Gazprom* will recognize Brussels as an entity capable of making such a contract. The limits of an EU energy policy, except for advocating and exhorting the implementation of renewables, notably solar and wind, are significant.

Europe's Recoverable Unconventional Shale–Natural Gas Resources

Europe's unconventional recoverable shale gas resources are estimated at only 15 % of the world's total, and if Russia is excluded, the technically recoverable gas resources are reduced to 11 %.[38] According to the United Kingdom's Department of Energy and Climate Change (DECC), the Asia-Pacific and North America have combined 283 Tcf of unconventional natural gas, and Europe, including the former Soviet Union contain

[37]The Aarhus Convention, Annex I, List of Activities Referred to in Article 6, Paragraph 1(a).

[38]EIA Report (revised June 2013) online. Accessed on July 20, 2015. Together, China and the USA have 23 % of the world's total estimated reserves of shale gas, and Europe, including Russia, has 15 %. If Russia is not considered part of Europe, Europe's share drops to 11 %.

Table 1 Estimated recoverable Shale Gas Resources in Europe in Tcf (trillions of cubic feet)

Country	Amounts in Tcf
US	*827* (revised estimate by EIA in 2012)
Marcellus Shale (US)	*141* (revised estimate by EIA in 2012)
Russia	285
Ukraine	247
United Kingdom	134
Poland	133.6
France	128.6
Germany	80
Spain	42
Bulgaria	35
Romania	No reliable estimates by EIA
Netherlands	26

Source US Energy Information Administration (EIA) Analysis and Projection of Technical Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States (May 17, 2013). The estimated Tcf reflects the EIA's higher projections of recoverable natural gas from the shale formations in each of the European countries listed

7 %, and excluding the former Soviet Union, only 4 %.[39] In the US Energy Information Administration (hereafter cited as EIA) Analysis and Projection of Technical Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the USA (May 17, 2013), Russia is included as a part of Europe with 285 Tcf of technically recoverable shale gas.[40]

The EIA's estimate of recoverable natural gas from shale formations in Russia and Ukraine together is 532 Tcf, which is 60 % of the EIA's estimate for the entire USA and almost four times larger than the Marcellus Shale in the USA, thus suggesting that either separately, or together, it would be economically viable to tap these plays.[41] For the time-being in Ukraine, only in the Lviv Depression is there a

[39]*Energy and Climate Change Committee*, Fifth Report, Shale Gas (United Kingdom Parliamentary Report, May 23, 2011). Table 1, "Global Unconventional Natural Gas Resources in Place (trillion cubic meters)". Prepared by the Department of Energy and Climate Change (DECC) 17. The USA is estimated to have 615.7 Tcf (trillion cubic meters), while the People's Republic of China is estimated to have 9,107 Tcf. The United Kingdom Parliamentary Report estimates that recoverable natural gas from shale formations could increase world production by 40 % to 16,143 Tcf., 11. Hereafter cited as UK Parliamentary Report, Shale Gas.

[40]EIA Report (May 17, 2013), p. IX-10-11. www.eia.gov/analysis/studies/worldshalegas/oil, recovery.

[41]Urbina, Ian, "New Report by Agency Lowers Estimates of Natural Gas in US," *The New York times* (January 29, 2012) A16. This report further states that under this reviewed EIA estimate, the Marcellus Shale in western Pennsylvania, New York, Ohio, and West Virginia, which was previously thought to hold enough gas to meet the entire US demands for 17 years, i.e., until 2029, at current levels of consumption, contains instead only a six year supply, or until 2018.

real possibility for development, because the larger potential in the Donetsk Basin is in an active war zone. However, Russia's major interest in shale formations in the Bazhenov Shale is the extraction of oil, not gas.[42] According to EIA estimates, the Bazhenov Shale in the West Siberian Basin contains 4.4 billion barrels of recoverable oil.[43]

The following analysis of unconventional shale gas recovery, requiring hydraulic fracturing, will focus primarily on Poland, the United Kingdom, and Germany. These are the three European countries where exploration using hydraulic fracturing is continuing, but at a much slower and at an uneven pace in Germany. France has had a total ban on fracking since 2011, based primarily on environmental concerns, and the fact that France produces over one-third of its energy from nuclear power, which provides a degree of security not shared by other western European countries.[44] In that Ukraine remains an active war zone, the development of shale gas there has been delayed.

Poland and the United Kingdom vie for one and two rankings in terms of having the greatest potential for recoverable shale gas by unconventional means—hydraulic fracturing and horizontal drilling. Also, the move to aggressively push for large-scale shale gas exploration and production has been supported by the leaders of the national governments of both Poland and the United Kingdom. Germany is the exception in this case. Former Polish Prime Minister, Donald Tusk, has been a strong proponent of developing shale gas as well as other hydrocarbon fossil fuels, as has Prime Minister David Cameron, the British Prime Minister, whose Conservative Party just recently was re-elected in the United Kingdom.[45] Both Poland and Britain share long histories in extracting mineral resources, especially coal, but the United Kingdom has had 50 years of recent experience in drilling for oil in the North Sea. These experiences make the Polish and British efforts and their advocates confident in developing their shale gas potential. Nevertheless, both countries have encountered enough negative results along the way in these previous endeavors to the extent that they are cautious and deliberate in proceeding toward production. Thus, both countries are still in the exploration stage of development.

[42]Kramer, Andrew, "Russia Sees New Benefits to Shale Oil Extraction," *The New York Times* (November 14, 2012) B4.

[43]EIA Report, IX–10 and IX–11. Several oil companies operating in Russia, including RusPetro, have been profitably extracting oil from shale rock and other geological formations in Siberia. Also, Rosneft, Russia's national oil company, has signed agreements with Exxon Mobil and Norway's Statoil with the aim of using horizontal drilling and hydraulic fracturing. See Kramer, "Russia Sees New Benefits to Shale Oil Extraction." The Bazhenov Shale is considered similar to the Bakken Shale in North Dakota, the most successful American oil shale patch. The Bazhenov is much larger.

[44]Geoffron, "France's Ban on Shale Development." Presentation at conference hosted by the University of Pittsburgh, Pittsburgh, Pennsylvania, on March 19, 2015.

[45]The role that a national government's political leadership plays in either advancing or holding-back on energy development has been crucial. Messrs. Tusk and Cameron provide excellent examples of promoting unconventional drilling, while President Francois Hollande has been an outspoken critic in promoting the ban in France.

Poland and the United Kingdom, along with Germany, together with every other European country that has potential shale gas formations, have paid heed to the development of the shale gas industry in the USA and particularly to the problems encountered.

Along with the reports of the various visiting delegations to the USA, referred to above, the government ministries and legislative committees responsible for carrying out the required environmental impact studies have kept up-to-date on all the official, unofficial, and journalistic reports concerning baseline studies in the various localities of the major shale gas formations in the USA. As of mid-2015, the environmental concerns, having to do with unconventional drilling for natural gas, have predominated in the slow move toward production. These concerns include noise and air pollution, contamination of ground water, disposing of wastewater from hydraulic fracturing, the impact on wild life, possible seismic activity, and the general detritus caused by big truck transport to and from hydraulic fracturing sites. Because of the recent situation concerning Russia and Ukraine, and the decision to foreswear nuclear power, especially after the Fukushima accident in Japan in 2011, the commercial and economic considerations of hydraulic fracturing have become increasingly important.

The Polish Situation

Probably environmental concerns over unconventional drilling have played a decidedly lesser role in Poland's exploration for shale gas than in any other European country (Fig. 4). During the past five years, enthusiasm over Poland's shale gas resources has run the gamut from exceedingly high to moderate. Certainly, then US Secretary of State, Hillary Clinton's 2010, visit to Poland (see endnote #18) in order to support Poland's efforts to cooperate on a global shale initiative is a case in point. On the high end of viewing Poland as a major player in the "Golden Age of Gas" was an interview with James Elston, Director of Palladian Energy Advisory, posted in *Shale Gas, Recent News, News By Country*, entitled "Europe's Shale Gas Laboratory," August 15, 2011.[46] Mr. Elston placed emphasis on the confidence shown by 3Legs Resources and Conoco Phillips, which had drilled the first horizontal shale well in Poland in 2010.[47] In the same interview, Mr. Elston took swipes at *The New York Times* and the "polemical film" *Gasland* as being inaccurate and biased against unconventional drilling.[48]

[46]"Europe's Shale Gas Laboratory," posted in *Shale Gas, Recent News, News By Country, Poland.* August 15, 2011. www.naturalgas/Europe.com/Europa-shale-laboratory. Mr. Elston is a strong advocate that Polish drilling companies should dominate the exploration for and production of shale gas in Poland. In the interview, Mr. Elston predicted that by December 2011, "there would be a great flow of news on unconventional gas, overwhelmingly from Poland."

[47]Ibid.

[48]Ibid.

Fig. 4 Poland. *Source* U.S Energy Information Agency (EIA) May 17, 2013

In a 2014 article, "Can hydraulic fracturing make Poland self-sufficient in natural gas?" an Uppsala University study, its authors take a positive position on Poland's shale gas resources. The authors' assumption is that Poland hopes to replace natural gas from Russia, which currently amounts to approximately 12.4 billion cubic meters (0.44 Tcf) per year.[49] According to their analysis, Poland needs "to drill 400 new shale gas wells per year for Poland to become self-sufficient."[50] Furthermore, these researchers agree that if it is judged absolutely necessary that Poland be self-sufficient in natural gas, "then the EU should assist in importing 40 to 50 drilling rigs and hydro-fracturing equipment from the USA."[51] This is the only study or report located where its authors recommended direct EU assistance in exploring for and producing shale gas.

[49]Alekett, Kjell, Patzek, Tadeusz (Tad), Sevenson, Björn, and Jarosz, Rafat, "Can hydraulic fracturing make Poland self-sufficient in natural gas?" Pre-peer reviewed version, which will be published in final form in a special issue of *Energy Technology on Shale Gas Technology*. Gaia.pge.utexas.edu/papers/140519_Fracking_in_Poland_submitted_Energy.Technology.pdf., 1. Hereafter cited as the Uppsala study.

[50]Ibid.

[51]Ibid., 3.

The goal of the Uppsala study was to determine the number of wells that must be drilled in Poland to make Poland self-sufficient in natural gas.[52] To that end, the authors have calculated that with 400 new gas wells drilled per year over 30 years that would result in 12,000 shale gas wells in Poland, which would be less that the current number of wells in the Barnett Shale in Texas.[53]

The Uppsala study's calculations are based on the production history of shale gas in the Barnett Shale in Texas in the USA. The study's methodology was predicated on drilling 300, 400, and 500 wells per year.[54] In all scenarios, it was assumed what it would take to ramp up to the respective required drilling rate. A first month's production was assumed to be 2.0 million cubic meters (mcm), which was expected to be representative of the Barnett Shale in Texas.[55] Thus assuming the same production curve, the scenario with 400 new wells per year would attain a level of production equal to Poland's current natural gas imports after a period of six years.[56]

Posited against the Uppsala study is another study, which takes into account another set of calculations concerning the Barnett, Haynesworth, and Marcellus shale formations made by David Hughes in *Drill, Baby, Drill*, *Can Unconventional Fuels Usher in a New Era of Energy Abundance?*, published in 2013.[57] While Hughes' study focuses only on the USA, and specifically on the shale "plays" (i.e., "fields" in the lingo of the natural gas industry) mentioned above, he argues that shale gas formations in other parts of the world will not be as large or as rich as those in the major US "plays." Acknowledging that US natural gas production from shale formations went from 2 % of all natural gas, including that extracted by conventional drilling, in 2000, to 40 % in 2012.[58] While, according to Hughes, this unconventional drilling more than made up for the decline in conventional gas production during that time, it has reached a zenith, or soon will, in terms of reserves and commercial viability.[59] Hughes points out that 20 % of shale plays in the USA provide 88 % of production.[60] Individual well decline rates of gas production are

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[52]Ibid., 1.

[53]Ibid., 4.

[54]Ibid.

[55]Ibid.

[56]Ibid.

[57]Hughes, J. David, *Drill, Baby, Drill*, *Can Unconventional Fuels Usher in a New Era of Energy Abundance*? (Post Carbon Institute, 2013) http:www.postcarbonorg/reports.DBD-report-FINAl.pdf, especially "The Shale Revolution," 49–77 *passim*. J. David Hughes is a geoscientist who has studied the energy resources of Canada for almost 40 years, including 32 years with the Geological Survey of Canada as a scientists and research manager. Currently, Dr. Hughes is the president of Global Sustainability Research, Inc., a consulting firm dedicated to research on energy and sustainability issues.

[58]Ibid., 50.

[59]Ibid.

[60]Ibid. Hughes states that high productivity shale plays vary in terms of so-called sweet spots with in the play. For example, six of 30 shale plays in the USA provide 88 % of shale gas production.

high, ranging from 79 to 95 % after three years.[61] Thus, these overall decline rates that range from 30 to 50 % of production must be replaced annually with more drilling.[62] In the three plays that Hughes examined, he claims that "[O]verall well quality is declining for 36 % of US shale gas production and is flat for [another] 34 percent."[63] Hughes also believes that the US Energy Information Administration (EIA) has a propensity for overstating the recoverable reserves of natural gas from the recoverable reserves of natural gas from those shale formations in the USA. He points out that in 2012, the EIA revised its original estimates of unproved technically recoverable shale gas resources in the USA as a whole from 827 Tcf in 2011 to 482 Tcf in 2012, or by 42 %.[64] As dramatic was the EIA revision downward of the Marcellus Shale in parts of Pennsylvania, New York, Ohio, and West Virginia, from 410 Tcf in 2011, to 141 Tcf in 2012, a 66 % decline.[65]

While the Uppsala study does not dismiss Hughes' conclusions, its authors still advocate shale–natural gas as being a panacea for Poland's energy self-sufficiency. They conclude that Poland would be self-sufficient in natural gas within seven years once production had began, and 400 new wells would be drilled each year.[66] The Uppsala study concludes that the average shale gas well in Poland will be as productive as the average Barnett shale well in Texas.[67]

In addition, the Uppsala researchers point out that Poland does not need to develop new technologies, because they can apply already-used techniques that have been refined in the USA, thus telescoping the time frame considerably.[68] Compared with the USA, Poland's time frame for achieving production can be shortened because the state owns the mineral rights (which is the case with almost all the European countries), and therefore, drilling companies have only to negotiate with the state, and not individual landowners to sell exploration rights and to sign contracts.[69] One negative factor that the Uppsala group does not have a solution for is the disposal of the large quantities of the contaminated wastewater used in the hydraulic fracturing process.[70]

Despite the recent optimism for natural gas self-sufficiency in Poland, the reality by mid-2015 is quite different. The pursuit of shale gas appears to be stalled or is not moving forward quickly. The strongest evidence is that US energy company,

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[61]Ibid.

[62]Ibid.

[63]Ibid.

[64]Ibid.

[65]Urbina, Ian, "New Report by Agency Lowers Estimates of Natural Gas in US," *The New York Times* (January 29, 2012) A16.

[66]Uppsala Study, 11.

[67]Ibid., 12.

[68]Ibid.

[69]Ibid., 13. However, the report states that the Polish government will have to compensate landowners quite generously, and this may provide a potential for conflict.

[70]Ibid.

Chevron Corporation, announced on January 31, 2015, that it will stop exploring for shale gas in Poland, because that sector has failed to live up to its projected goal of transforming eastern Europe's energy supplies.[71] The announcement said that Chevron's Polish unit "has decided to discontinue shale gas operations in Poland as the opportunities here no longer compete favourably with other opportunities in Chevron's global portfolio."[72] Among the big international energy-producing companies, Chevron made the largest commitment to shale efforts in Europe, mostly in Eastern Europe.[73] While Chevron's departure from Poland is the most significant in terms of commitment, since 2012, Exxon Mobil, Total (France), and Marathon Oil have quit shale gas exploration there as well.[74] As part of its quest to explore for unconventional natural gas shale formations in Eastern Europe, Chevron drilled several wells in Poland and Romania, as well as signed agreements to drill in Ukraine and Lithuania.[75] Chevron has already pulled out of Romania, but still maintains an office in Ukraine.[76]

Two points are to be made concerning Chevron's recent pullout from Poland, one financial and the other technical. On January 31, 2015, Chevron also reported that its earnings for the fourth quarter of 2014 fell almost 30 % compared with 2013, to $3.5 billion.[77] The company blamed lower oil prices for much of the damage.[78] The technical aspect is that the shale rocks that drillers encountered proved difficult to work. Unlike shale formations in the USA, which are fragile and easily fractured because of calcium carbonate, Polish shale is plastic-like and difficult to fracture.[79] Furthermore, some of the shale formation structures have clay material that swells considerably upon encountering water, thus gumming up the flows.[80] Dr. Grzeygorz Pienkowski, a director of the Polish Geological Institute, believes that the most likely scenario for Poland is that there will likely be some "isolated" production areas rather than one big continuous shale, belt as originally hoped. Dr. Pienkowski stated that the few drillers remaining in the game now know how to better their efforts, thus giving some hope of future success.[81]

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[71] Lowe, Christaian "Update 1-Chevron to stop its shale gas exploration in Poland", *Reuters* (January 31, 2005. www.reuters.com/article/2015/01/31chevron-poland-shale-idUSL6NOVA08820150131.

[72] Ibid.

[73] Reed, Stanley, "Chevron to Abandon Shale Natural Gas Venture in Poland", *The New York Times* (January 31, 2015) B3.

[74] Lowe, *Reuters*.

[75] Reed, "Chevron to Abandon Shale Natural Gas Venture in Poland." Up to this time 68 unconventional wells have been drilled in search of shale resources, but none is in production.

[76] Ibid. The ongoing war between Ukraine and Russia has stalled any progress there for the time-being.

[77] Ibid.

[78] Ibid.

[79] Ibid. This explanation was provided by Dr. Grzeygorz Pienkowsi, a director of the Polish Geological Institute in Warsaw, who Staley Reed interviewed.

[80] Ibid.

[81] Ibid.

As of now, some state-owned firms and a handful of private oil and gas groups remain behind to continue to explore unconventional gas formations. State-owned firms are the most active in exploring for shale gas. Out of 53 concessions awarded, PGNiG holds 12 concessions, and Orlean Upstream holds nine, or together 40 % of all concessions.[82] The "go-slower" policy of Poland in exploring and producing shale gas is both economic and technical as stated above. However, it is part of the historical experience that Poland has had with the extraction of coal and lignite that has determined the administrative approach to shale gas. Consequently, there is a great deal of public involvement at the local and regional levels. Thus, Polish regions and municipalities have strong authority over allowing shale gas exploration.[83]

Dr. Michael LaBelle, who is an assistant professor at the Central European University (CEU) Business School and Department of Environmental Sciences Policy in Budapest, Hungary, has recently addressed the issue of bureaucratic red tape in Poland as possibly having been an impediment in expediting shale gas exploration and discouraging investment even at the exploration stage.[84] While none of the big companies, such as Chevron, Exxon Mobil, Total, and Marathon Oil, has ever stated so publicly, circumstantial evidence suggests that the delays caused by bureaucratic red-tape may have played a role in their exit from Poland.

There are five state ministries in Poland that are involved in overseeing and administering the extraction of shale gas: Economics, Environment, Finance, Foreign Affairs, and Treasury.[85] In that "learning" about shale gas from the American experiences in Texas and Pennsylvania, the Ministry of Foreign Affairs has a role to play. Institutional clashes can be anticipated as a result of overlapping jurisdictions. For example, the Treasury owns the state-owned oil firms, such as PGNiG and Lotus, while the Finance Ministry collects the taxes.[86] The Ministry of Environment is the central administrative body overseeing shale gas development in coordination with local units of government, and it is the ultimate authority for granting concessions and approving drilling activities.[87] Within the Environmental Ministry, there are two key departments: The General Directorate for Environmental Protection (GDOS) and The General Inspectorate for Environmental Protection (GIOS). The Directorate provides the initial input concerning potential 'mining' activities, while the Inspectorate provides environmental monitoring after

[82]LaBelle, Michael Carnegie, "Poland: Staying the course on fossil fuels," unpublished draft of a paper presented at a conference hosted by the University of Pittsburgh, Pittsburgh, Pennsylvania, on March 19, 2015, entitled "managing Risks in the Shale Industry: A Comparison of Policies Worldwide". Dr. LaBelle was kind enough to provide me with a copy of a draft of the paper on April 22, 2015, 3.

[83]Ibid., 1.

[84]Ibid., 7–9 *passim*.

[85]Ibid., 7.

[86]Ibid.

[87]Ibid.

a project is completed.[88] The final decision on licensing is made by the regional municipality after consulting with the Ministry's Directorate (GDOS).[89]

The slowness at which this process has moved was the subject of a 2014 report by Poland's State Supreme Audit, which addressed a range of issues. For example, legally the Ministry of Environment must give a decision within 30 days of a company's application to drill, but approval took an average of 132 days![90] At that rate the audit pointed out it will take 12 years to drill 200 test wells.[91] These delays are due both to understaffing and a lack of clear administrative procedures that drilling companies can abide by and rely upon.[92] While these bureaucratic procedures are cumbersome and frustrating, they can be overcome and probably will be shortly. More significant for the foreseeable future, however, is that Poland will continue to be wedded to the tried and true, but also the dirtiest fossil fuels insofar as pollution and climate change are concerned, especially coal.

This is especially significant in terms of Poland's development of its electrical energy grid. Dr. Wladyslaw Mielczarski, Professor in Power Engineering at the Technical University of Lodz, Poland, predicts that by 2050, 60 % of Poland's electrical power will be generated by coal, 40 % anthracite, and 15 % lignite.[93] Another 20 % will be produced by natural gas, and the final 20 % by renewables, primarily solar and wind.[94] Projected costs of shale-produced natural gas are a negative factor against large-scale production. The Oxford Institute of Energy Studies (OIES) projected the cost of Polish shale gas (along with production in Germany) by 2020 in a best-case scenario at $8.00 per thousand cubic feet (tcf), and in a worst case at about $12.00 per tcf.[95] This is compared with foreign suppliers, including Algerian piped gas, Qatar LNG, Nigerian LNG, and the Russian-Yamal piped gas, all of which would be $5.00 per tcf. Thus, Dr. LaBelle's working title for his paper, "Poland: Staying the course on fossil fuels," will seemingly prevail for well into the twenty-first century, and therefore has validity.

Among the three country-focused studies in this report, Poland reflects the least concern about the environmental impact of unconventional drilling. Nevertheless, the quantity and the quality of recoverable gas from shale formations have stalled the move toward production. In terms of the use of conventional fossil fuels, especially for electrical energy, in the foreseeable future, this suggests that Poland puts energy security ahead of environmental and climate concerns.

[88]Ibid.

[89]Ibid.

[90]Ibid.

[91]Ibid.

[92]Ibid.

[93]Mielczarski, Wladyslaw, Prognozy produkcji energii elektrycznej i zuzycia paliw (The Forecast of the Production of Electrical Energy and the Use of Fuels) (Krynica: 4 wrzesnia 2012) slides 3a, 4 and 5.

[94]Ibid.

[95]Memorandum from Ofgem (Ev w 13). Found in UK Parliamentary Report, Shale Gas, 25.

The British Situation

The United Kingdom (UK) is probably nearer to producing shale gas by hydraulic fracturing than any other European country at this time. However, the exploratory stage is still underway, and in terms of the timetable in making the transition to

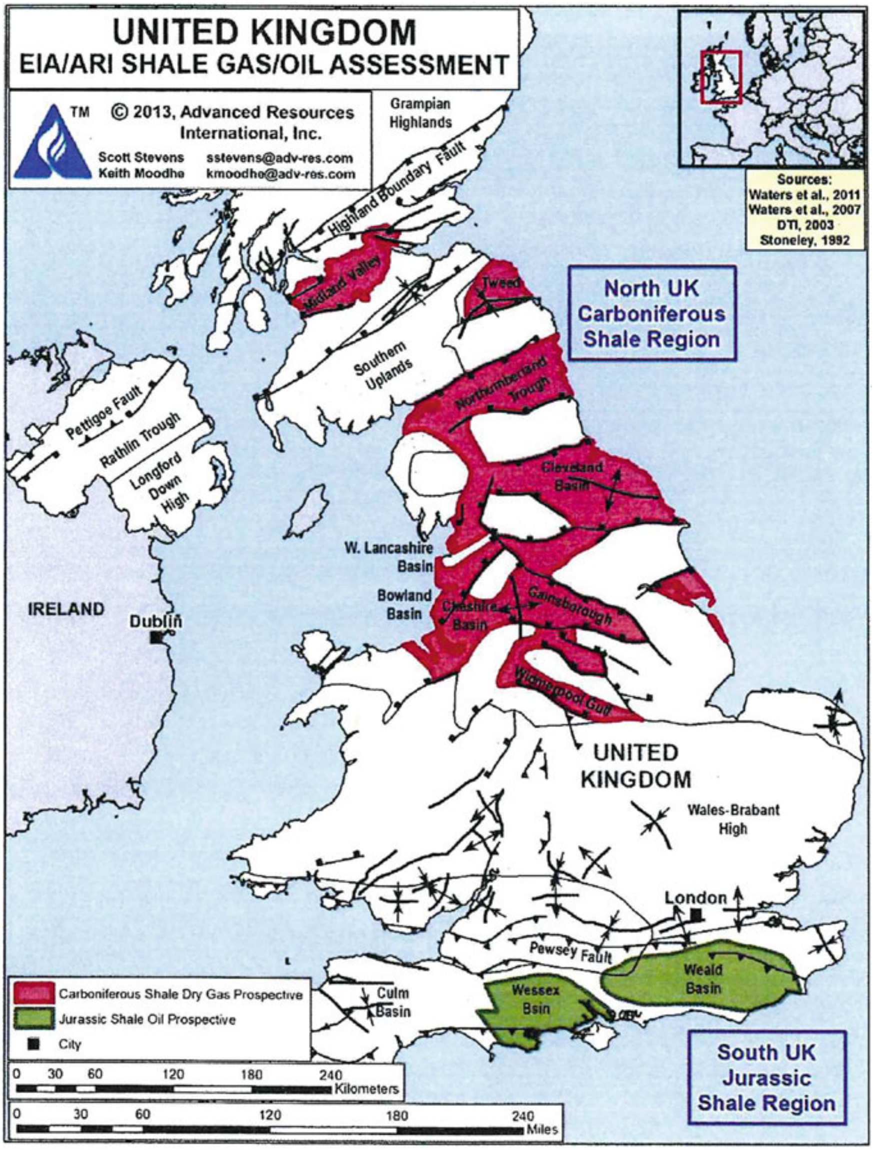

Fig. 5 United Kingdom. *Source* U.S Energy Information Agency (EIA) May 17, 2013

production, politics prevails. The UK has a considerable shale gas resource, particularly offshore. However, as the Energy and Climate Change Committee of the British Parliament concluded [in its Fifth Report, Shale Gas] in 2011, it is unlikely that Britain's shale gas formation will be a "game changer" to the same extent as in the USA[96] The Report's authors suggested that domestic shale gas resources could enhance self-reliance, but that "they are unlikely to have as large an impact on our security of supply due to the limited extent of the resource…."[97] Certainly, the UK will never be an exporter of natural gas.[98]

The British government has moved more quickly on developing shale gas potential than any other European country, because a strong political consensus exists on the issue. There are several reasons for this. First, administratively, there already exists an efficient top-down procedure for licensing as the result of 50 years of offshore drilling for oil in the North Sea.[99] Second, while mentioned as a concern in the Parliamentary Report, there has not been much of a debate on any dangers posed to ground water or green-house considerations.[100] The Parliamentary Report states categorically that the "risks of water contamination were due to issues of well-integrity"; thus, these are no different than concerns that have been encountered during the extraction of oil and gas from conventional reservoirs.[101]

The Report does concede that the large volumes of water used in hydraulic fracturing could exacerbate regions already experiencing water stress.[102] Therefore, the Environmental Agency needs to ensure that companies declare the type, concentration, and volume of **all chemicals** [emphasis added] added to the hydraulic fracking fluid.[103] Also, the Department of Energy and Climate Change (DECC) has an obligation to try to decrease Britain's dependency on coal for electricity generation, and the development of shale gas is a good bet to help shift this balance.[104]

Fourth, when Britain moves into the production stage, there will be a smaller number of wells than in the USA.[105] Lastly, there are no large companies interested in shale gas in the UK. Cuadilla Resources Holdings Limited began drilling near Blackpool in the Bowland Shale, which runs from Preston to the Irish Sea.[106] (see Fig. 5). In terms of investment, it is still considered better to invest offshore insofar as energy is concerned.[107]

[96]Ibid. 3.

[97]Ibid.

[98]Ibid.

[99]Skea, "Shale Development in the UK."

[100]Ibid.

[101]UK Parliamentary Report, Shale Gas, 3.

[102]Ibid.

[103]Ibid.

[104]Ibid.

[105]Skea, "Shale Development in the UK."

[106]UK Parliamentary Report, Shale Gas, 5.

[107]Skea, "Shale Development in the UK."

There is a significant discrepancy between the estimates of recoverable natural gas formations made by the British Geological Society and the US's EIA. At the current rate of natural gas consumption in the UK, the British Geological Society estimates that there is 1½ years, or 18 months, supply, or 15 years of the UK's current LNG imports. The EIA, on the other hand, estimates that Britain has the equivalent of 5.6 years of unconventional shale gas, or 56 years of LNG.[108]

Despite advocating the development of shale gas, the Parliamentary Report takes seriously the rapid depletion of shale gas formations. The authors present what they refer to as a "pessimistic" and an "optimistic," or their term, "hyperbolic" view on declines in production. Both scenarios show steep declines after production begins. The optimistic view is more gradual and levels out in terms of arbitrary units of time with 20 % of the shale gas reserves remaining within 40 % of the time units.[109] For example, Professor Paul Stevens of Chatham House observed that "although unconventional gas resources were estimated to be five time those of conventional gas, there was concern that [due to the nature of unconventional gas reservoirs] their depletion rates are much faster."[110]

The more optimistic view, expressed by Cuadilla representatives, was that the only "scientific method currently available to estimate these [depletion rate] factors for UK shale formation is by analogy to commercial North American shale plays." adding that "long-term shale gas production decline rates remain projections rather than based on scientific facts."[111] The Cuadrilla representatives explained that "in common with other unconventional wells, [a typical shale gas well] will witness steep early production decline rates—typically of around 30 to 40 % for one to two years—followed by up to 50 years of commercial life at low decline rates, typically 5 to 7 %."[112] In either of the two scenarios, the decline rates would appear to call into question the economic feasibility for mass-scale development.

The decline in the extraction of conventional natural gas and oil in the North Sea has been fairly steady, although the decline of gas has outpaced oil.[113] From 2004 until 2009, the importation of natural gas has increased to the extent of 32 % of total consumption.[114] By 2009, 58 % of natural gas came from Norway, 16 % from the Netherlands, 2 % from the Belgian interconnector pipeline, and 25 % constituted LNG imports.[115] From 2005, consumption of natural gas has remained steady, while importation of gas has increased.[116]

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[108]UK Parliamentary Report, Shale Gas, 5.

[109]Ibid., Fig. 2, "Optimistic and Pessimistic Shale Gas Depletion Rates," 19.

[110]Ibid., 18.

[111]Ibid.

[112]Ibid.

[113]Ibid., 19.

[114]Ibid.

[115]Ibid.,19–20.

[116]Ibid., 20. See Fig. 3—"Natural gas production, net exports/imports and consumption." Source: DECC, *Digest of UK Energy Statistics 2010*. Chart 4.1, 97.

In the opinion of the British Geological Survey, offshore shale gas would have the size to affect the potential reserve figures more dramatically than onshore, because the UK's onshore basins are smaller in comparison with the UK's offshore basins.[117] The position of the UK's Energy Ministry is that offshore shale gas would most likely be extracted by horizontal drilling reached from onshore facilities.[118]

As a member of the EU, the UK's Parliamentary Report makes only one reference to the EU in Chapter 5, "Environmental Risks of Shale Gas." In connection with the DECC's 14th Onshore Oil and Gas Licensing Round in July 2010, the DECC published a Strategic Environmental Assessment (SEA) for draft plans of their forthcoming 14th round of onshore oil and gas drilling. SEAs are required under European Directive 2001/42/EC and would be implemented through the UK's Environmental Assessment of Plans and Programmes Regulation of 2004.[119] The Report's conclusion is that hydraulic fracking "in itself does not pose a direct risk to drinking water aquifers provided that the well-casing is intact before the process commences." It recommended that all companies involved in fracking should declare the type of concentration and volume of chemicals they are using.[120] An environmental concern that is addressed in the EIA 2013 report, as well as in the UK Parliamentary Report, is seismic hazards. In 2011, when the first fracking of a shale well was attempted in the Bowland Sub-basin near Blackpool, Lancashire, it induced "several dozen small earthquakes close to the down shale injecting zone."[121] The EIA report states that the timing of the earthquakes corresponded with the fluid injection and continued for several hours after the injection ceased.[122] The most intensive earthquakes measured a magnitude of 2.3 and 1.5 on the Richter scale, and no surface damage was reported. The UK government shut down fracking in Lancashire for 18 months.[123]

Many county councils have expressed concerns about hydraulic fracturing, especially in the exploratory stage, where the UK currently is. Those issues include a broad spectrum from high levels of noise associated with unconventional drilling, increased truck traffic, and the damage to roadways to and from the sites. In the long run, Britain is moving toward the production stage of shale gas, but it is being done in a safe and methodical way.

In terms of committing itself to the production of natural gas from shale formations, the UK is the European country closest to transitioning to the production stage. However, even though the gas produced by hydraulic fracturing will add to Britain's national energy security, it will still depend on the importation of energy.

[117] Ibid.

[118] Ibid., 21.

[119] Ibid., 36.

[120] Ibid., 39.

[121] EIA Report, XI–8.

[122] Ibid.

[123] Ibid.

The German Situation

Unlike either Poland or the United Kingdom, the public debate in Germany over unconventional drilling continues to be contentious and well-organized. The opposition has been strengthened by several scientific-economic studies, one of the most in-depth of which is the SRU's (German Advisory Council on the Environment) *Fracking for Shale Gas Production,* a contribution to its appraisal in the context of energy and environment policy, Statement (May 2013), No. 18, which has a bibliography of 182 scientific papers and statistical-assessment reports. As is reflected in the SRU report, environmental concerns top the priority list with economic matters a close second.

Since about 2011, the topic of hydraulic fracturing has received widespread attention in the media, in public discussions, and among experts. Several citizens' initiatives opposed to shale gas exploration and production have been founded, especially in the German *Länder* of North-Rhine Westphalia and Lower Saxony. To date, these two states contain the two most promising natural gas shale plays (see Fig. 6). The two most high profile citizens' initiatives opposing fracking are the *Bundesverband Bürgerinitiativen Umweltschutz e.V* (BBU, Germany's National Association of Citizens' Environmental Protection Initiatives) and "No Moor

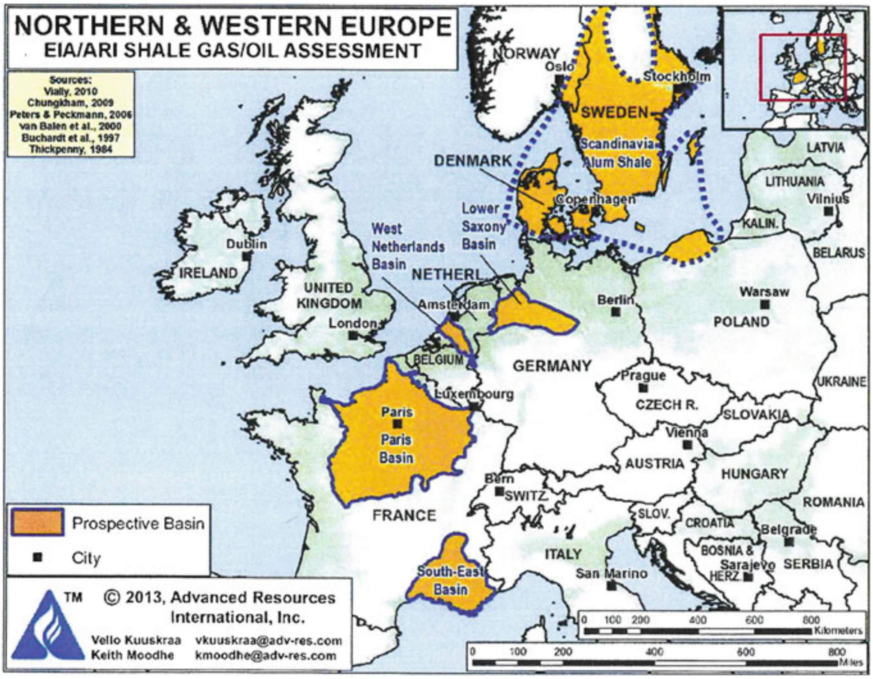

Fig. 6 Northern and Western Europe, to include Germany. *Source* U.S Energy Information Agency (EIA) May 17, 2013

Fracking."[124] The Web site *Gegen Gasbohren* (against gas drilling) is the joint communication platform of many German citizens' initiatives against shale gas development in Germany. Other strong opponents of hydraulic fracturing include the German beer brewers and the environmental protection officers of the Protestant churches in Germany.[125]

Hydraulic fracturing has been applied for conventional (i.e., vertical drilling) in tight gas reservoirs in Germany since the 1950s to increase production. Since then, more than 300 hydraulic fracturing jobs have been conducted in-depths of more than 5000 m.[126] According to the annual report for the *Landesamt für Bergbau Energie und Geologie* (State Office for Mining Energy and Geology—LBEG) in 2012, "there has been no known environmental damage during these years."[127] However, hydraulic fracturing for shale gas production is still new for Germany, and the geological formations with the most shale gas potential are at shallower depths, and the fracking volumes are considerably greater than with conventional reservoirs.[128] The citizens' initiatives, referred to above, point to the lack of monitoring or systematic investigations of environmental impacts of fracking activities carried out to date.[129] All parties involved, including citizens, public authorities, environmental associations, the science community, and industry, that intensive research on all aspects of the topic of shale gas is required.

As recently as 2011, ExxonMobil Production Deutschland GmbH initiated an information and dialogue process on the potential risk and environmental impact of unconventional gas production as a response to widespread public opposition to ExxonMobil's exploration activities in northwestern Germany.[130] A major result of this information and dialogue process was a panel of eight leading experts from German research organizations who addressed a broad spectrum of questions regarding environmental and health risks that might be associated with fracking. The scientific experts who were selected had to possess excellent scientific credentials and to be entirely independent from the natural gas industry and in particular from ExxonMobil. Their report, *Risikostudies Fracking* (The Study of Fracking Risks) was presented at a final conference on April 25, 2012, in Osnabrück, Germany. The main conclusions were: (1) compared to conventional gas production, hydraulic fracturing in unconventional reservoirs, i.e., shale formations, bears a new range of risks stemming from an increased number of wells and a related increase in water consumption, the use of chemicals, and increased

[124]Vetter, Alexandra, GFZ German Research Centre for Geosciences, "Shale Gas in Germany—the current status" (October 2012; updated April 2015). alexandra.vetter@gfz-potsdam.de. Accessed on June 22, 2015. Hereafter, cited as Vetter.

[125]Ibid.

[126]Ibid.

[127]Ibid.

[128]Ibid.

[129]Ibid.

[130]Ibid.

traffic; and (2) the assessment of risks has shown that a slow and cautious development of hydraulic fracturing in unconventional reservoirs should be possible, and (3) there is no factual basis for a ban on the technology.[131] Following the publication of this report, ExxonMobil announced that it would implement all the recommendations in future hydraulic fracturing in Germany, including the kinds and amounts of chemicals used in the process.[132] Actually, ExxonMobil had carried out one test drilling in 2008, at Damme 3, in Lower Saxony, to achieve an estimate of the production potential of the shall formation, and published the chemical composition of the fracking fluids used in the three fracking treatments.[133]

Despite strong opposition to hydraulic fracturing in Germany, the overall legal situation will continue to permit it. Any prohibition of fracking must be approved by the *Bundestag* (the Federal Assembly) in that such a ban must apply to the whole of Germany under the Federal Mining Act.[134] In July 2014, the Federal Environment Ministry and the Federal Economics Ministry presented a combined framework document. The provisions included the strongest regulation ever seen in this matter, with the stated intention that there would no commercial production for financial purposes in the foreseeable future. Only scientifically supported testing measures would be authorized.[135] This framework document was interpreted by both opponents and proponents of fracking as a total ban. In response, ExxonMobil launched an advertising campaign in September 2014, under the title "Let's Talk about Fracking."[136] In an open letter, ExxonMobil claimed that it had "succeeded in fulfilling a key political and public demand: our fracking will only use two non-toxic and easily biodegradable additions (Cholinchloride and Butoxyethoxyethano).[137]

There has been opposition to this attempt to ban fracking in Germany, especially from Dr. Hans-Joachim Kümpel, president of the *Bundesanstalt für Geowissenschaften und Rohrstuffe* (Federal Institute for Geoscience and Natural Resources) or BGR, which is the central geo-scientific authority providing advice to the German Federal Republic on all geo-relevant questions. In opposing a ban on fracking, Dr. Kümpel claims that "Often dangers are evoked that simply do not exist. The use of fracking for natural gas production arouses widespread fear amongst the population, fear that from a geological perspective is simply unfounded."[138]

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[131] Ibid.

[132] Ibid.

[133] Ibid.

[134] E-mail, dated August 26, 2015, from the office of Herr Jürgen Trittin MdB, *Die Grünen* (The Green Party) in answer to my query as to whether the individual German states (*L*änder) could ban fracking. He further pointed out that there has been a push by states with Green Party participartion in the government to implement a fracking ban in the *Bundesrat* (State Council), but even if approved, it would not constitute an official ban.

[135] Ibid.

[136] Ibid.

[137] Ibid.

[138] Ibid.

While there is no way of knowing whether Dr. Kümpel's views had any impact, but the original framework document was revised in November 2014, stating that

> exceptions can be made following successful test measures and commercial fracking may be permitted provided an independent expert commission votes positively with respect to environmental impact and earthquake security; the relevant German federal state authorities must additionally approve these activities. The vote of the expert commission is not binding for German federal state authorities.[139]

On April 21, 2015, the German *Bundeskabinett introduced a bill regularting hydraulic fracturing in Germany that* is still pending.[140] This legislation, if passed, allows for commercial fracking in areas until 3,000 meters depth are reached, and includes several loopholes for fracking activities.

As part of a concerted effort by Germany to reduce its dependence on fossil fuels and lower its emission of CO_2, the government of Chancellor Angela Merkel has embarked on an *Energiewende* (Energy Transition) that is primarily based on renewables, principally solar and wind.[141] While the EU has set a series of renewable energy targets in which approximately 35 % of Europe's electricity is projected to come from renewable sources, Germany's *Energiewende* is targeted to go further. By 2025, Germany aims to produce 40–45 % of its electricity from renewable sources, rising to at least 80 % by 2050.[142]

The *Energiewende* has been accelerated by the government's decision to shut down all of Germany's nuclear power plants by 2022 in the aftermath of the Fukushima disaster in Japan in 2011. Eight nuclear reactors have already been shut down, and there are nine remaining.[143]

A key part of the *Energiewende* is what some locals call the "*Stromautobahn*," "electricity corridor" from Wilster, in Schleswig-Holstein on the North Sea, southward to Germany's industrial corridor in Hesse and northern Bavaria, a distance of more than 300 mi.[144] This grid of electrical transmission lines will carry electrical power, primarily generated by wind turbines in the North Sea. In early 2014, Chancellor Merkel stated that "No country of Germany's scale has pursued such a radical shift in its energy supply."[145] One German government estimate projects that by 2040, the *Energiewende* will have cost up to €1 trillion or about $1.4 trillion (US), which is about one-half of Germany's GDP.[146] This cost is

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[139]Ibid.

[140]Ibid.

[141]Karnitshnig, Matthew, "Germany's Expensive Energy Gamble," *The Wall Street Journal* (August 27, 2014). A1 and A8. Also, Schreurs, "Germany's Moratorium on Shale Development," presentation at the University of Pittsburgh, March 19, 2015.

[142]Ibid., A8.

[143]Schreurs, "Germany Moratorium on Shale Development," presentation at the University of Pittsburgh, March 19, 2015.

[144]Karnitschnig, "Germany's Expensive Energy Gamble," A8.

[145]Ibid.

[146]Ibid.

nearly as much as the country spent on the reunification of East and West Germany.[147]

In that shale gas is a less harmful fossil fuel in terms of contributing to climate warming, it might be considered as part of the *Energiewende*'s transition to its carbon-free energy goal. In a section of the German Advisory Council on the Environment (SRU) report cited above, the issue of unconventional drilling is discussed in terms of a potential transition to a low- or non-carbon energy development. One of the key points in its conclusion is the eventual cost of the production of shale gas relative to other sources of natural gas. While not referring directly to the Oxford Institute of Energy Studies (OIES) estimates of the costs of European shale production versus other sources of supply by 2020 (see "The British Situation" above), the conclusion is the same, and thus would not be a positive contributor to the *Energiewende*.[148] The OIES's best-case outcome for Germany was that shale gas would be $11.50 (US) per tcf (thousand cubic feet) and the worst-case scenario would be approximately $15.00 (US) per tcf.[149] All of the external sources of natural gas for Germany are predicted between $2.50 (US) to $8.00 (US) per tcf.[150] In terms of achieving the production stage of shale gas, Germany is moving very slowly.

Germany has a fairly stable backup plan if it fails to reach the plateaus of self-sufficiency through the use of renewables, which is central to the *Energiewende*. That is, the Nord Stream pipeline links Russia and Germany directly, which runs under the Baltic Sea. Although a joint stock company, Russia's *Gazprom* owns a 51 % share, and its CEO is former German Chancellor, Gerhard Schröder. Conveniently, at least from Russia's vantage point, it bypasses the Baltic States and Poland. At the time the deal was consummated in 2005, the Nord Stream was derisively referred to by many Europeans outside Germany as the "Molotov-Ribbentrop" pipeline, thus conjuring up the memory of the August 23, 1939, non-aggression pact and its "secret protocol."[151]

Germany's commitment to the *Energiewende* has put a damper on shale gas exploration. The Federal Government's adherence to the development of renewables, especially wind and solar, along with the high degree of public opposition to hydraulic fracturing, places Germany at the end of the line insofar as the production of shale is concerned among the individual countries considered in this report.

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[147] Ibid.

[148] SRU (German Advisory Council on the Environment), *Fracking for Shale Gas Production*, A contribution to its appraisal in the context of energy and environment policy, Statement (May 2013). Section 3, "Shale gas in the context of the *German Energiewende*", 9–10.

[149] UK Parliamentary Report, Shale Gas, 25. Figure 4—estimated costs of European shale gas versus other supplies in 2020. Source: Memorandum from Ofgem (Ev w13).

[150] Ibid.

[151] Högselius, 212–216 *passim*.

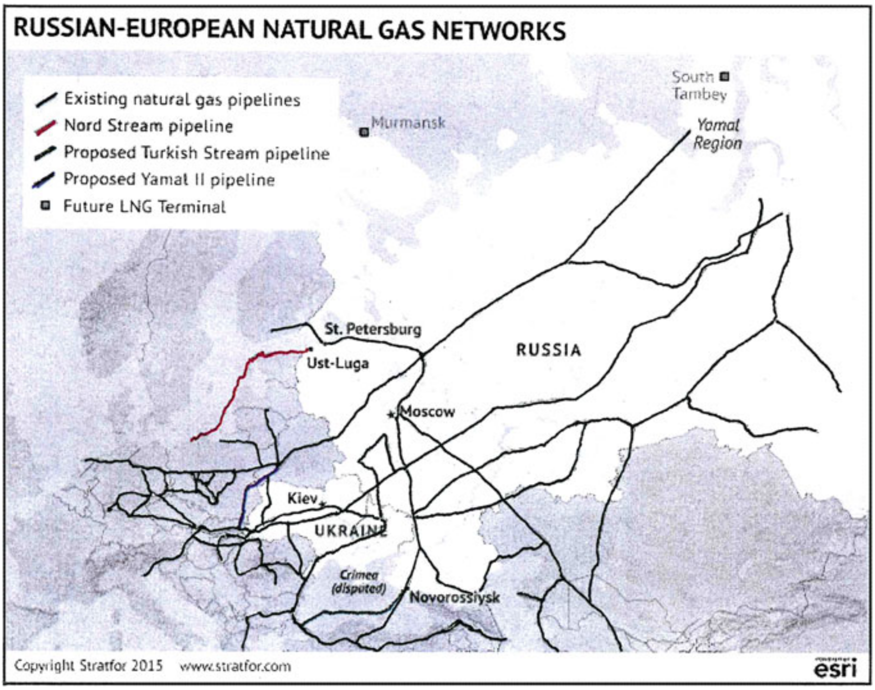

Fig. 7 Russian-European natural gas network, Stratfor, 2015

Conclusion

It is fairly clear that the existence of potentially large plays of shale formations containing natural gas throughout Europe is not going to result in a natural gas bonanza as it has in the USA during the last decade. The potential estimates of recoverable gas from shale formations have not lived up to expectations. The most noticeable example was the announcement in January 2015 by Chevron that it has stopped exploring for shale gas in Poland. The fact that Exxon Mobil, Total, and Marathon Oil have quit Poland since 2012 is further evidence that Poland is no energy "Shangrila" either for Poland or Europe as a whole.

In addition, the shale formations in Poland are not as pliable as those in the Barnett and Marcellus shale in the USA. They are more plastic-like and difficult to fracture compared with the harder and more easily penetrable calcium carbonate formations in the USA. Estimates on comparative costs of extracting shale gas per thousand cubic feet (tcf) projecting them out only to 2020 are considerably higher than importing gas from foreign suppliers. This is the case for Germany as well.

While a major emphasis for pursuing shale gas in Europe is to make it less dependent on Russian natural gas, which has been a mainstay in Europe's energy supply system since the late 1960s, but equally important is the goal of combatting global warming by significantly reducing CO_2 emissions into the atmosphere. In that natural gas is substantially less of an atmosphere pollutant than coal or oil; it has been argued that natural gas, extracted by hydraulic fracturing, makes a practical transition in the quest to make Europe as carbon-free as possible. However, in the Polish case, its government has opted for continuing the use traditional fossil fuels, especially coal, as the basis for its generation of electricity at least up until 2050. There is little doubt that the Polish government places greater emphasis on its energy security than it does on reversing global warming.

The United Kingdom is probably on the cusp of beginning to produce shale gas, which will constitute a substantial addition to its energy security, but it will never be sufficient enough to make Britain energy independent. It will always have to import energy resources.

The most ambitious undertaking to become carbon-free is the German *Energiewende*, which places its goals and expenditures on renewables, wind and solar. This policy has been a cause and an effect of massive public opposition to unconventional drilling involving hydraulic fracturing. If worst comes to worst, Germany still has access to conventional natural gas transported by the Nord Stream Pipeline that directly links Germany to Russia under the North Sea.

For the time-being, France and Bulgaria have opted out of exploring for shale gas. France can afford to be content because of its heavy reliance on nuclear energy. Bulgaria wishes to maintain a certain degree of dependence on Russia for natural gas so as not to alienate Moscow any more than it has already by joining NATO and the EU. The next-emerging country could be Romania, where exploration was authorized in late 2013.[152] As for an EU policy on energy, it is a goal for its 28 members, but each member is free to choose its own path to energy independence. As of yet, there is no "ever closer union" within the EU insofar as energy development is concerned.

A major cost-related factor in natural gas production, whether conventional or unconventional, is transportation. The UK Parliamentary report on shale gas emphasizes that natural gas is essentially a regional, rather than a truly global market because of the "tyranny of distance."[153] The high cost of transportation of liquefied natural gas (LNG) is both a high-value, low-value commodity relative to distance and the type of transport. Building LNG facilities for super-cooling and regasification are expensive in addition to building a fleet of natural gas container ships. These distances, along with the cost of transport, will restrict such trade to specific regions, leading to a range of regional pacts. Oil, on the other hand, has much more flexibility in terms of transport and trade and is priced in dollars globally. Thus, pipelines, directly linking the source with the user, will remain the

[152]IASS Fact Sheet 1/2015, "Shale Gas and Fracking in Europe," (June 2015) 5.

[153]UK Parliamentary Report, Shale Gas, 24.

most cost-effective way to transport natural gas (Fig. 7). A substantial pipeline grid for natural gas is already in existence, and new pipelines are planned, thus ensuring them as the most cost-efficient way to transport natural gas. In such a case, Russia will remain a significant supplier of natural gas to Europe.

Shale Development and China

Haitao Guo, Yongsheng Wang and Zhongmin Wang

Abstract China is currently the only Asian country producing shale gas commercially. Shale development in China faces both opportunities and challenges. Natural gas accounts for a small percentage of China's energy consumption, but the vast shale gas reserve in China provides great potential for development. The lower emissions of natural gas compared to other fossil fuels present China with much needed environmental benefits. However, technological difficulties due to geological formations, water shortage, and monopolistic nature of China's oil and gas industry tempered the incentive to invest. Market reforms and technological advancements could speed up the development of shale in China.

Introduction

China is the first and only country in Asia producing shale gas commercially. The shale revolution in the USA has significantly inspired shale development in China. Shale development, if successful, could have two major impacts in China: increasing energy security and improving the environment. In the past, natural gas accounted for a small percentage of China's energy consumption. In recent years, China promoted natural gas consumption, which reached 5.6 % of China's energy consumption in 2014. However, it is still far below 23.7 %, the average level of natural gas consumption in the world.

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While shale development in China is moving forward, several obstacles emerged, including geology, market structure, and regulation. First, the rich shale reserves in China are located in deep formations and surrounded with difficult terrain which created technical challenges to development. Second, oil and gas industry in China has been monopolistic in nature for a long time which limited the number of companies capable of shale development even after the significant effort of attracting market capital from the Ministry of Land and Resources.

In June, 2014, China's National Energy Administration announced its plan to adjust the goal of shale gas production from the original range between 60 billion cubic meters (Bcm) and 100–30 Bcm. The momentum of development was further tempered by the following downturn of international oil price. It was reflected through much smaller size of investments from the winning bidders of the second round national shale resource auction. Only large state-owned companies such as China National Petroleum Corporation (CNPC) and China Petrochemical Corporation (Sinopec) increased their investment. Due to lack of participation, Ministry of Land and Resources postponed its shale resource auction which was scheduled in June, 2015. The rest of the chapter will give some background information on shale gas reserve, energy consumption, and energy supply in China and discuss the major challenges for shale gas development.

Background

Shale Gas Reserve in China

China has vast shale gas reserve. In 2011, US Energy Information Agency (EIA) ranked China as the number one country of retrievable shale gas resources with 36 trillion cubic meters,[1] while the Ministry of Land and Resources of China reported its own estimate of 25.08 trillion cubic meters.[2] Chinese Central Government put high hope on shale gas and its potential impact on energy independence, energy consumption, and environment. Not only state-owned companies such as CNPC and Sinopec are actively involved, but also many private companies participated in the two rounds of shale gas right auction organized by the Ministry of Land and Resources.

Chinese oil and gas industry still has some concerns about the potential of shale. Compared to the USA where tens of thousands of shale wells were drilled, there were

[1]World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the USA, EIA, April 2011, http://www.eia.gov/analysis/studies/worldshalegas/archive/2011/pdf/fullreport.pdf, (retrieved on 8/8/2015).

[2]National shale gas resource survey and rich area selection report (2011) http://wenku.baidu.com/link?url=MTVfZG-v3B_hOCnBfxBTSy1NOUrKFM8g6be6tirxQCKpeUIK0QB4OZEYcbElKDoosjaG6gQxI4ZZF98MHwMCd-azWq1g7ayCge5d4Xpf0US, (retrieved on 8/8/2015).

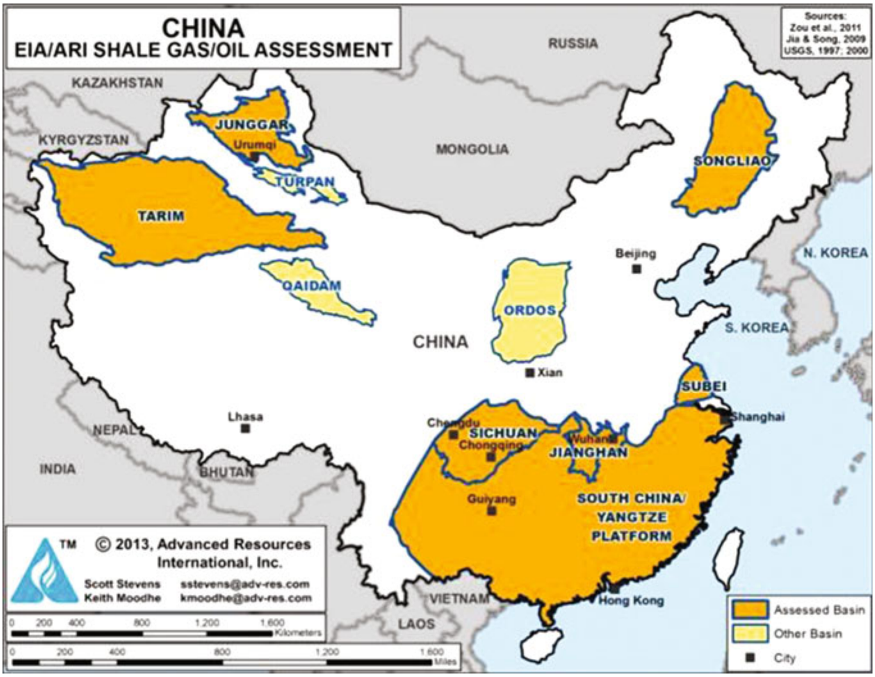

Fig. 1 Shale plays in China. *Source* US Energy Information Administration and Advanced Resources International. http://www.eia.gov/todayinenergy/detail.cfm?id=13491 (retrieved on 6/14/2015)

only 780 shale wells in China in 2014.[3] Of course, China is still at a very early stage of its shale development and did not have its first horizontal drilling well until 2011.[4] The estimate of recoverable shale gas varies across different agencies (Fig. 1).

Consumption of Natural Gas in China

With the fast growth of the economy, especially since 2000, the demand of energy increased significantly in China. However, the devastating consequence of pollution from coal consumption pushed for the change of energy consumption and more efficient energy sources with less environmental impacts. With the support of governmental policies, natural gas consumption increased gradually. Before 2000,

[3]China Shale Resources Survey Report (2014), The Bureau of Geological Survey, the Ministry of Land and Resources, http://www.cgs.gov.cn/UploadFiles/2015_06/24/20150624093321310.pdf (retrieved on 8/8/2015).

[4]http://news.cnpc.com.cn/system/2011/08/05/001343687.shtml.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total Primary Energy Consumption	1791.4	1961.5	2133.7	2213.3	2312.5	2471.2	2679.7	2794.5	2898.1	2972.1
Total Natural Gas Consumption	43.5	52.2	65.6	75.6	83.2	99.4	121.4	136.0	153.7	166.9
Total Natural Gas Consumption (BCM)	48.3	58.0	72.9	84.0	92.5	110.5	134.9	151.2	170.8	185.5
%	2.43%	2.66%	3.07%	3.42%	3.60%	4.02%	4.53%	4.87%	5.30%	5.62%

Fig. 2 Natural gas consumption in China (Million tonnes oil equivalent, Mtoe). *Source* BP Statistical Review of World Energy, June (2015)

natural gas only accounted for around 2 % in the total energy consumption. Between 2003 and 2013, natural gas consumption kept double-digit growth annually and increased from 30 Bcm in 2002 to 185.5 Bcm in 2014 which was about 5.62 % of the total energy consumption according to BP Statistical Review of World Energy (2015) (Fig. 2).

In 2014, the growth of natural gas consumption slowed down quite bit due to the slowing economy, cheaper price of coal, and domestic natural gas pricing challenges. It is only temporary. The natural gas consumption potential in China is huge and still an important part of governmental campaign on "Anti-pollution for Cleaner Atmosphere."

In China, natural gas is mainly for energy uses in household, transportation, industry, and power generation. Due to the challenge of domestic pricing, natural gas is not competitive for industrial and power generation uses. To a certain extent, it hindered the expansion of natural gas consumption. China is ahead of the world on using natural gas as a transportation fuel for vehicle and ship. Between 1999 and 2009, China pushed for the campaign of "Clean Car" and provided supporting policies. By 2013, there were 1.87 million natural gas vehicles in China and maintained an annual growth of 100,000 unit.[5]

However, changes of domestic policies on oil and natural gas created problems to maintain this growth. In 2010, National Development and Reform Commission (NDRC) announced that the price ratio between natural gas and #90 gas must not be lower than 0.75–1. After that, the price of natural gas as vehicle fuel increased around the country and caused the decreased sales of LNG heavy trucks. In 2013, the situation deteriorated together with the high cost of LNG on the market.[6] Domestically produced natural gas is much cheaper than imported ones through either international pipelines or ships (LNG). Compressed natural gas (CNG) has lower technological requirement and can be easily produced domestically. It is also an alternative to fuel natural gas trucks. Thus, it is much more competitive on the market than LNG which is mainly imported with high cost. In the first half of 2015,

[5]http://wap.cnpc.com.cn/system/2015/02/01/001527029.shtml, (retrieved on 8/8/2015).
[6]Ibid.

	2000	2005	2006	2007	2008	2009	2010	2011	2012
Residential	13.2%	17.0%	18.3%	20.3%	20.9%	19.9%	21.2%	20.3%	19.7%
Commercial (Transportation, Warehouse, and Postal)	3.6%	8.1%	8.4%	6.6%	8.8%	10.2%	10.0%	10.6%	10.6%
Industrial	78.6%	66.3%	63.1%	58.0%	56.3%	50.3%	46.8%	47.8%	49.3%
Sub: Chemical	36.2%	30.2%	31.6%	29.4%	24.6%	19.8%	17.5%	17.9%	17.1%
Power Generation	2.6%	4.0%	5.3%	10.0%	9.1%	14.3%	16.9%	16.5%	15.4%

Fig. 3 Natural gas consumption structure in China. *Source* Chinese Statistical Yearbook, 2014

the sales of LNG bus increased, but not the LNG heavy truck. The reason for these two different trends of sales is that public transportation gets more policy support and has less pressure on cost.[7] Thus, the future direction heavily relies on changes of governmental pricing policies (Fig. 3).

Domestic Natural Gas Supply, Current Sources of International Supply

In 2014, the recoverable natural gas was estimated as 3.5 trillion cubic meters, 164 % increase from 2002, and production was 134.5 Bcm, 299 % increase. China moved on the world natural gas production across countries ranking from 16 in 2000 to 6 in 2014. Demand in China increased 515 % compared to that of 2002 which is about twice the amount of the increase in production during the same period. Due to the shortage, import becomes more and more important.

With the increase of dependence on imports, China has been pushing the diversification of sources of natural gas imports. It gets natural gas through pipelines and ships. Pipeline is less flexible than ships in terms of transporting natural gas. Once, it is set up. Pipeline can contribute to the transportation capacity right away. Between 2010 and 2014, the imports through pipelines increased from 3.55 to 31.3 Bcm. Two key pipelines are the Central Asia–China gas pipeline and Sino-Myanmar gas pipeline. LNG imports by ship increase steadily. They are mainly from Australia, Indonesia, Malaysia, and Qatar. In 2014, the total amount reached 27.1 Bcm and accounted for 44.5 % of total natural gas import. There are several more pipelines are either under construction or under agreement. The D line of the Central Asia–China gas pipeline is under construction and will be completed in 2016 which will increase the total capacity of the Central Asia–China gas pipeline to 85 Bcm. China and Russia gas deal expects to increase the capacity to 68 Bcm once both the eastern and western routes are completed. The maximum capacity of the Sino-Myanmar gas pipeline is 12 Bcm. The total capacity of the

[7]http://www.cet.com.cn/nypd/trq/1591789.shtml, (retrieved on 8/8/2015).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Reserve (Tcm)	1.6	1.7	2.3	2.8	2.9	2.8	3.0	3.2	3.5	3.5
Production (Bcm)	51.0	60.5	71.5	83.0	88.1	99.0	108.8	114.3	124.9	134.5
Consumption (Bcm)	48.3	58.0	72.9	84.0	92.5	110.5	134.9	151.2	170.8	185.5
Excess Demand (Bcm)	2.6	2.5	-1.3	-1.0	-4.4	-11.5	-26.0	-36.9	-45.9	-51.0
Import Dependence	-	-	1.8 %	1.2 %	4.7 %	11.3 %	21.3%	26.8 %	27.6 %	32.2 %

Fig. 4 China natural gas consumption and production comparison. *Source* BP Statistical Review of World Energy (2015)

above three major pipelines should eventually reach the capacity of 165 Bcm. Shale gas boom in the USA completely changed natural gas shortage on the international market. There could be more LNG available from different regions, e.g., the Middle East, East Africa, and Canada, coming to Asian market (Fig. 4).

Shale Gas Production and Demand Challenges

The vast shale reserve in China attracted energy companies around the world, especially from North America to enter the market and form joint ventures with major state-owned corporations (SOC) such as CNPC, Sinopec, and China National offshore Oil Corporation (CNOOC). These three SOCs dominate natural gas production. According to the annual financial report of CNPC (2014) and the presidential speech of CNPC on the 25th World Gas Conference, CNPC alone provides 70 % of national natural gas supply and operates 78 % of natural gas pipeline.[8] In China, shale-related joint venture started in 2007 (Gao 2012). In 2012, National Energy Administration announced the first national plan on shale gas development during the 12th five-year national economic plan period (2011–2015). The goal is to complete the national survey of shale resources and reach the production of 6.5 Bcm annually by 2015. In 2014, shale gas output in China reached 4.9 Bcm (173 Bcf) which is a 42 % increase compared to the year before,[9] although, by comparison, it is a pretty small amount which is less than 2 % of the production in the USA. According to the Ministry of Land and Resources (MLR), the national target of shale gas production is to reach 30 Bcm (1059 Bcf) per year by 2020 which is less than 10 % of the level of production in the USA in 2013 and 50 % of the original proposed level several years ago. Why the No. 1 country of shale gas reserve sets up such a low target? It is due to multiple layers of challenges from geology, mineral rights, market structure, technology, and water shortage.

[8]http://www.cnpc.com.cn/en/speeches/201407/658c2d0d1abc4624b515aaf0798e91cc.shtml.

[9]http://www.platts.com/latest-news/natural-gas/singapore/chinas-2014-unconventional-gas-output-soars-42-27013858 (Retrieved on 8/8/2015).

Major Shale Gas Supply Challenges: Geology and Technology

Geological nature of shale gas reserve in China is not the best. It is scatted and deep. The most favorable shale play is at Sichuan Basin, a highly populated agricultural region. But, it is famous for its rough terrain surrounding the area and transportation difficulty. CNPC and Shell have a production-sharing contract to develop shale gas in this region. Stevens et al. (2013) mentioned that Shell found the good potential in the area through its drilling and testing, but the geology is not favorable. Sichuan is situated at one of the active fault zones of earthquakes. This tough geology scared private investors away, but major SOCs committed to keep up their domestic shale gas investment, especially CNPC and Sinopec. They have made technical progresses over time. CNPC made significant breakthroughs on horizontal fracking stages and minor earthquake detection; Sinopec had advancement on drilling equipment and fluids; and CNOOC built its own drilling design capability.[10] Joint exploration with foreign energy companies is very important in technology development. In addition to Shell, CNPC has agreement with ConocoPhillips, Chevron, Exxon Mobil, and Hess.[11] So far, Sinopec took the lead in shale gas production with the help from the successful Fuling field in Sichuan. It plans to produce 5 Bcm in 2015[12] which is 77 % of national annual production target. However, these breakthroughs are not enough to warrant the original national shale development goal as stated earlier. Due to the geological differences, shale gas drilling in China faces significant technological challenges even with the help of the joint-venture partners from the US SOCs and their partners have to develop a set of unique technology for shale formations locally which is capital-intensive, risky, and time-consuming.

The inferior geology compared to the American shale gas fields put SOCs and their foreign partners in a significant disadvantage. After billions of RMBs of initial investment, companies are slowing down their effort although they are still pushing forward. SOCs not only operate from a regular business perspective, but also have to follow both long- and short-term policy changes from the Central Government, the largest shareholder of these companies. Central Government concerns about not just revenues from SOCs, but public interest, e.g., energy security and market stability. In China, mineral resources are nationally owned. The dominance of oil and gas SOCs brings them the benefit of occupying the best resources and relaxed policy environment for exploration. Essentially, this is a shared monopoly between the Central Government and those SOCs through which the government decides pricing and SOCs manage the production. This relationship was established through laws and regulations. Potentially, these laws and regulations make it possible for SOCs to sit on the resources with not much action. In particular, under the recent

[10]http://finance.chinanews.com/ny/2013/03-19/4654512.shtml.

[11]http://www.epmag.com/momentum-builds-chinas-emerging-shale-gas-sector-778291#p=full.

[12]*PetroChina behind Sinopec in China's shale gas race,* Lucy Hornby and Julie Zhu, Financial Times, 8/28/2014.

downturn of oil and gas market, this kind of legal framework gives breathing space for SOCs.

Here are some examples of these laws and regulations. The Law of Mineral Resources states that the application and permission of the exploration of special mineral resources such as oil, natural gas, and radioactive materials must be reviewed and granted by the State Council. The Regulation of the Registration of Mineral Resources Exploration requires that, for any crude oil and natural gas exploration, agents must provide either the direct permit from the State Council on the establishment of an oil company or the direct permit of crude oil and natural gas exploration activity together with its corporation legal charter. The Regulation of International Cooperation on Oceanic Oil Resource Exploration granted CNOOC the exclusive right to represent China on all international cooperation activities on oceanic oil resource exploration. Until now, there are only four companies were granted oil and gas exploration rights including the three dominant SOCs and Shanxi Yanchang Petroleum Corporation.

Once the exploration starts, the dominant SOCs have further regulatory protection to hold their exploration rights for a long time. The Regulation of Mineral Exploration Control states that (1) the one-time permit of oil and gas exploration is for seven years; (2) the fee of exploration is 100 Yuan per square kilometer (km^2) for the first three years and will increase by 100 Yuan per year starting on the fourth year, but the maximum limit is 500 Yuan/km^2.[13] So far, the exploration size of the big three SOCs is about 4 million km^2.[14] Even under the maximum, the total exploration fee is only 20 million (Billion) Yuan ($3.2, Billion) annually which is a small amount compared to the annual revenue of these SOCs.[15] The operating revenue for CNPC in 2014 is 2.73 trillion Yuan ($440 billion).[16] The low fee enables these SOCs to occupy the best land first without speedy exploration. The rolling permit for exploration can be as long as 15 years. During the production phase, the fee for mineral right usage is 1000 Yuan/km^2 ($417/$mi^2$) annually, a small amount and not linked with the volume extracted. Additionally, SOCs also have sales control. In 2001, the State Council consolidated the wholesale and retail oil market. Only CNPC and Sinopec can sell oil product on their own. All other oil companies must follow the national allocation. It is similar situation for natural gas market. CNPC controls pretty much most natural gas pipelines, whereas CNOOC controls most of the LNG imports.

The decreased level of subsidy and high drilling cost are not helpful in shale exploration. The shale gas subsidy is 0.4 Yuan/m^3 ($1.8/MCF). According to the Ministry of Finance, the subsidy on shale gas will be decreased to 0.3 Yuan/m^3

[13]The limit is equivalent to around $209 per square mile per year based on the exchange rate in June, 2015.

[14]http://companies.caixin.com/2015-07-07/100826287.html (Retrieved on 9/13/2015).

[15]Exchange rate used for the paper is 6.21 Yuan/$ on June 17, 2015.

[16]Annual Report of CNPC (2014).

from 2016 to 2018 and 0.2 Yuan from 2019 to 2020.[17] For Sinopec, the drilling cost of a typical shale gas well with the lateral length under 5000 ft is close to 70 million Yuan ($11 million).[18] In comparison, similar size well costs around $6 million in Marcellus Shale Play in the USA. The average cost of CNPC shale gas wells in Sichuan is around 55 million Yuan ($8.9 million).[19]

Shale gas drilling is water-intensive. The shale gas development in China is still in its early stage. With the progressing of its development, the challenge of water and wastewater disposal will emerge soon. Although the Yangtze River, the largest river in China accounting for 52 % of national total surface water runoff,[20] flows through Sichuan Province, this river has to provide many other needs, e.g., drinking, irrigation, and industrial, in addition to shale gas drilling. Water shortage is one of the top hurdles for the economic development in China. Are the over-burdened Yangtze River or local aquifers able to support the significant demand from shale gas wells? Yangtze River is in southern China. Currently, part of the water of Yangtze River is transported through pipes to northern China due to its severe water shortage. A single shale gas well could require between 7.2 and 25.5 million liters of water with 25–90 % of consumptive use (Reig et al. 2014). The more complicated issue is fracking wastewater disposal. It may not be on the top of the list of shale gas drilling development at this moment due to the small number of wells drilled. Lower the water usage is one way to decrease the drilling cost. One way is to use non-water-based drilling, e.g., high-pressure air drilling.

Major Demand Challenges

It is hard to understand that an energy thirsty country like China would have trouble to consume natural gas. There are two major reasons: cheap price of coal as an energy substitute and the complicated domestic natural gas pricing structure. Natural gas is priced by the government in China. Although the imported natural gas is pretty high, the government was able to lower the natural gas price for end users through subsidy and lower the price of natural gas from domestic producers. It created an inefficient pricing pattern of the upstream providing subsidy to the downstream. In 2014, average residential natural gas price from shale gas field in Sichuan is 1.47 Yuan/m^3 ($8.52/MCF plus governmental subsidy) lower than the average residential natural gas price in major shale gas area in the USA ($11.68 in Pennsylvania and $11.02 in Texas)[21] (Fig. 5).

[17] *Beijing plans curbs on shale gas subsidies,* Lucy Hornby, Financial Times, 4/29/2015.

[18] Ibid.

[19] Ibid.

[20] *Impending Water Crisis in China*, Nina Brooks, the Arlington Institute. http://www.arlingtoninstitute.org/wbp/global-water-crisis/457.

[21] http://www.china5e.com/news/news-904692-1.html.

	2007	2008	2009	2010	2011	2012
Well site	1.1	1.1	1.1	1.2	1.3	1.3
City Gate	1.5	1.5	1.5	1.6	1.7	1.7
Residential	2.2	2.3	2.4	2.5	2.5	2.4
Industrial	2.5	2.6	2.7	2.9	3.1	3.2

Fig. 5 Natural gas price in China (RMB/m^3). *Source* Industry forecast, China International Capital Corporation Limited, 2013

Residential Gas Pricing

In China, residential gas price is comprised of two parts: city gate price and city gas transportation fee. Although the government is pushing for market-oriented price reform, the current pricing still follows the traditional way of segmented management. NDRC decides city gate price and local government is in charge of local sale price. The basis of pricing is company cost. Normally, NDRC considers the distance of pipeline to determine provincial-level city gate price. Natural gas management companies from each province add local pipeline fees to form the price for cities within the province. Finally, city gas companies will add their own pipeline fees to form the sales price for local residents. City gas companies have no choice, but to accept gas from the provincial gas companies. The wholesale price accounts for about 70 % of the total cost of city gas companies. Since these provincial and city gas companies are pure monopolies, local sale price is not market price. However, local city gas companies do not enjoy their monopolistic market position because they do not have right to price their own product which is controlled by the pricing department of the local governments. This local governmental pricing department is one of the last marks of past planning economy in China. They arbitrarily determined the residential sales price without considering the high cost of local city gas companies servicing low and uncertain household consumption. Thus, it is hard to cover its cost of operation. The imported LNG follows similar pricing process once it enters the pipeline. Due to the non-market pricing process, there is no incentive for LNG importers to push for sales through pipelines. As long as it stays away from pipeline, LNG can enjoy free market pricing. Depressed local natural gas price and high drilling cost dilute the benefit of market power from drilling right and discourage SOCs to speed up shale gas exploration in the short run.

Gas Pricing for Industrial and Power Generation

Industrial and power generation users of natural gas pay much high price than residents, which discourages the uses of natural gas in China. In developed countries, different users vary significantly in terms of their sensitivity to prices. Power generation is most sensitive and usually has the lowest price, industrial and

	China	U.S.	U.K.	Japan	Korea	Germany
Proportion of Gas Power Generator out of Total Power Generators	3.4	40	36	28	21	-
Proportion of Gas Power Generation out of Total Power Generation	2.5	30	41	-	-	10.5
Proportion of Gas Usage in Power Generation out of Total Natural Gas Consumption	17.2	39	34	70	46	26

Fig. 6 Gas power generation across countries (%). *Source* Oil observer (2015). http://www.oilobserver.com/tendency/article/1544

commercial users the second, and residents the last. Normally, in the USA, the ratio between industrial price and residential price is between 0.4 and 0.5. Canada and France have similar situation (Hu and Dong 2015). The prices among different users are quite different in China with the residential price the lowest and high prices for industrial and power generation. Usually, the ratio between residential price and industrial price is between 1.1 and 1.3. In 2013, residential natural gas supply accounted for 80 % of the business of local city natural gas supplying companies and the profit was negative; their key profit source was industrial and commercial businesses. The price of industrial and commercial was 3.61 RMB/m^3 and 0.91 RMB more than that of residential users. For local companies, city gate price is the same for all users. Gross profit margin from industrial and commercial natural gas could reach 25 % (Li and Chen 2013). This imbalanced pricing system among different users depresses power generation and industrial use of natural gas.

In addition, the feed-in tariff for gas power generation is provincial government control and varies across regions which significantly hinder the demand of natural gas. So far, there is only peak load pricing in Shanghai and surrounding area. The rest of the country still follows the one-price tradition which means each power plant charges one price for its power. This government-controlled pricing is inflexible. With the fast economic development, many metropolitan cities in China suffer high peak–trough difference, high seasonal difference, and low load factor of power demand. Compared to coal and nuclear power, natural gas power plant is more flexible in switching and able to provide power relatively quickly during the peak season. Power plants supposed to charge peak load price during the peak season. However, it is hard to realize that during the current one-price scheme. Many developed countries allow peak load prices.[22] The peak load price can be 1.8–2 times of the normal level of feed-in tariff and 3–5 times of the trough price (Fan et al. 2015).

Natural gas accounts for an increasing level of power generation in developed countries. Gao (2013) shows that during the ten years before 2013, 80 % of newly

[22] http://www.nea.gov.cn/2012-02/10/c_131402513.htm, (retrieved on 8/8/2015).

increased capacity of power generation came from natural gas power plants. As showed in Fig. 6, less than 5 % of power generators in China is gas power generator. There is also less than 5 % power in China generated by gas. That proportion of gas power generator is more than 30 % in the USA, the UK, and Japan.

Until now, there is still no regulation or policy on how to determine the peak load price. It would be helpful if there is seasonal and timing differentiated market pricing policy. In this way, there would be higher demand on natural gas for power generation.

Natural Gas Imports

Approximately 30 % of natural gas consumption in China is from import. Increasing natural gas consumption is a national priority. In the long run, the potential of shale gas is huge. According to the recent forecast from BP, the production of shale gas in China could account for 13 % of the global production. Together with the USA, both countries could provide 85 % shale gas on the world (BP 2015). The inefficient pricing caused significant losses for natural gas importing companies. For example, CNPC lost more than 20 billion RMB and 41.9 billion RMB in 2011 and 2012, respectively, due to its import operation from the Central Asia–China gas pipeline. After government subsidy in 2013, it still lost more than 40 billion RMB.[23] In 2014, CNPC lost 17.68 billion RMB from the natural gas import from the Central Asia–China gas pipeline, 20.45 billion RMB from the LNG import, and 3.47 billion RMB from the Sino-Myanmar gas pipeline import according to CNPC Annual Report (2015). CNOOC started its LNG import operation much earlier and is still able to profitable due to the low price on the long-term contracts. However, it is also facing the profit erosion from the higher price on the new contracts.

The low end user price is realized through lower city gate prices. Compared to the prices from international pipeline and imported LNG, the city gate prices in China are too low. For example, in 2012, the receiving price at the Khorgos terminal from Turkmenistan was from 1.8 to 2.6 RMB/m^3. The price of sending it to Guangdong Province was from 2.6 to 3.4 RMB/m^3 after the 0.8 RMB/m^3 pipeline fee. The maximum governmental city gate price in Guangdong was 2.74 RMB/m^3 which left no space for profit for natural gas supply companies.[24] The price from domestic suppliers was 1.3 RMB/m^3 in 2012 which was much lower than the price from international pipeline. However, government required the same city gas price for all natural gas transporting through long-distance pipeline, which

[23] http://business.sohu.com/20140924/n404595757.shtml, (retrieved on 8/8/2015).

[24] http://www.360doc.com/content/14/1016/14/584_417415313.shtml, (retrieved on 8/8/2015).

implies that domestic natural gas entered the market with lower price. It is clear that, sometime, it is not the SOCs' best business interest to import natural gas, but they have to do it based on intergovernmental agreements directed by the Central Government. These agreements are normally long-term. Thus, SOCs have to use the profitable domestic operation to finance its losing importing business. CNPC got 9.4 billion RMB and 10.3 RMB tax subsidy in 2012 and 2013, respectively, for its operation with the Central Asia–China gas pipeline. These subsidies were still much smaller compared to its losses, which means that it is the government and domestic natural gas suppliers shared the burden of losses to ensure the low city gate prices.

Storage Facilities

The natural gas pricing process in China did not consider seasonal peak pricing and regional differences. Li and Qu (2015) showed that the peak and trough ratio of natural gas consumption in Beijing could be as high as 10–1. There are limited gas storage facilities in China which only account for 2.2 % of total annual consumption, while the capacity is 16 and 20.8 % in the USA and EU, respectively.[25] The construction of storage facility is high cost and long duration. Without the peak season price, natural gas companies have no incentives to build these facilities. On the contrary, the storage facilities in the USA and EU often operate independently and enjoy market rate return from peak seasonal price. Under the natural gas consumption level of 310 Bcm, the capacity for seasonal peak usage purposes should be more than 40 Bcm (Qian 2015). The current capacity is 4 Bcm.

Major Competing Energy Substitute: Coal

Low price makes coal a strong substitute for natural gas, especially for power generation purposes. It is a worldwide phenomenon. Zhang and Zhang (2009) showed that the fast growth of natural gas power generation happened under the context of low local natural gas price and high environmental cost of coal. With the decrease of coal price in 2013, the USA experienced the decrease (8.9 %) of natural gas power generation for the first time since 2008 according to BP World Statistical Review (2014). In China, the major power generation is from coal. The dynamics of coal price has much stronger influence on gas power generation. Gradually, there are more natural gas supplies on the market. After satisfying the residential sector, naturally, there will be more gas available for power generation and industry. Cost-effectiveness is the key for gas in power generation. Energy situation in China is often described as "plenty of coal, not enough oil, and lack of gas." It will not change in the short term. In 2014, national average city gate price in China is about

[25] http://cj.gw.com.cn/news/news/2015/0407/200000425236.shtml, (retrieved on 8/8/2015).

2.5 times of that in the USA (Henry Hub). Before the gas price reform in 2013, cost of gas power generation was 100–170 % higher than that of coal power generation. After the reform, gas price went higher and the market price of coal came down. In 2014, the cost difference reached 2–2.5 times. Thus, gas power plants can only operate with the support from government and its own parent company. According to the Chinese Association of Power Plants (2014), if the demand of gas for power generation reaches 68–80 Bcm in 2020 as expected, it will need 76–88 billion RMB governmental subsidies. Such vast financial burden is almost impossible for the governments under the context of slowing economy. Coal has wide impacts on industries, e.g., power generation, steel, construction, and chemical industry. In the short term, it is very unlikely there will be governmental policy focusing on increasing the price of coal. Coal will maintain its competitive edge on the energy market relative to natural gas.

Market Reform and Shale Gas Potential

The future of shale gas development relies on the reform in three areas including technology breakthrough, natural gas pricing, and coal consumption. The first one is in process, but painfully slow and uncertain. Here is an example of city gate price reform. Since 2011, Guangdong Province and Guangxi Province have served as the provincial testing centers of city gate natural gas price. The newly reformed price process starts with the prices of market traded imported heating oil and liquefied petroleum gas which are called the alternative energy source. 60–40 % of the prices of these two alternative energy sources, respectively, comprise the price of alternative energy source of equivalent heating value unit. Then, the city gate price will be 85 % of this newly formed price. Although it is still not a pure market price, at least, its starting point is market based. The rationale behind this calculation is to maintain the pricing advantage of natural gas and encourage more natural gas consumption. So far, this price applies to all non-residential natural gas users in the reform testing regions.

As stated above, it shows that the local residential gas pricing in China is upside down. It starts with a socially acceptable sales price determined by the government, and it is up to natural gas companies to figure out ways to cover their costs. Most companies are state-owned. Thus, if the sales price is lower than the cost, it would be a form of energy subsidy for natural gas users. The current reform for local residential price in cities such as Zhengzhou, Changsha, Shenzhen, and Nanjing is designed in different layers. Price will go higher by layers and get close to free market price. Each layer has a certain volume of consumption. For example, the first layer consumption level is up to 600 m^3/year per household in Zhengzhou and Changsha which is way beyond the normal usage of local families. If the limit of the first layer is this high, it would be pretty hard for any family to consume natural gas based on a free market price. Thus, natural gas companies will not see much sales of gas with a free market price any time soon.

In addition, natural gas price is not independent in China. It is linked with international oil market. Before 2014, there were high oil price on the international market and high coal price domestically. After five times of price adjust (2005, 2007, 2010, 2011, and 2013), natural gas price in China was still pretty low which was only 33 % of the price of crude oil per BTU and much lower than the 65–80 % level in developed countries. In the USA, the level is 80–90 %. This low price was one of the reasons for the relative growing demand for natural gas in China, but natural gas still cannot compete with cheap coal domestically.

According to the experience of developed countries, during the fast developing period, demand of natural gas from power generation increases together with that from residential uses. Once entering the mature period, residential and commercial uses are stable and the main increase is from power generation (Du and Huang 2014). Figure 3 shows that China is following a similar path. However, since 2014, the advantage of natural gas price has decreased with the depressed prices of coal and crude oil. The growth of natural gas demand has been slowing down. In April, 2015, natural gas demand and production even decreased. The low price level of natural gas creates uncertainty for shale gas development. Since price reform is slow, the only factor that could bring an American style shale boom to China is technological breakthrough to lower the cost of drilling. Compared to other kind of natural gas, e.g., regular natural gas and coalbed methane, the cost of shale gas is the highest.

As for minimizing coal consumption, it has obtained consensus from environmental perspective, but the concern from economic growth hinders its progress. The most difficult one is the third one. It goes beyond the oil and gas industry itself. In particular, the reform of the upstream is related to energy security and determines the effectiveness of the reform for the entire industry. Thus, reform of market structure has the most direct impact on shale gas development.

Conclusion

Currently, the key reasons for China to develop shale resource include pollution caused by coal consumption and high dependence on energy import. Based on the experiences of developed countries, low end industries with high energy consumption require high input of resources to clean their pollution. China is still going through its industrialization process. The size of its industries with high energy consumption is enormous and consumes way more coal than did developed countries at the same developmental stage. The best goal for China before 2020 is to figure out how to maintain the status quo without further environmental deterioration.

Although natural gas market is slowing down in China, the demand is still strong and the government policy support on shale gas development will continue. It would be hard to have a fast development of shale gas in the near future. Before 2020, it would be hard to have technological advancement to low the cost of shale gas compared to regular natural gas and coalbed methane; it would be also hard to improve the efficiency of natural gas pricing among various sectors. It would be hard to change the dominant position of SOCs in shale gas development. For SOCs, it is not a good idea to focus on shale development in the short term due to their large holdings on regular natural gas fields and coal fields. From business perspective, it is always wise to develop the ones with lowest cost. The downturn of international oil market brought gloomy future for many SOCs with shale gas operations, especially Sinopec. According to the medium-term oil market report from EIA in 2015, oil price could increase to $73 per barrel in 2020. This price is still lower than the prices before 2014, normally above $100. Many SOCs entered the market during the high price time period around 2012. The future of low prices presents significant challenge to the long-term strategy of these companies. Private capital could not fill in the gap due to its smaller size.

In summary, before 2020, it is not a friendly environment for large shale gas development in China. Even if the shale gas output in 2015 could reach 6.5 Bcm, it would be extremely hard to push the output to 30 Bcm as planned. The future of shale gas development in China mainly depends on the market reform, which could stimulate the investment. Technological advancement could lower the drilling cost and make shale gas more competitive. The extra market demand from power generation could bring more shale gas consumption.

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Shale Gas Development and Japan

Clifford A. Lipscomb, Hisanori Nei, Yongsheng Wang and Sarah J. Kilpatrick

Abstract As the third largest economy on the world, Japan's energy consumption and impact on shale gas development deserves our attention and will have long-term impacts on the global economy. Japan has faced various energy challenges in recent years. In March 2011, the Great East Japan Earthquake caused a tsunami that resulted in the Fukushima Dai-ichi nuclear reactor meltdown and destroyed approximately 110,000 homes, partially destroyed another 140,000 homes, and damaged approximately another 500,000 homes (Japan Real Estate Institute). After the Fukushima disaster, Japan began moving away from nuclear power to alternative energy sources.

Moving forward in time, the conversations began between Japan and various countries as it relates to shale and, in particular, liquefied natural gas (LNG). Natural gas has become an increasingly large component of Japanese energy consumption. Geographic limitations and political constraints are important to consider as it relates to Japan's energy portfolio; as an archipelago, Japan faces

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potential shortages if supply chains are disrupted due to its heavy reliance on natural gas imports. The export of LNG from other countries to Japan, coupled with the abundant global supply of shale gas, has certainly changed Japan's energy portfolio along with that its energy security situation. In this chapter, we explore how global shale gas development has and will continue to affect Japan and the global energy economy.

Introduction

The previous chapters focus on shale resource-rich countries and analyze the economic impact and policy changes in these countries due to shale oil and gas development. In order to have sustainable development, supply cannot be the only side of the economy worthy of focus; one must also pay attention to the demand side of the equation. As of this writing, the recent drop in oil and natural gas prices reflects a combination of strong supply and weak demand.

According to the US Energy Information Administration (EIA), Japan "is the world's largest liquefied natural gas importer, second largest coal importer, and third largest net importer of crude oil and oil products" (EIA 2015). It is the second largest importer of fossil fuels in the world only behind China, based on 2012 EIA data. Japan is the most resource scarce country among top economies in the world. Thus, it plays a critical role on the demand side of the international energy markets. In order to diversify its energy supply, Japan pushed hard on the development of nuclear energy, which used to account for more than 30 % of national power supply before the 2011 Great East Japan Earthquake and subsequent Fukushima disaster. After the disaster, nuclear power in Japan ceased, then briefly restarted, stopped completely again, and restarted again in August 2015. While Japan's long-term energy policy calls for an increase of its nuclear power generation to approximately 20 % of its total power generation by the year of 2030, there is a long way to go for Japan to rebuild its nuclear power generation capability. Natural gas is one of the major energy sources that has filled the significant gap of energy supply in recent years. The extra supply, or glut, of natural gas on the international market from shale gas development helped alleviate the situation, especially the imports of shale gas from the USA, and has also pushed the price of natural gas down significantly in recent months.

However, due to the high cost of transportation and storage, the world natural gas market is still largely regional in nature. According to Fig. 1 below, the price differences among major price points, e.g. UK National Balancing Points (NBP), US Henry Hub, and Japan LNG import price, are enormous. In August 2011, the LNG import price in Japan was approximately $16 per MMBtu, which was about 300 % higher than the price at the US Henry Hub (As of this writing, the price in Japan is approximately $15 per MMBtu). The spot market in Asia is very limited

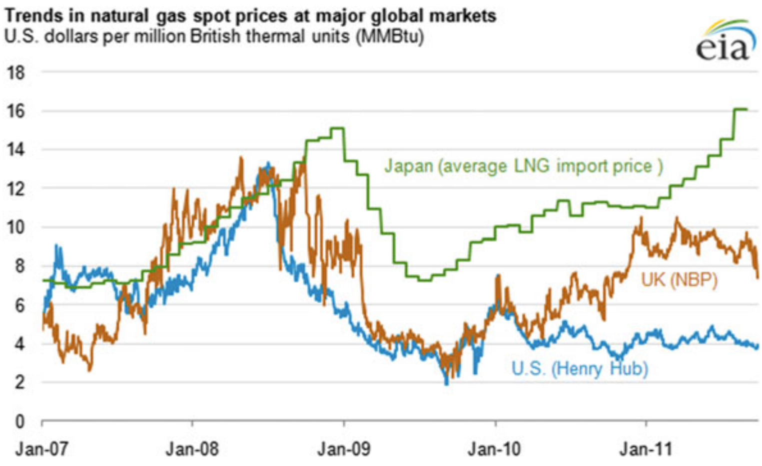


Fig. 1 Trends in natural gas spot prices at major global markets. *Source* U.S. Energy Information Administration, based on Bloomberg, L.P. *Note* Average Japanese LNG prices available only monthly, latest figures are for August 2015

compared to the relatively very active North American natural gas market. With the dominance of long-term contracts, it is hard for the market to closely reflect the dynamics of changes in the market place. It is an exciting time to observe how policy changes across shale resource rich countries and technology breakthroughs related to transportation and storage could further propel the international flow of natural gas. It could be a win-win situation for energy producers and energy-thirsty countries like Japan. Given Japan's reliance on natural gas (LNG imports in particular), its LNG sources have a direct impact on Japan's energy expenditures.

With this background in place, the purpose of this chapter is to explore Japan's energy history, before and after the Great East Japan Earthquake, and how shale gas development around the world could potentially affect its path of recovery in energy supply under the context of its geopolitical relationships.

Japan's Recent Energy History

Japan's Nuclear Era Before Fukushima

Given the focus on Japan's energy sector in the aftermath of the Fukushima accident, only a brief history of Japan's energy history is appropriate here. Japan wanted to make significant changes to its energy supply system after the oil crisis of the 1970s. The changes that it made included diversifying its oil supply sources, establishing a strategic petroleum reserve, increasing nuclear power production capacities, improving energy efficiency, and developing renewable energy technologies. At first, this effort paid off: Japan increased its energy self-sufficiency rate to 19.5 % in 2010 from 12.6 % in 1980 (with nuclear considered part of the self-sufficiency calculation); it achieved 2.4 times the economic expansion with only 1.3 times the energy consumption; and it developed the strategic petroleum reserve equivalent to 200 days of consumption. This is consistent with data from the US EIA, which indicates that during this period Japan's domestic energy resources were able to meet about 20 % of its energy needs (EIA 2015). Intriguingly, in 2009, Japan's strategic energy outlook said that the country was looking to increase its share of nuclear energy production to 50 % in 2030 from the current 30 % (as of 2009).

Japan Since Fukushima

Obviously, the events of March 11, 2011 changed this outlook. It was on this date when a 9.0 magnitude earthquake occurred off the coast of Sendai, Japan. This earthquake, called the Great East Japan Earthquake, triggered a large tsunami, which resulted in damage of the Fukushima Daiichi nuclear reactors. The immediate consequence was the shutdown of all of Japan's nuclear reactors (about 10 gigawatts of nuclear electric generation capacity), but there were other consequences, too. Japan has largely increased its fossil fuel imports, which, along with depreciation of the Yen, has further exacerbated its energy trade deficit. Specifically, the depreciation of the Yen has made energy commodity price imports (priced in US dollars) more expensive in Yen terms (McCracken 2014).

After the events of 2011, Japan's energy portfolio mix moved away from nuclear power and more toward natural gas. Before the Fukushima accident, nuclear power accounted for approximately 30 % of Japan's power sources. As of this writing, LNG's share as a power source has soared to 45 % from 25 % prior to the Fukushima accident (Pfeifer 2014). According to the Japan Petroleum Exploration Co., Ltd. (JAPEX), Japan has some fracking activity occurring in Akita Prefecture. Environmental investigations to ensure that the fracking process can be performed safely in this area were being conducted as early as 2012 (JAPEX 2014). As of this writing, however, Japan produces very small amounts of shale oil compared to other countries with more mature shale oil/gas operations. One source says that daily production at the Akita site is about 220 barrels per day compared to nearly one million barrels per day in the US state of North Dakota (Iwata 2014). Japan's limited domestic energy resources have been able to meet less than 9 % of the country's energy use (EIA 2015).

Oil refinery capacity tells an interesting story about Japan. In 2014, Japan had oil refinery capacity of 3.74 million barrels per day, compared to 14.0 million barrels per day in China and 17.7 million barrels per day in the USA (BP Statistical Review of World Energy 2015, p. 16). This lack of infrastructure to meet energy demand (through oil imports) clearly shows why Japan demands so much natural gas,

Table 1 Natural gas consumption in Japan, 2004–2014

2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
77.0	78.6	83.7	90.2	93.7	87.4	94.5	105.5	113.5	113.5	112.5

Source BP Statistical Review of World Energy (2015, p. 23). Numbers expressed in billion cubic meters of natural gas consumption

especially after the Fukushima accident. As a result, Japan's natural gas utilization rate has increased to 87 % from 70 % before the Fukushima accident; and its oil power plant utilization rate has increased to 56 % from 31 % before the Fukushima accident (METI 2015).

Japan's Natural Gas Usage

Natural gas consumption in Japan has changed quite a bit in the last decade. As of 2014, natural gas consumption increased by 46.1 % over the 2004 level. Table 1 below shows natural gas consumption in Japan over this time period.

Compared to other sources, natural gas still accounts for almost one-quarter of Japan's total energy consumption, as Fig. 2 shows. This includes the use of natural gas as a fuel source in the transportation sector (Tsukimori 2015).

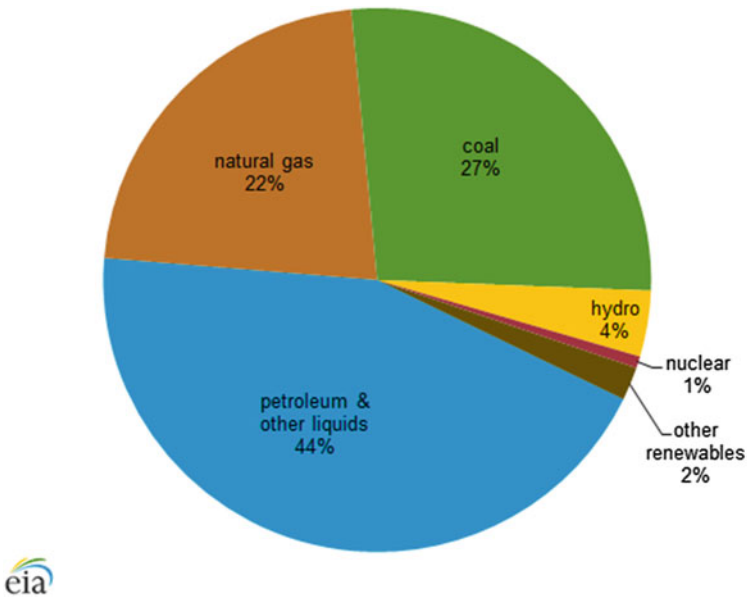


Fig. 2 Japan's total energy consumption, 2013. *Sources* US Energy Information Administration's International Energy Statistics, *BP Statistical Review of World Energy 2014*

Geological Limitation and Alternatives of Japan's Domestic Gas Resources

It is well known that Japan is an area with lots of seismic activity. There are growing concerns in Japan about fracking-induced earthquakes in an area already prone to earthquakes. While the fracking process is a concern, a likely larger concern is the earthquakes that could occur when fracking wastewater is injected into wastewater injection wells. The US experience with fracking-induced earthquakes has increased in recent years, as seismic events in Oklahoma, Texas, and Arkansas have been linked to wastewater injection wells nearby (e.g. Holland 2011).

There is some natural gas native to Japan. In April of 2014, Japan's first commercial shale production began. The estimated production for this facility is 220 barrels of shale oil per day, which is well below Japan's oil consumption levels (Iwata 2014).

In addition to the more traditional forms of oil and gas extraction (vertical drilling, horizontal drilling), Japan is exploring increases in its domestic supply of natural gas through methane hydrate. In 2013, according to Japan's Ministry of Economy, Trade, and Industry (METI), extracted natural gas from a methane hydrate source was confirmed in the world's first offshore production test off the coasts of the Atsumi and Shima Peninsulas (METI 2013). Methane hydrates "are crystalline ice that is found in lower sediments of deep sea regions and polar regions that have methane gas trapped within them. When melted, methane hydrates turn into water and methane" (Agnihotri 2015). Currently, the deposits of methane hydrates are so large that they could provide Japan with enough natural gas for at least 100 years (Ibid.). Japan's goal is to have methane hydrate be a viable, working solution to its need for natural gas imports by 2020 (Pfeifer 2014).

Major International Gas Supply Sources for Japan

Due to the geological limitations and lack of domestic energy supply, Japan must import a majority of its energy resources. In 2014, Japan was the third largest importer of petroleum products, the second largest importer of coal, and the top importer of LNG (EIA 2015). Despite being the largest importer of LNG, Japan pays some of the highest prices for LNG with an average of $15.3/mmBtu in 2013 (IGU 2014). In 2014, Japan consumed 3.3 % of the world supply of natural gas (or 112.5 bcm), down slightly from 113.5 bcm in 2012 and 2013 (BP 2015).[1]

Japan's rising energy costs, fueled by its need for oil and gas imports to offset power generation formerly provided by nuclear generation sources, are spurring other nearby countries to locate more oil and gas to export to Japan. Primarily due

[1]BP Statistical Review notes that this number "Excludes natural gas converted to liquid fuels but includes derivatives of coal as well as natural gas consumed in Gas-to-Liquids transformation."

to location, most natural gas imported by Japan is LNG. No foreign pipelines export to Japan at this time, though domestic natural gas pipelines networks do exist. A submarine natural gas (not LNG) pipeline from Russia's Sakhalin Island has been proposed but has not been developed yet. While natural gas from Russia via pipeline would reduce natural gas import costs for Japan by approximately "half", seismic activity in the region may be prohibitive. Projected costs for the 1500 km pipeline from Russia to Japan are estimated at $3.5 billion (Kuchma 2015).

In 2013, Japan imported 37 % of the world-wide supply of LNG exports (IGU 2014), and approximately 36.2 % of the LNG imports for 2014 (BP 2015; EIA 2015). Japan's LNG imports increased to 120.6 billion cubic meters (bcm) in 2014 from 119 bcm in 2013 (BP 2015). Currently, Japan's major sources of natural gas come from Australia, Asia and the Middle East. LNG supplies from traditional suppliers Malaysia and Indonesia are becoming more constrained; as a result Japan is seeking to diversify its contracts and investments in other LNG ventures (EIA 2015). This is one reason why Australia surpassed Malaysia in 2012 to become Japan's single largest source of LNG imports. In 2013, only nine countries made up 94 % of Japan's LNG imports with Australia leading the way by exporting 21 % of Japan's LNG imports. Figure 3 below shows the distribution of Japan's LNG imports by country of origin.

Intriguingly, of the top 10 producers of natural gas worldwide (USA, 21.0 %; Russia, 16.7 %; Qatar, 5.1 %; Iran, 5 %; Canada, 4.7 %; China, 3.9 %; Norway, 3.1 %; Saudi Arabia, 3.1 %; Algeria, 2.4 %; and Indonesia, 2.1 %), several of them do not appear in Fig. 3 above, and export little to no natural gas to Japan (BP 2015). Arguably the most interesting country missing from the list of Japan's top natural gas sources is the United States, the world's top producer.

Historically, Japan began importing LNG from Alaska in 1969 from Kenai LNG (EIA 2015; CRS 2015). This relationship has continued to the present time with the exception of an idle period from 2012 to 2014. More recently, the US has been producing large amounts of natural gas in its unconventional shale gas (and fracking) boom in states like Pennsylvania, Texas, North Dakota, Arkansas, and Oklahoma, among others. The current shortage of gas pipelines in some states has energy companies eager to install new pipelines; but local residents are opposing the new pipelines in places. For example, unconventional shale gas activity in Pennsylvania is producing enough natural gas for export purposes. New Jersey residents have raised concerns about new pipelines in their backyards, so now a LNG export terminal in Maryland is a conduit through which US shale gas can be shipped to Japan (Phillips 2015).

According to the US Federal Energy Regulatory Commission (FERC), there are 110 LNG facilities in the USA. What limits the amount of US natural gas that can be exported to Japan is twofold. One reason is a lack of export-ready LNG terminals, though underutilized import terminals are actively being converted to export terminals (particularly along the Gulf of Mexico region). Probably the more difficult obstacle is the length of the approval process, which includes FERC (under section "Geological Limitation and Alternatives of Japan's Domestic Gas Resources" of the Natural Gas Act) and the Department of Energy (DOE). While

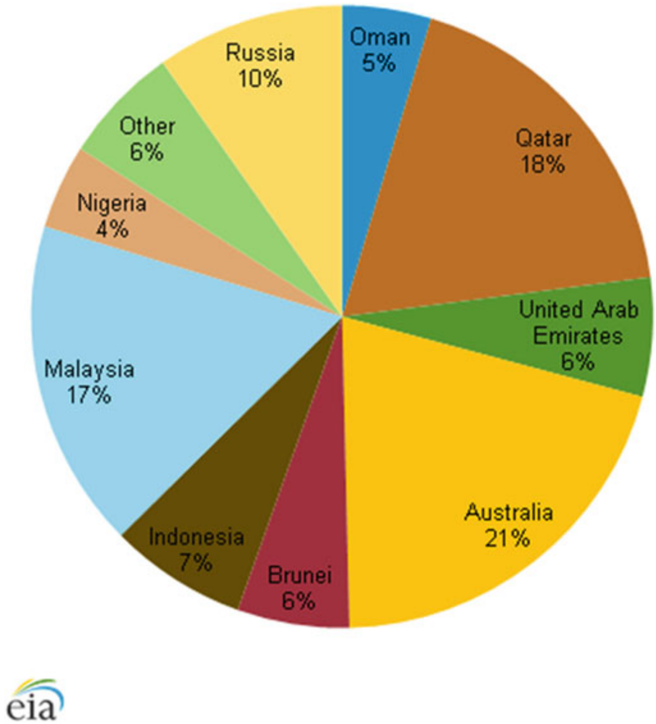


Fig. 3 Japan's LNG imports by country of origin, 2013. *Source* BP Statistical Review of World Energy 2014. Other category includes Algeria, Egypt, Norway, Equatorial Guinea, Trinidad, Yemen, Peru, Angola, re-exported amounts

the USA can export LNG to countries with which it has free trade agreements (FTA), Japan does not have a FTA with the USA as of this writing. There is a proposed FTA, known as the Trans-Pacific Partnership (TPP), but it is still being negotiated.

In Japan's Niigata Prefecture, engineers are preparing for the anticipated arrival of LNG from Louisiana in the year 2018. Currently, steps are being taken to ready the Cameron Parish LNG terminal in Louisiana. Ironically, a few Japanese companies own 33 % interest in the Cameron plant (Northey 2014; EIA 2015). By 2020, Japanese companies will be receiving approximately 1000 Bcf/y from US LNG terminals set to come online (EIA 2015). LNG exports to Japan have been approved from Freeport LNG (100 Bcf/y for 20 years starting in 2017), Cave Point LNG (110 Bcf/y for 20 years), and Cameron LNG (384 Bcf/y for 20 years starting in 2017) (EIA 2015). Will US LNG exports to Japan be feasible if gas prices remain low or continue decrease? Low gas prices may be a determining factor as it relates to economic feasibility for new terminals and terminal conversion, albeit free-trade policy would likely regulate pricing as worldwide competition is introduced and surpluses in the US dissipate with freer exports.

Russia, the number two producer of natural gas and one of Japan's nearest exporting neighbors, exported 10 % of Japan's LNG in 2013 (EIA 2015). A proposed natural gas pipeline (not LNG), if feasible, could dramatically lower the price of natural gas imports for Japan.

Canada, the fifth largest producer of natural gas, does not currently export any LNG to Japan. In fact, while there are a variety of projects in Canada with Japanese investment, there are no completed LNG terminals. While many LNG projects are approved, and some are even approved to export to Japan, none are actively doing so at the time of this writing.

China, the sixth largest producer of natural gas, a near neighbor to Japan, is not a significant trading partner of LNG to Japan. China does, however, export coal and other petroleum products to Japan.

Australia, the number one exporter of LNG to Japan, is posed to quadruple its LNG exports in the next 4 years, and expectations are that it will pass Qatar as the number one exporter of LNG to Japan by 2018 (Cunningham 2014).

Japan has a variety of sources for natural gas, primarily in the form of LNG. With its limited domestic supply, foreign relations and trade policy will continue to play a vital role in Japan's energy sector in perpetuity. Energy independence for Japan is unlikely, unless alternative sources are developed, such as solar, hydroelectric, and methane hydrate.

The Impact of Fukushima Accident on Energy Portfolio and Policy

Even before the Great East Japan Earthquake of March 11, 2011, Japan's nuclear energy consumption rose through the mid-2000s, declined in 2007–2008, and then rose again up to 2011. Table 2 below shows the change in nuclear energy consumption in Japan over this time period.

Clearly, this table shows the significant impact on Japan's energy portfolio with respect to nuclear energy (and the resulting increases in oil and gas imports after the events of March 2011). As of 2013, nuclear energy consumption decreased by 93.6 % compared to the 2003 level. Note that the energy consumption numbers for 2012 and 2013 represent the restart of two nuclear reactors in July 2012 (Kansai Electric's Ohi reactors 3 and 4) and the subsequent shutdown of these two reactors in September 2013 with no nuclear energy production occurring in 2014

Table 2 Nuclear energy consumption in Japan, 2004–2014

2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
64.7	66.3	69.0	63.1	57.0	65.0	66.2	36.9	4.1	3.3	0.0

Source BP Statistical Review of World Energy (2015, p. 35). Numbers expressed in million tonnes oil equivalent

Table 3 Renewable energy consumption in Japan, 2004–2014

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Hydro	21.1	17.9	20.4	17.5	17.5	16.4	20.6	19.3	18.3	19.0	19.8
Other	5.4	6.5	6.6	6.9	6.8	6.8	7.2	7.5	8.2	9.5	11.6

Numbers expressed in million tonnes oil equivalent
Source BP Statistical Review of World Energy (2015, pp. 36, 38)

(EIA 2015). According to some experts, rural Japanese communities want the nuclear power plants to restart because "they receive major subsidies from the production of nuclear power and are struggling without those. But these communities are exceptions to the general public stance" (Aldrich et al. 2015).

Was the Great East Japan Earthquake a catalyst for development/investment in alternative energy sources (e.g. solar and wind)? The short answer seems to be "yes" when looking at the increase in hydroelectric and other renewable energy consumption in Japan post-Fukushima in Table 3 below.

Interestingly, Japan has had other disasters post-Fukushima, most notably the eruptions of Mount Ontake in 2014 and Mount Shindake in 2015 (BBC 2015a), which further calls into question whether nuclear energy production is a safe option on an archipelago with such active earthquake faults and seismic activity (Aldrich et al. 2015).

Another result of the shutdown of nuclear energy production in Japan is that the country now runs an energy trade deficit because of the all the LNG imports. This lead Japan to have an overall trade deficit from June 2012 until March 2015, when it recorded its first trade surplus in 3 years (BBC 2015b).

Even when nuclear reactors come back online, Japan's Ministry of Economy, Trade and Industry (METI) projects that nuclear will comprise between 20–22 % of Japan's energy portfolio compared with 27–30 % prior to the Fukushima accident (Government of Japan 2014; EIA 2015). This percentage of nuclear power in Japan's energy portfolio is important as Japan seeks to meet its commitment to the Kyoto Protocol and its "goals of lowering carbon dioxide emissions, achieving energy supply security, and keeping electricity costs low for corporations" (Aldrich et al. 2015).

Potential/Future Shale Gas Imports

We cannot discuss potential shale gas imports without first discussing the role that global oil prices play in those import decisions. As Fig. 4 below shows, Japan's crude oil imports are imported primarily from the Middle East. Interestingly, Japan's oil pipeline transmission network is not as extensive as the country's geographic spread might suggest. According to the EIA (2015), crude oil and petroleum products are delivered to consumers mainly via coastal tankers and tank trucks.

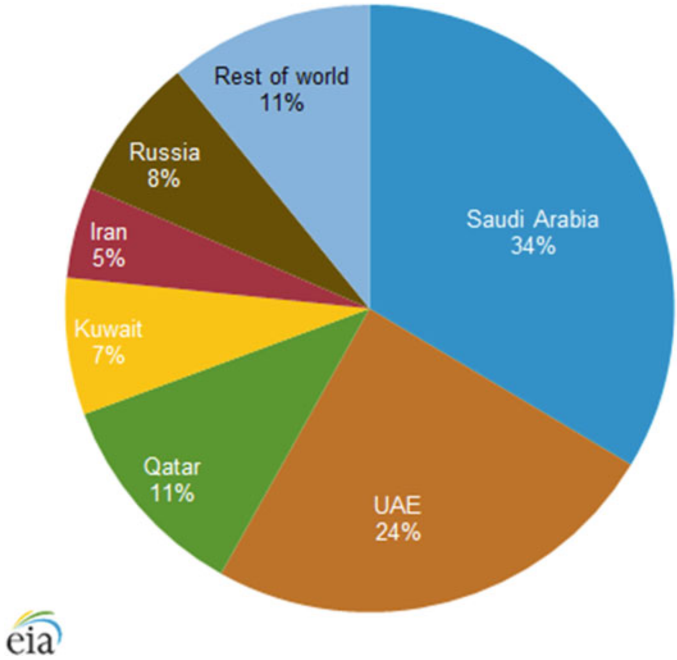


Fig. 4 Japan's crude oil imports by source, 2014 (11 months). *Sources* Japan's Ministry of Finance, Global Trade Information Services

As of this writing, the price of a barrel of oil is around $50. With oil and other fuels (including natural gas) being substitutes, lower oil prices increase the quantity demanded of other fuels, including natural gas and fuel oil. In a pre-Fukushima environment, Japan would also have substituted toward nuclear fuel; however, with the limited number of nuclear reactors in operation currently, this is not a viable option. Given the lack of current nuclear capacity, Japan has relied on additional oil imports from Russia. Specifically, Russia's 2900-mile Eastern Siberia–Pacific Ocean (ESPO) pipeline started sending crude oil to Japan in 2009. This is a major reason why Russian now accounts for about 8 % of Japan's crude oil imports.

The global price of oil has also impacted other countries. For example, global oil prices have slowed down the pace of shale oil wellhead starts in the USA. But, US shale gas production continues to be strong, which keeps gas prices low. Figure 5 below shows the LNG estimated prices for December 2014.

Spot prices for natural gas may be Japan's best option as gas futures are more closely tied to oil prices, which may not be the best measuring stick indicated by earlier research, particularly with excess supply of natural gas in places like the USA. Craig Pirrong, a professor at the University of Houston, in a study sponsored by commodity trading firm Trafigura, said, "The shift away from oil-based pricing can be made, will be made, and must be made" (Yep 2014). Pirrong added "As long as the industry relies on oil to price gas, it will resemble the drunk who looks for his

Fig. 5 LNG estimated landed prices, December 2014. *Note* Data in $US/MMBtu. *Source* Federal Energy Regulatory Commission/Waterborne Energy, Inc./IHS Global

keys under the streetlamp not because that's where he lost them, but because that's where the light is the best." (Yep 2014).

Impact on Japan's Energy Portfolio from Shale Gas Imports

Before Fukushima Accident

Japan relies on natural gas imports because of a lack of domestic natural gas supply. Figure 6 shows the gap between natural gas production and consumption in Japan from 2000–2010.

Also, Fig. 7 below decomposes Japan's energy consumption in 2010 into its various parts.

After Fukushima Accident

Maybe even more intriguing than point-in-time statistics on energy consumption and production are the past, present, and future energy portfolio mixes in Japan. Table 4 below shows the past and present actual energy portfolio mixes in Japan along with the Government of Japan recommended energy portfolio by the year 2030.

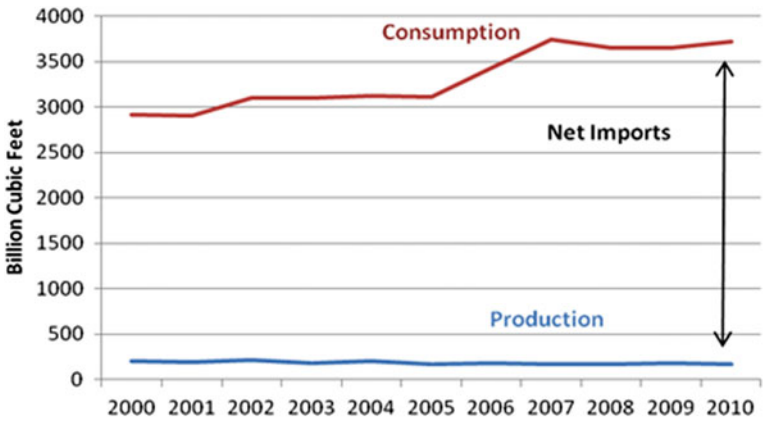
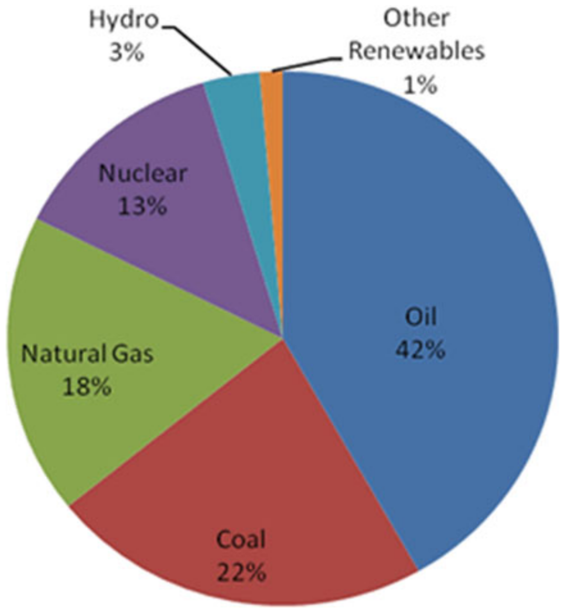


Fig. 6 Japan's natural gas production and consumption, 2000–2010. *Source* EIA *International Energy Statistics*

Fig. 7 Japan total energy consumption, 2010. *Source* EIA *International Energy Statistics*



According to Sheldrick (2015), engineers and regulators warned that the restart of a nuclear reactor after sitting idle for 4 years might encounter some issues. Japan put the Sendai No. 1 reactor back online on August 11, 2015, but issues occurred with its pumping equipment and full production was temporarily delayed (As of this

Table 4 Pre- and Post-Fukushima energy portfolio mixes

Source	Pre-Fukushima 10 year average (%)	FY2013/2014 (%)	2030 Mix METI recommended (%)
Gas (LNG)	27	43.2	27
Coal	24	30.3	26
Renewable	11	10.7	22–24
Hydro		*8.5*	*8.8–9.2*
Solar			*7*
Biomass			*3.7–4.6*
Wind			*1.7*
Geothermal			*1–1.1*
Nuclear	27	1	20–22
Oil	12	13.7	3

Source Sheldrick and Tsukimori (2015) (*adapted*)

writing, the reactor is back online). Of the 42 operable reactors in Japan, only seven are likely to restart in the next few years, which is down from 14 predicted to restart last year (Hamada and Sheldrick 2015). With a life of only 40 years, nuclear reactors may not be the long-term solution for Japan especially since it lacks the elements necessary for reactor cores. As noted previously, Japan considers nuclear power a "self-sufficient power source," with Prime Minister Shinzo Abe strongly advocating the return to nuclear power. Public opinions on the subject vary, and additional safety measures and regulations have been put in place post-Fukushima.

Japan's METI recently finished its 2030 long-term energy supply and demand outlook report. According to METI, Japan's oil use is likely to fall by 33 % by 2030 to 2.5 million barrels per day. Drivers of this decreased demand for oil include (1) population declines, (2) consumer switches to more fuel-efficient vehicles and equipment, (3) government encouragement for a return to nuclear power generation, and (4) government encouragement of increases in the percentage of power generated from renewable sources. According to the Government of Japan, this translates into oil accounting for 3 % of total power generation in 2030, down from 13.7 % in 2013. Also, the report says that the share of nuclear energy is to be 20–22 % and LNG to be 27 % by 2030. Figure 8 below presents the same information from Table 4 above in a slightly different way.

Impact on Japan's Energy Security of Shale Gas Imports

The Japanese government claims that it is important to ensure a stable energy supply by developing multilayered and diversified energy demand and supply structures. One measure of energy stability is energy self-sufficiency, which has been the big goal of energy policy in Japan for many years. In 2010, Japan's energy self-sufficiency rate (including nuclear power) was 19.9 % (METI 2014). After the

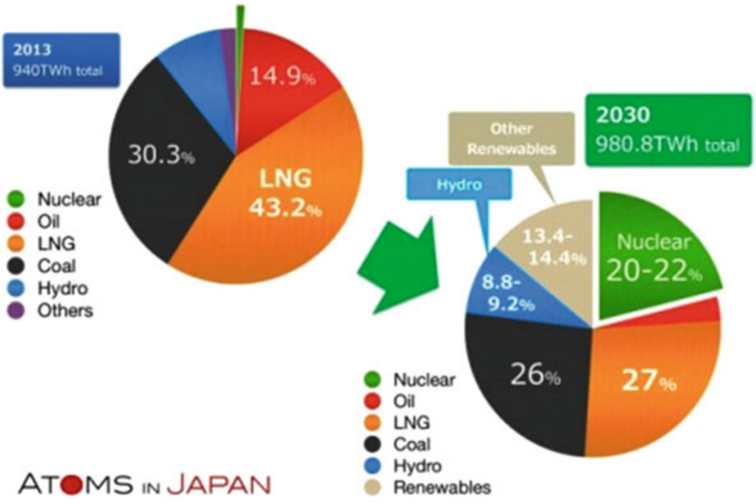


Fig. 8 Japan's current and proposed future energy mix. *Source* JAIF

Great East Japan Earthquake, the country's energy self-sufficiency rate has declined to 6 %, mainly driven by the complete shutdown of all nuclear reactors in Japan. This shutdown has moved Japan down in the ranks to the second lowest position among the 34 OECD member countries in terms of energy self-sufficiency, meaning that non-resource-producing countries like Spain (26.7 %), Italy (20.1 %), and Korea (17.5 %) are more energy self-sufficient. By 2030, Japan's energy self-sufficient rate should be about 25 %, up from the current self-sufficiency rate of 6 % (Ibid.). Interestingly, even though it imports all of its uranium fuel, Japan considers nuclear power a domestic energy source for these self-sufficiency calculations.

The current natural gas supply for Japan primarily comes from the Middle East and the Asian–Pacific region. Japan imports nearly one third of natural gas and more than 80 percent of crude oil from the Middle East. The political turmoil and military unravel in that region pose serious threats to the security of Japan's energy supply. However, the situation could change if future imports of shale oil and gas come from different regions. Currently, most shale resource-rich countries are relatively politically stable. Major shale resource countries, such as the USA, are also close political and economic allies to Japan. As of this writing, shale gas exports from the USA to Japan are relatively small in proportion to the natural gas imports Japan receives from other countries. The current low prices and glut environment of oil and gas, domestically, coupled with the much higher natural gas prices in Japan, have made it possible for the USA to consider more exports of shale gas in the future.

Another future major player in the shale gas industry is China. Although the high energy demand from China, driven by its economy, makes it unlikely to export its own oil and natural gas, Japan's future production of shale gas (including methane

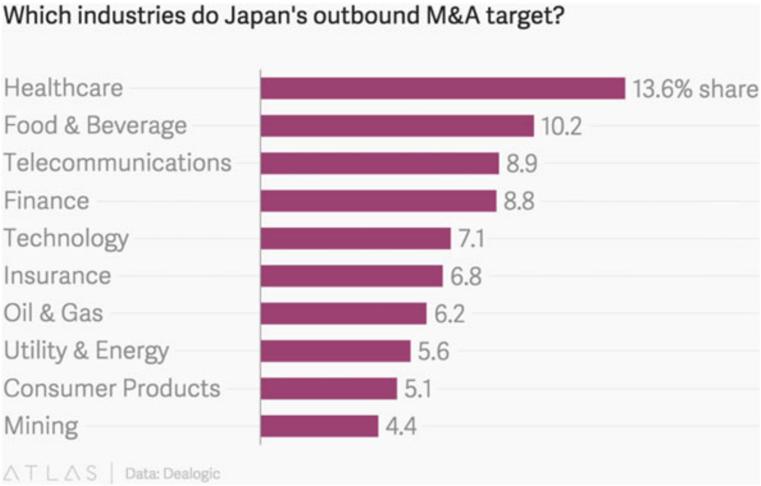


Fig. 9 Japan's outbound M&A target industries. *Source* http://qz.com/465638/charts-and-maps-how-japans-companies-are-beating-chinas-in-overseas-ma/ (retrieved on August 25, 2015)

hydrate) and oil would definitely alleviate the pressure from Chinese conventional oil and gas imports on the international markets.

The 2014 Strategic Energy Plan says:

> Since Japan depends heavily on overseas energy resources, the country always faces risk of supply instability due to the limits of its negotiating power in resource procurement and the effects of changes in the situations of resource-supplying countries and sea lanes. Ensuring energy security continues to be a significant challenge for Japan. (METI 2014, p. 20)

One solution would be to invest in the upstream of the energy industry and directly participate in foreign energy source development. For example, the US shale oil and gas market is open and friendly to foreign investors. As one example, MidAmerican Global Ventures (2013) put forth the idea of attracting US shale gas investments from foreign investors. Relatedly, a comparison of the past ten years (2005—2015) of overseas merger and acquisition activities between China and Japan, the top two fossil fuel importers in the world, Figs. 9 and 10 below show a similar size of investment activity annually.[2] Looking closely at the *types* of investments, however, one can see that Japan targeted only 6.2 % of its investment activity toward the oil and gas industry. By contrast, China spent more than a quarter of its investment dollars in the oil and gas industry.

[2]http://qz.com/465638/charts-and-maps-how-japans-companies-are-beating-chinas-in-overseas-ma/ (Retrieved on August 25, 2015).

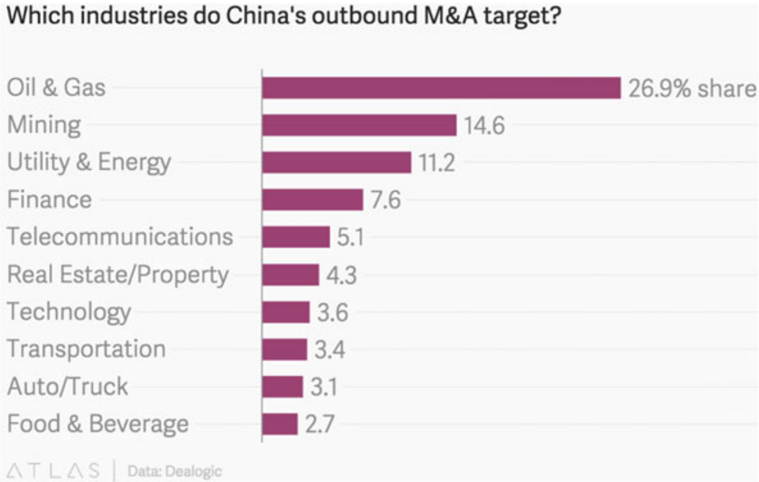


Fig. 10 China's outbound M&A target industries. *Source* http://qz.com/465638/charts-and-maps-how-japans-companies-are-beating-chinas-in-overseas-ma/ (retrieved on August 25, 2015)

Impact on Japan's Geopolitical Relationships of Shale Gas Imports

According to the World Trade Organization (WTO), Japan has 24 free-trade agreements (FTAs) and economic partnership agreements (EPAs) either under negotiations or entered into as shown in Table 5 below.

FTAs and EPAs are necessary for Abenomic policies to succeed, where "growth strategy" plays an important role in revitalizing the Japanese economy (World Trade Organization 2015). Figure 11 below shows the geographic coverage where Japan has agreements in place or where agreements are currently being negotiated.

With energy dependence comes the need for cooperative agreements. Ironically, while freer trade helps with "growth strategy", it does not solve the issue of Japan's energy dependence. Some believe the return to nuclear power is the only known option for energy independence in Japan. The second-best option may simply be to diversify its energy portfolio further. To maintain a diverse energy portfolio, given that Japan is an archipelago, it must engage in trade.

In theory, nearest neighbors become the most likely trading partners for Japan, but political concerns or even economic competition can inhibit these relationships. Forming ally relationships with some countries may prevent other ally relationships from occurring. Looking at Japan's nearest neighbors, the relationship with China and South Korea is still clouded by the painful memory of World War II. China and Japan are still disputing over part of the East China Sea, where offshore drilling may provide a viable energy source. Russia and Japan also have political boundary disputes with the Kuril Islands of Shikotan, Kunashir, Iturap, and the Habomai Group (also known as the Northern Territories).

Table 5 Japan's free trade and economic partnership agreements

	FTA/EPA	Status	Date of Entry
1	Singapore	*Entered into Force*	November 30, 2002
2	Mexico	*Entered into Force*	April 1, 2005
3	Malaysia	*Entered into Force*	July 13, 2006
4	Chile	*Entered into Force*	September 3, 2007
5	Thailand	*Entered into Force*	November 1, 2007
6	Indonesia	*Entered into Force*	July 1, 2008
7	Brunei Darussalam	*Entered into Force*	July 31, 2008
8	ASEAN	*Entered into Force*	2008–2010 (plurilateral)
9	The Philippines	*Entered into Force*	December 11, 2008
10	Switzerland	*Entered into Force*	September 1, 2009
11	Vietnam	*Entered into Force*	October 1, 2009
12	India	*Entered into Force*	August 1, 2011
13	Peru	*Entered into Force*	March 1, 2012
14	Australia	*Signed (now in Force)*	Signed July 8, 2014
	FTA/EPA	**Status**	**Negotiations Began**
1	The Republic of Korea	*Under Negotiation*	December 2003
2	Gulf Cooperation Council (GCC)	*Under Negotiation*	September 2006
3	Mongolia	*Under Negotiation*	June 2012
4	Canada	*Under Negotiation*	November 2012
5	Columbia	*Under Negotiation*	December 2012
6	China, Japan and Republic of Korea (CJK)	*Under Negotiation*	March 2013 (trilateral)
7	Regional Comprehensive Economic Partnership (RCEP)	*Under Negotiation*	May 2013 (multilateral)

(continued)

Table 5 (continued)

	FTA/EPA	Status	Date of Entry
8	European Union (EU)	*Under Negotiation*	April 2013
9	Trans-Pacific Partnership (TPP)	*Under Negotiation*	July 2013 (multilateral)
10	Turkey	*Under Negotiation*	December 2014

Source Adapted from WTO (as of January 19, 2015)

Fig. 11 Current FTAs and EPAs with Japan. *Source* Ministry of foreign affairs of Japan

Several of Japan's other neighbors are also relatively energy import dependent; as a result they are less inclined to or even able to trade energy resources. Japan's best option is to pursue as many different energy partners as possible, which allows them to diversify supply chain risk and get the competitive pricing from the countries with which it is able to trade energy resources.

Most of Japan's natural gas imports are in the form of LNG. Of Japan's top LNG suppliers (2012) Australia, Malaysia, Indonesia, and Brunei have EPAs in place, and there is bilateral agreement with Russia. Of the world's top 10 producers of natural gas (2014), Japan is negotiating FTA/EPAs with the USA, Canada, China, the EU (of which Norway ranked 7th is a part), and has a bilateral agreement with Russia and an EPA with Indonesia (as a part of ASEAN).

Opening up Japan's access to trade, and consequently to natural gas supplies, helps Japan and its trading partners as well. For example, the Trans-Pacific Partnership (TPP)[3] is made up of 12 countries, including Japan and the USA. This group of countries comprised 38 % of global GDP in 2012. If the TPP comes to

[3]Countries negotiating include Japan, U.S., Singapore, New Zealand, Chile, Brunei, Malaysia, Canada, Mexico, Australia, Peru, and Vietnam.

fruition, it is estimated that it will result in 2 % growth to the Japanese GDP alone (Shujiro/JFPF 2014). The vastness of the TPP hopefully will lead toward what many call the Free-Trade Area of the Asia-Pacific (FTAAP), which adds the Asian-Pacific Economic Cooperation (APEC) countries[4] to the mix, and in total comprises 58 % of global GDP in 2012 (Shujiro 2014). It is estimated that the FTAAP would increase Japan's GDP by 4.3 %, the USA by 1.3 %, and global GDP by 0.2 % (Shujiro 2014).

While the USA did not make the list of top ten exporters to Japan in any recent year, it is the world's top producer of natural gas (EIA 2015). A FTA between Japan and the USA would likely mean that FERC would consider LNG trade with Japan "in the public interest" and not require additional approvals as discussed above (CRS 2015). The USA, in turn, has benefits to gain from open trade with Japan, especially since the USA has what many consider a surplus of natural gas. The ability to negotiate long-term contracts with Japan would allow the USA to continue to develop its LNG export facilities, which require large capital outlays.

Globally, sanctions from the EU and USA (over the conflict in Ukraine) against Russia, the world's second largest producer of natural gas, have altered the world supply of natural gas. In this particular instance, these sanctions may actually help Japan, which imported 10 % of its LNG from Russia. Increased supply in Russia due to limited trading partners, coupled with falling oil prices, will likely bring lower gas prices to Japan.

In the context of the FTA/EPAs Japan is negotiating with the EU and USA, it will be interesting to see if these countries would require sanctions against Russia as part of their trade agreement negotiations. Further, what if Russia in return would not trade natural gas with Japan if it agreed to the FTA/EPAs with countries that have sanctions against it? While perhaps not an imminent example, the point remains that energy dependence is a precarious position, and Japan should arduously pursue trading relationships with multiple energy sources.

Future Research

As energy demand increases due to its future economic growth (coming out of Abenomic policies), Japan is taking steps to position itself for that additional demand by promoting energy conservation, which in the best-case scenario will improve energy efficiency to levels experienced prior to the current oil price drop. Technical feasibility of the energy supply projections offered by the Japanese government is affected by the amount of source fuel available from foreign suppliers as well as Japanese nuclear energy policy. In its current condition, the limited

[4]Australia, Brunei, Canada, Chile, China, Hong Kong-China, Indonesia, Japan, Republic of Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, Peru, Philippines, Russia, Singapore, Chinese Taipei, Thailand, United States, and Vietnam.

nuclear energy production results in increased reliance on foreign natural gas imports and thermal power plants, the latter of which increases greenhouse gas emissions and hinders Japan's desire to meet its greenhouse gas emission reduction goals. The current state of Japan's energy portfolio does not promote industrial competitiveness; industrial competitiveness requires a stable energy supply structure, reduced energy procurement costs, and a greater reliance on renewable energy, which translates to increased power supply costs at least in the short run.

Alternate and renewable fuel sources such as solar, wind, and geothermal should be explored as these are sources that can contribute to a self-sufficient energy supply (Amaha 2015). As of this writing, mid-year 2015 saw a decrease in LNG imports due to an increase in solar power generation. Without the infrastructure to increase the production of solar power significantly, we expect LNG imports to rise again in the near future.

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Can a Shale Gas Revolution Save Central and South Asia?

Jennifer Brick Murtazashvili

Abstract This chapter explores how the potential for shale gas might affect the energy landscape in the countries of Central and South Asia. Although three countries in the region—India, Kazakhstan, and Pakistan—feature significant unconventional gas reserves, none of these countries has supported drilling for these resources in any significant way. This chapter explores the reasons for the lack of active drilling, including economic and security constraints as well as the absence of a coherent policy framework in these countries that would encourage foreign investors to actively engage in the development of shale gas. Furthermore, many countries in the region—especially Kazakhstan, Turkmenistan, and to some extent Uzbekistan—maintain abundant conventional oil and gas supplies that reduce the urgency to develop shale gas resources. Finally, the US government has actively promoted a "Silk Road" strategy to link the economies of Central and South Asia. Part of this strategy involves the encouraging countries of Central Asia to export gas and excess hydroelectric power via Afghanistan to the countries of South Asia.

Introduction

This chapter explores the impact of the shale gas revolution in the countries of former Soviet Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) as well as the largest countries in South Asia (India and Pakistan). The shale gas revolution refers to the dramatic development of new technologies for the extraction of natural gas, primarily hydraulic fracturing and horizontal natural gas well drilling.

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Despite the shale revolution that has swept North America and other parts of the world and discovery of vast unconventional gas resources in the region, shale gas has yet to have an impact in Central and South Asia. This is for two reasons, in Central Asia wide availability of conventional oil and gas resources in have eliminated the urgency of local governments to invest heavily in exploration of shale gas reserves. In South Asia, where conventional energy supplies do not meet rapidly growing local demand, environmental, geographic, and political constraints prevent the exploration of abundant shale gas reserves.

A shale gas revolution in the region could provide an important solution to the dire energy situation particularly in South Asia, whose growing economies have been stymied by a sharp energy deficit. This is particularly true in India, where energy deficits threatens the foundations of the new Indian economy. It also has important ramifications in Pakistan where very serious energy deficits have not only thwarted the country's efforts to achieve economic growth but such shortages have also unleashed anger among citizens resulting from prolonged energy deficits and corruption of state energy agencies.

The development of shale gas in Central and South Asia must be understood in the broader geopolitical environment, with significant attention to the roles played by Russia and China. For example, most of the initial infrastructure available to export gas and oil from Kazakhstan and Turkmenistan all went through Russia. This meant that the Russian government was able to dictate prices to Central Asian countries as there were no alternative transport routes available. As Central Asian states began developing their oil and gas reserves, neighboring China experienced enormous economic growth and demand for natural gas and oil. It has turned to new markets in Central Asia for these resources. As a result, the Central Asian republics now find themselves in a bargaining position as these countries are now in the process of building pipelines to China allowing them to move away from Russia.

The development of shale gas in these countries is almost entirely dependent on the will of the governments not only to facilitate the development of a policy framework for shale gas policy, but also to consider the cost of domestic conventional resources as well as the ability to cheaply import conventional resources from neighboring countries. For countries such as Kazakhstan, that have significant conventional gas reserves, it may not be worth the investment to undertake more expensive unconventional gas drilling. Countries such as India and Pakistan appear to have abundant shale gas resources, but are also looking to import liquefied natural gas from other countries, which may in the short term be a more viable option. Furthermore, unconventional gas requires vast quantities of water, which are not easily accessible in many parts of the region.

The paper begins by exploring the overall energy situation in the individual countries of Central and South Asia. The subsequent sections explore shale gas and its recent developments in the region before exploring regional solutions to the energy deficit in the region, many of which have affected the calculus of these countries to engage in unconventional gas exploration. The next section explores policy and security constraints on shale gas development before concluding.

Table 1 Size and populations of countries in Central and South Asia

	Population	Total land area (km^2)
Afghanistan	32.6 million	6,52,230
India	1.252 billion	2,973,193
Kazakhstan	18.1 million	2,699,700
Kyrgyzstan	5.7 million	1,99,951
Pakistan	199.1 million	7,96,095
Tajikistan	8.2 million	1,44,100
Turkmenistan	5.2 million	4,69,930
Uzbekistan	29.2 million	4,47,400

Source CIA World Fact Book (2014)

The Energy Situation in the Region

Central and South Asia is a region wealthy in conventional natural gas, oil, and other important sources of energy. This section provides an overview of the energy bundle in each of the countries in the region. Without a firm understanding of more conventional energy resources, it is not possible to fully understand the incentives countries face to exploit unconventional gas resources. An overview of the total population an total land area (in km^2) can be found in Table 1.

South Asia

Afghanistan, with an estimated population of around 32 million people, is the most energy-starved country in the region. It depends almost entirely on outside sources for oil, gas, and electricity. In 2011, the US Geological Survey issued a report on the country's potential energy and mineral wealth to enormous fanfare, which showed that the country has significant potential gas reserve on the border with Turkmenistan in the Amu Darya Basin. At the same time, the government pursued bids for the drilling of several natural gas wells in Jawzjan province in northern Afghanistan (these wells had been discovered in the 1980s). In 2011, the government awarded a contract to the China National Petroleum Corporation (CNPC) in partnership with Afghanistan's Watan Group for the development of two oil facilities in Sari Pul and Faryab provinces—the only active oil wells in Afghanistan. All the oil from the facility is shipped to Turkmenistan, as Afghanistan has no capacity to refine the product (Juhasz 2013). The Watan Group, a company established by close relatives of former Afghan President Hamid Karzai, was later disbarred from entering into contracts with the USA as a result of massive fraud discovered with military and security contracts, including use of contract funds to allegedly support the Taliban.[1] Despite decreasing security in the area around

[1]For more on the Watan Group scandal, see Tierney (2010).

Jawzjan, in 2015 the government announced it had formed a consortium with Turkish and Afghan companies to review the potential for natural gas exploration in that province, where there were 34 wells operating in three fields with very limited production (around 1.5 million cubic feet; about 70 % less than the production of the entire Marcellus shale formation in the northeast US) (Graeber 2015). In October 2013, the Afghan government also signed an agreement with UAE-based Dragon Oil for exploration and production for oil in areas near the Uzbek and Turkmen borders (Graeber 2014).

The country has among the lowest rates of electricity uses of any country in the world. As of June 2015, only about 38 % of the country's population is connected to power grid, with the entire population consuming only around 3 megawatts of grid-supplied electricity. About three-fourths of all grid supplied power comes from imported energy supplies. The rest comes from domestic hydroelectric sources and the generators and diesel thermal plants. With increased imports of electricity from lines built from Central Asia, more people are relying on the grid but this has put a heavy load on the existing infrastructure and causes frequent outages. The distribution of electricity heavily favors those in urban areas: Almost 80 % in major cities have electricity, less than ten percent in rural areas have access to grid-connected sources.[2]

With over 1.2 billion people, India has the second largest population of any country in the world and is the world's fourth largest consumer of energy. The country is struggling to provide regular energy supplies amid skyrocketing demand. The dramatic growth of the economy in the past fifteen years has accelerated demand for energy and only made the country more dependent upon energy imports. As the world's largest democracy, the government's inability to provide energy for the country's urbanizing population has sparked protests as well as sentiment against politicians who fail to remedy the situation.

Energy consumption in the country has more than doubled between since 1990. The largest energy sources in the country are coal, petroleum, and traditional biomass and waste. As the country has urbanized in the past 25 years, the economy has moved away from use of biomass and waste to gas, oil, nuclear, biofuels, and some renewables. The power sector in the country is driving demand of energy despite the fact that approximately 25 % of the population remain without access to electricity, while electrified areas suffer from periodic blackouts. The transportation sector remains reliant upon petroleum products. After the US, China, and Japan, India is the fourth largest consumer of crude oil and petroleum products in the world and is heavily dependent upon sources in the Middle East for these resources (US Energy Information Administration 2014, pp. 2–3).

Although the country has significant oil reserves, large coal reserves, and is a net exporter of petroleum products, it has a significant deficit of natural gas. According to the International Energy Agency, gas demand in the country will triple to 180 bcm by 2035, with most of the demand coming from the power sector (Ahn and Graczyk

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[2]The World Bank, October 2015, Afghanistan Overview: http://www.worldbank.org/en/country/afghanistan/overview.

2012, p. 69). India began importing natural gas in 2004, when the domestic supply was no longer sufficient to meet demand. Since that time, it emerged as the world's fourth largest liquid natural gas importer in 2013. Natural gas consumption has increased at an annual rate of 8 % since 2012. In recent years, natural gas imports have declined, leading some electric generators to turn to coal as an alternative source of power (US Energy Information Administration 2014, pp. 10–11).

Like its neighbor to the south, Pakistan is also heavily dependent on energy imports; thus, the ability to develop shale gas resources would help fill the country's crippling energy deficit. In the past ten years, demand for energy in Pakistan has grown 47 %, yet at the same time, its domestic energy production has stagnated. This means that the country imports one-third of its domestic energy needs, despite the fact that it hosts significant deposits of coal, natural gas, and water resources that potentially could free the country of dependency on imports (Lesnick 2015, p. 53). November 2015 report, funded by the US Agency for International Development (USAID), found that Pakistan has more recoverable shale gas and oil reserves than its existing conventional gas and oil reserves (see below) (Kiani 2015). Although the preliminary results were released by the Pakistani Minister for Petroleum and Natural resources, as of writing, the full text of the USAID report had not become available.[3]

The primary source of energy for most Pakistanis remains biomass and waste. Natural gas is the second largest source of energy, accounting for 32 % of the country's energy supply in 2012. In the past decade, dry natural gas production grew more than 80 % from 809 Bcf in 2002 to 1412 in 2013. Despite this, the country faces a significant deficit of natural gas. In 2013, this shortfall was 912 Bcf. Not only are the country's domestic natural gas reserves in decline, the government lacks the necessary infrastructure to import more gas. As a result of these shortages, Pakistanis must rely on firewood for heat, which has rapidly exacerbated deforestation. Unlike India, whose forest cover is 23 %, forest cover in Pakistan is only 2.1 %. Despite increasing domestic oil production from 70,000 barrels per day (b/d) before 2012 to 98,000 b/d in 2014, crude oil imports grew 11 % from 2013 to 2014. Domestic consumption of oil has grown rapidly and by 2013 averaged 4,37,000 b/d. To remedy the natural gas deficit, the Government of Pakistan has supported a number of challenging international pipeline projects that would bring more gas to the country from neighbors, including Iran, Afghanistan, and Turkmenistan (see below). Although energy generation in the country has increased from 69 billion kilowatt hours (kWh) in 2001 to over 93 KWh in 2012, utilization for existing power plants has been less than 60 %. This means that less than 70 % (56 million people) of the population had regular access to electricity in 2012. The electricity industry faces serious policy constraints, as the electricity industry is ripe with power generation theft, low collection rates, line losses, natural gas subsidies, and insufficient natural gas supply. As a result, power generation companies have unsustainable and unpredictable financial situations, which in turn leads to frequent

[3]The data on shale gas and oil in this paper rely primarily on the 2013 EIA estimates.

power shortages. Furthermore, government subsidies for electricity keep the government in a system of debt, as the government typically charges consumers less than half of the cost of producing electricity, which in turn means the utilities are unable to pay for fuel (Data in this section are from EIA 2015d).

Central Asia

Unlike the countries of South Asia, the former Soviet Central Asian countries of Kazakhstan, Turkmenistan, and to some extent Uzbekistan have enormous conventional energy resources allowing them to export energy. As a result, the domestic economies of these countries are dependent on revenues from conventional gas and as a result may be reluctant to pursue shale gas exploration as increased global gas supply will likely result in reduced prices for gas on world markets, thus harming these energy-dependent economies. The situation in the southern Central Asian countries of Kyrgyzstan and Tajikistan is quite bleak: neither has sufficiently active production of oil or gas to satisfy domestic demand (see Kolb (2014) for an excellent overview of issues related to energy resources in the region). A map of the countries in Central Asia can be found in Fig. 1.

An energy boom has driven the economy of the former Soviet Republic of Kazakhstan. Although the country has just over 18 million people, as home to the world's 12th largest proven oil reserves, the energy sector is the centerpiece of the economy. Although the country has a relatively small population, transport of energy is complicated by the vast size of the country. The total area of the country is more than 2.7 million square kilometers, making it the ninth largest country in the world in terms of geographic size. Although oil was discovered in Kazakhstan in the early twentieth century, full exploration of reserves did not occur until foreign investment came into the country facilitated by the collapse of the Soviet Union. To illustrate the extent of the energy boom: GDP increased from $16.9 billion in 1999 to $224.4 billion in 2013. Along with the sweeping rise in GDP has come a reduction in poverty from 47 % of the population in 1999, to just 3 % in 2013 (Karatayev and Clarke 2014). Most of the energy boom has come from oil exports. By 2014, the country was producing 1.70 million barrels of oil per day (bbl/d). The country has more than 30 billion barrels of proven crude oil reserves. The bulk of Kazakhstan's oil exports ends up in European markets through Caspian Sea pipelines. Less than 20 % of gas exports go to Chinese markets, although this number is expected to rise in the future as oil production is expected to rise in the near future (EIA 2015a).

In addition to hosting vast oil reserves, the country has become a significant producer of natural gas. There are an estimated 85 billion Tcf of proven natural gas reserves in Kazakhstan. Gas reserves are also located in the same location as the country's largest oil fields. Most of the natural gas produced in the country is used for domestic consumption, is reinjected into oil wells to boost oil recovery, or is used at well sites to generate electricity. Approximately 30 % of the country's natural gas is exported to Russia (EIA 2015a).

There are two significant pipelines that export natural gas to external markets: The Central Asia Centre (CAC) pipeline goes through Western Kazakhstan into Russia and the Turkmenistan–China pipeline, which travels from southern Kazakhstan and into China. The Turkmenistan–China pipeline is primarily a vehicle for natural gas exports from Turkmenistan (see below) along with some gas from Kazakhstan and Uzbekistan. A final pipeline, the Bukhara–Tashkent–Bishkek–Almaty pipeline, provides gas to domestic markets in the south of Kazakhstan with gas from Turkmenistan and Uzbekistan. The country relies on imported gas for the domestic market, despite having enormous capacity, because internal pipelines are not adequate to get natural gas from its production sources in the northwest of the vast country, to population centers in other parts of the country (gas and oil reserves are located in sparsely populated areas). New pipelines under construction will be able to move gas around the country to satisfy domestic markets as well as facilitate exports. These new pipelines will focus on connecting directly to China, which would allow gas produced in northwest Kazakhstan to be exported to its eastern neighbor (EIA 2015a, pp. 8–9).

In addition to hosting vast oil and gas reserves, Kazakhstan hosts the second largest coal reserves in the former Soviet Union (after Russia) holding 3.7 % of the world's total recoverable coal reserves. After a period of decline in the 1990s, output of coal has increased in recent years, making the country a net exporter sending most exports to Russia and Ukraine. Coal is also used for domestic purposes, to produce electricity and power the domestic iron and steel industry (World Energy Council 2013). The domestic economy still relies heavily on coal, as it accounts for 63 % of the country's total energy consumption, making it the 12th largest consumer of coal in the world (EIA 2015a, pp. 9).

Further complicating incentives to develop its shale gas reserves, Kazakhstan is also the world's largest producer of uranium, as it maintains about 15 % of the world's uranium supply, including 38 % of total global production. In addition, Kazakhstan is increasingly developing and promoting renewable energy alternatives to fossil fuels. Hydropower makes up 13 % of the country's electricity capacity. The government has also actively encouraged the development of several large wind plants, as the country's flat steppe geography makes it ideal for generation of wind power (Karatayev and Clarke 2014, pp. 100–101).

Turkmenistan has vast oil and natural gas resources but is limited in its ability to play a major role in global energy markets, unlike Kazakhstan, because it lacks infrastructure that facilitates exports. Turkmenistan has a very small population of just 5.3 million people, and as a result, the extremely elusive and authoritarian government can focus on export of energy resources for rents.

Turkmenistan is the world's sixth largest natural gas reserve holder, with 265 Tcf as of January 2015. It is home to the Galkynysh Natural Gas Field, which can produce more than 1 Tcf/year. It is the world's second largest gas field. Despite being rich in natural gas the country struggles to export its resources due to insufficient pipeline infrastructure. Turkmenistan has 600 million barrels of proven oil reserves and in 2013 averaged production of 2,29,000 b/d. The country has a small domestic crude oil pipeline that links onshore oil fields with a refinery and orts on the Caspian Sea, but in general has almost no international pipeline infrastructure (EIA 2015b).

With almost 30 million people, Uzbekistan is the most populous country in former Soviet Central Asia. Like Kazakhstan and Turkmenistan, Uzbekistan has experienced significant economic development since 2000, with average annual GDP growth rates at 7.7 %. The export of natural gas, at 19 % of total exports, has played a significant role in the country's economic growth (Gómez et al. 2015).

Uzbekistan has a total of 594 barrels of proven crude oil reserves, but by 2014, production was down to 67,000 b/d. Although the country has thee oil refineries with high levels of capacity, the refineries operate below capacity due to the lack of domestic production. Other than a pipeline that links two refineries in Kazakhstan and Turkmenistan, the country has limited pipeline capacity that can bring oil in from the outside world. As a result, the country has looked to shale oil (see below) as an option to resolve the domestic oil shortage. Following Russia and Turkmenistan, Uzbekistan **is** the third largest natural gas producer in Eurasia. It has 65 Tcf of proven natural gas reserves. In 2014, the country produced about 2 Tcf of natural gas and consumed 1.7 Tcf. As is the case in Turkmenistan, the country has large natural gas reserves, but lacks sufficient pipelines to export the gas. Furthermore, Soviet-era infrastructure has hampered both production, distribution, as well as exports. In addition to serving as a producer of natural gas, Uzbekistan is also an important transit country for gas produced in Turkmenistan onto markets in Russia and China. In 2014, Uzbekistan exported approximately 300 million cubic feet in 2014. Half of these exports went to Russia, while the other half were split between China and Kazakhstan. In recent years, Uzbekistan has signed an agreement with China to send 350 Bcf per year through a new gas pipeline. Uzbekistan holds the world's seventh largest uranium reserves (EIA 2015c).

Kyrgyzstan and Tajikistan are the two smallest countries in Central Asia in terms of geography, with populations, respectively, of 5.7 million and 8 million; both countries are heavily dependent on the outside world to satisfy energy needs. Both countries have small amounts of oil and gas production, but rely heavily on imports of natural gas and oil from other countries. Kyrgyzstan and Tajikistan were among the poorest and most isolated countries in the former Soviet Union, owing to their mountainous geography and lack of arable agricultural land. They also sat on the most remote corner of the Soviet Union. Due to the lack of domestic hydrocarbons, both countries are actively utilizing their geographic resources and investing heavily in hydroelectric power generation to satisfy both domestic consumption and export to countries in South Asia (see below).

In recent years, Tajik government officials have announced the discovery of major gas and oil reserves in Bokhtar district in Kulob Province in the southern part of the country. In 2013, the government made an agreement with Tethys Petroleum (UK) to fully explore and develop gas and oil fields in the Bokhtar Basin. Tethys said the country may be home to 3.22 m^3 of gas and 8.5 billion barrels of oil. The agreement was developed in partnership with China National Petroleum Corporation (CNPC) and Total of France. Officials said that the new discovery could host reserves that could meet China's natural gas consumption for 24 years

Fig. 1 Map of Central and South Asia (*Source* US Department of State)

(Lee 2013). Just over two years later, Tethys was removed from the Total/CNPC joint venture in Tajikistan after the company missed a payment to other parties (Exarheas 2015). The development of oil and gas would be a boon to the Tajik economy by providing the government with access to badly needed revenue. Such energy discoveries would give the country independence, helping lift its dependence for energy from Russia and other neighbors.

The development of gas in Kyrgyzstan is entirely dependent upon the Russian firm Gazprom, which owns a 100 % stake in the recently remained Gazprom Kyrgyzstan (from the previous KyrgyzgazProm). Gazprom Kyrgyzstan owns the entire domestic gas transmission and distribution system in the country and is also the exclusive importer of natural gas, giving Russia a veritable monopoly on Kyrgyzstan's gas sector development (Natural Gas Asia 2015).

Shale Gas Reserves and Its Recent Development

Of the eight countries included in this study, only three—India, Kazakhstan, and Pakistan—have known shale gas reserves. These countries are also the three largest economies in the region. As discussed below, Uzbekistan may have shale gas reserves but has been hesitant to explore the gas for political reasons, although it is actively mining shale oil.

Kazakhstan is an energy-rich country that has abundant natural gas and oil reserves and a very small population. The government of Kazakhstan, which controls all subsurface mineral rights, has signaled that it will begin exploration of shale gas, but has done little in terms of actual exploration. This may be a result of fears that additional gas supplies will hurt demand for and subsequently lower the price of the country's conventional gas, on which the Kazakh economy is heavily dependent. The dynamics in India and Pakistan are quite different. India and Pakistan have potential for enormous economic growth, but energy deficits threaten this trajectory. Of the countries in the region, India has made the most progress exploring shale gas reserves, but the lack of a regulatory framework has slowed the pace towards extraction. In the case of Pakistan, political stability and lack of water necessary to undertake underground horizontal drilling provide very real constraints on the ability to extract shale gas.

The prospects for shale gas development are starkly different in energy-starved and population-rich South Asia from the situation in the former Soviet Central Asian republics that are relatively energy-rich and have low population densities.

South Asia

Countries in South Asia are looking to the shale gas revolution in the USA as a model to emulate. In the USA, shale gas has allowed the country decrease its energy independence on foreign countries while simultaneously paving the way for substantial decreases in energy costs. Countries in South Asia are also highly dependent upon imports for energy—this is increasingly true as the economies in the region grown—and are looking for ways to increase supply while bringing costs down.

The shale basins in India and Pakistan are geologically complex (EIA 2015e, XXIV–4). Assessments by the US Energy Administration estimate that there more recoverable shale gas in Pakistan than in India. There is a total of 1170 Tcf of risked shale gas in India and Pakistan (584 Tcf in India and 586 Tcf in Pakistan). Therefore, technically recoverable shale gas is estimated at 201 Tcf (96 Tcf in India and 105 Tcf in Pakistan) (EIA 2015e, XXIV–2).

According to initial reports, India has more than 21,000 Tcf of shale gas reserves. Initial explorations that began after these optimistic reserves were announced resulted in many dry wells and only small amounts of recoverable gas. As a result, these grand estimates were scaled back to much smaller number (Economist Intelligence Unit 2011, pp. 22–23).

There are four main shale basins in India. The Cambay Basin has been identified as a priority for drilling in India, yet there have been no plans to explore the basin. Located in the State of Gujarat, Cambray has an estimated 146 Tcf of shale gas along with 54 billion barrels of shale oil. The Krishna–Godavari Basin covers 7800 mi^2 in eastern India. The basin has 381 Tcf of shale gas, while 57 Tcf is technically recoverable. Close to 20 wells have been drilled in the basin. The Cauvery Basin covers 9100 mi^2 on the east coast of India. There are estimates of 30 Tcf of shale gas in place, with 5 Tcf technically recoverable. There has been no development of shale gas in this basin. The fourth shale basin in India is the Damodar Valley Basin, located in eastern India. It was the first shale basin to be explored in the country. The estimated shale gas in this basin is 27 Tcf, with an estimated 5 Tcf of shale gas technically recoverable (EIA 2015e, XXIV 7–34).[4]

The Indian government identified the Cambray and Damodar Valley basins as priorities for shale gas exploration. The first effort to extract shale gas has been recently completed; ONGC drilled and completed the country's first shale gas well, RNSG-1, northwest of Calcutta in the province of West Bengal. The well drilled at the base of the Barren Measure Shale in the Damodar Valley Basin to a depth of 2000 m has gas. Vertical wells were also tested at the Cambay Basin and had shale gas and shale oil produced from the Cambay Black Shale (EIA 2015e, XXIV–4). India may have significant shale gas reserves, which have caused many to believe that shale gas could be nothing short of a miracle to solve the country's increased energy demand. The exploitation of shale gas, as discussed below, remains in very early stages, largely due to policy constraints that limits the ability of investors to take risks on the energy market in the country.

A report funded by the US Agency for International Development (USAID) shocked the Pakistani public when it was revealed because it estimated the country has more than 10,159 Tcf of shale gas and over 2.3 trillion barrels of shale oil (Bhutta 2015b). Despite the enormous promise shale gas reserves hold for Pakistan's efforts

[4]There are several small basins in India that appear to contain shale gas including the Upper Assam Basin in northeast India, the Pranhita–Godavari Basin in eastern India, the Vindhyan Basin in north-central India, and the Rajasthan Basin in northwest India.

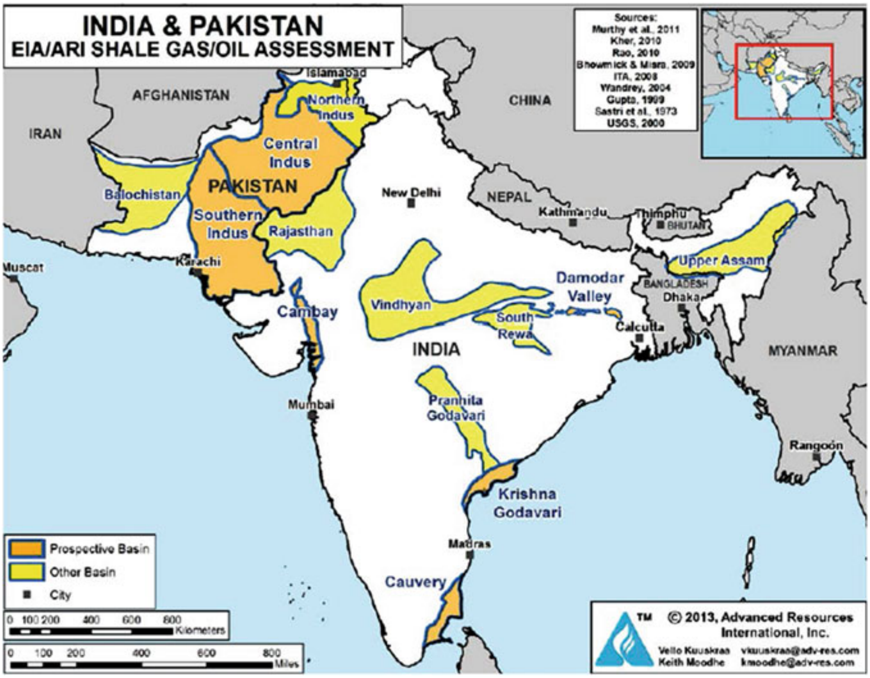

Fig. 2 Shale gas and oil basins in India and Pakistan (EIA 2015e, XXIV–1)

to become energy independent—or at least to better satisfy growing domestic appetite for gas—there are no active shale gas wells in the country.

Previous estimates from EIA in 2013 estimated that the country estimated the country had 586 Tcf of shale gas, of which 105 Tcf were technically recoverable.

Shale gas basins in Pakistan cover almost the entire geographic span of the country. The largest shale basin in Pakistan is in the lower Indus Basins,[5] located along the borders with India and Afghanistan. Within the Lower Indus Basins, the Sembar Shale has 531 Tcf of shale gas, with 101 Tcf identified as technically recoverable shale gas. The Ranikot Shale, located in the same Basin, has 55 Tcf of shale gas of which 4 Tcf is technically recoverable. There are no publically available data on shale gas development or exploration in this basin (EIA 2015e, XXIV 36–40). Figure 2 illustrates the location of shale gas and oil basins in India and Pakistan.

In 2014, the Federal Minister for Petroleum and Natural Resources, Shahid Khaqan Abbasi, signed an exploration license and petroleum concession agreement with a Canadian firm for the Karak North block play, located in Khyber Pakhtunkhwa province, which covers an area of 99 km^2 (The Express Tribune 2014), but this is the only significant agreement made for the commercial exploration of shale gas in the country.

[5]The Lower Indus Basin consists of the Southern Indus Basin and the Central Indus Basin.

Despite its enormous potential, exploration of unconventional gas is in its very early stages in both India and Pakistan. As we will see in subsequent sections, in India the energy regulatory environment is the most significant impediment to the development of unconventional shale, while in Pakistan, the security concerns and lack of water are the most important barriers.

Central Asia

The situation in landlocked Central Asia is far different from that of energy-starved South Asia. Central Asia is endowed with some of the world's largest oil and gas reserves, but are largely isolated and removed from world markets.

The only country in Central Asia that is known to possess shale gas reserves is Kazakhstan. Like most other countries in the region, the potential for a shale gas in Kazakhstan remains relatively unknown, as the country has yet to undertake exploration of the resources. Unlike other countries in the region, however, the government is under no pressure to explore for shale due to the vast quantities of oil, gas, coal, and even uranium resources currently being exploited to fulfill both domestic and international demand for energy.

Until 2015, very little was known about the quantity or quality of shale gas or oil resources available in Kazakhstan, despite indications that there were significant resources available. The US Department of Energy conducted a preliminary assessment indicating that there are substantial amounts of recoverable shale oil and shale gas in Kazakhstan. Specifically, it estimated that Kazakhstan holds 10.6 barrels of recoverable shale oil, along with 27 Tcf of recoverable shale gas. Gas is located in three basins in Kazakhstan: the North Caspian Basin, which covers 2,12,000 mi^2 that holds up to 21.6 Tcf of recoverable gas, the Mangyshlak basin, which covers 30,000 mi^2 that holds 3.1 Tcf of recoverable shale gas, and the South Turgay Basin, which covers 60,000 mi^2 and holds approximately 2.9 Tcf of recoverable shale gas as shown in (Fig. 3).

It is unknown whether Uzbekistan possesses shale gas reserves. As early as 2013, however, the Government of Uzbekistan began drilling for shale oil. The impetus for government-sponsored drilling was a direct result of falling oil production in the country and a desire on behalf of the regime to reduce oil imports from neighboring Kazakhstan. The government did not disclose the source of investment in the drilling of shale oil but has indicated that it was made possible with support of loans from foreign investors. Shale oil drilling could provide up to 8 million metric tons of shale oil and up to 1 million metric tons of oil products annually. The entirety of shale oil reserves is estimated at 47 billion metric tons (Sadykov 2013). In 2014, the government announced that it would build a shale oil processing plant at the cost of $1 billion, with investments coming from unnamed foreign sources. (UzDaily.com 2014) Uzbekistan's oil production has been in steady declaim for more than a decade, falling from 1,71,000 b/d in 2001 to 86,000 in 2011, while oil consumption increases to 91,000 b/d by 2011.

Fig. 3 Shale gas basins in Kazakhstan. *Source* (EIA 2015f, XXVIII–1)

Unlike its adventures in shale oil, the government has not pursued a strategy to explore possible shale gas resources. Some sources have reported that the government is simply not interested in the development of shale gas as a result of the risky investment and long-time horizons posed by its development (Times of Central Asia 2014). In a September 2013 speech to the sixth annual meeting of the Asian Solar Energy Forum, President Islam Karimov, who has ruled the country since independence in 1991, stated that although some countries had experienced a "so-called" shale revolution in the extraction of crude hydrocarbons, development of shale should not change government interest in development of renewable sources of energy, especially solar power (UzDaily.com 2013).

The government of Uzbekistan (along with Turkmenistan) is among the most authoritarian in the world. Since the collapse of the Soviet Union, Uzbekistan has not engaged in the wide-scale privatization of industry and agriculture as seen in most other countries. Instead, the government has embarked on what it termed the Singapore or Chinese model of state-led development. Although the human rights situation in the country is deplorable, economic growth has provided a puzzle for most economists working on the region as Uzbekistan has been able to maintain relatively high levels of economic growth despite not having embarked on the kinds of economic reforms and privatization most economists suggest generate sustained growth (Murtazashvili 2012).

The primary economic policy of the Uzbek government is a limited form of autarky whereby the government actively seeks to protect some domestic industries, shielding them from foreign competition. Although observers can never fully understand the decision-making process within the regime, it appears that the government, by not exploring the potential for shale gas in the country, is acting to protect existing investments in natural gas. Natural gas production and export has been an important driver of the country's coveted economic growth rates.

The case of shale oil on the other hand is different. The motivation for the regime to engage in shale oil mining is due to the fact that government oil production dwindled, and as a result, the country has experienced domestic shortages of oil. As early as 2010, the government agency responsible for managing oil and gas in the country, Uzbekneftegaz signed an agreement with Japanese companies to develop the country's shale oil potential. As one of only two double-landlocked countries in the world, the government appears to believe that mining shale oil will help it avoid costly oil imports. Furthermore, the government protects its foreign currency reserves and is not eager to use them to pay for oil imports. Although the region has a large amount of both oil and gas, regional processing capacity is low; thus, refined products are imported from Russia via Kazakhstan (Nutall 2013).

In 2014, Uzbekistan exported about 300 million cubic feet, with about half of this sent to Russia and the rest sent to China and Kazakhstan. Uzbekistan made an agreement with China to send another 350 billion cubic feet per year to China, but currently Uzbekistan does not have enough domestic capacity in gas production to completely fulfill the terms of the agreement.

The two smallest countries in former Soviet Central Asia, Kyrgyzstan and Tajikistan, are also the most dependent upon energy imports from other countries. Accessing natural gas is particularly challenging because of the difficult terrain of these mountainous countries along with their geographic isolation. This is compounded with particularly difficult relations with neighboring Uzbekistan, who frequently shuts off gas supplies to these countries when they fail to pay for their imports. Frequently, Uzbekistan uses payment failure as an excuse to cut off gas supplies for neighbors during the winter months. Using this strategy it uses threats to shut down energy supplies in order to get leverage on other policy issues with neighboring countries. It uses gas exports as a weapon in order to gain policy advantage.

Regional Solutions to the Energy Deficit: Implications for Shale Gas

The energy deficits in South Asia that have accompanied rapid economic and population growth caused countries in the region to look outside the region for a solution in the form of energy imports. India and Pakistan have begun to look north—to gas from energy-rich Turkmenistan and to potential hydroelectric exports from mountainous Kyrgyzstan and Tajikistan. In order for these resources to reach India and Pakistan, they must travel through the insecure and rugged, mountainous territory of Afghanistan. At first glance, it may seem almost absurd that the preferred solution to the energy crisis in South Asia lies in transit routes through Afghanistan; such transnational solutions have been heavily promoted by the United States, the World Bank, the Asian Development Bank, and several other bilateral and multilateral organizations. The potential to develop these energy transit routes has had an enormous effect on the calculus of political leaders in South Asia as they consider the cost and benefits of drilling for shale gas. If it is cheaper to import gas through these new transit routes, which are heavily subsidized by international donors than to drill for shale gas, then unconventional energy resource will remain untapped.

To address natural gas deficits, the Government of India has promoted the development of international pipelines with neighboring countries, many of which were not politically feasible. India withdrew from the Iran–Pakistan–India pipeline project in 2006 and negotiations between India and Bangladesh collapsed in 2005 (US Energy Information Administration 2014, p. 14). Despite enormous geopolitical challenges, India and Pakistan are still participating in a major pipeline project that would send natural gas from Turkmenistan to India. This project is known as the Turkmenistan–Afghanistan–Pakistan–India (TAPI) project. The TAPI pipeline is to be 1800 km long, including 200 km in Turkmen territory, 773 km in Afghanistan, and 827 km across Pakistan. The pipelines are designed to transmit up to 33 bcm of gas annually. Total project cost is around $10 billion. The cost of the project continues to escalate as a result of delays associated with project financing and instability in the region. The Asian Development Bank (ADB) has acted as the Secretariat of the TAPI project since 2003 and has been involved in selecting consortium to coordinate implementation of the pipeline.

Turkmenistan is eager to begin exporting gas to South Asia. This is due primarily to the fact that the Russian energy firm Gazprom announced that it would no longer purchase natural gas from Turkmenistan, this is despite that in 2003, Turkmenistan’s state-owned gas company signed a 25-year agreement with Gazprom for the delivery of 70–80 bcm of gas per year to Russia. As a result, China is the only significant export market for Turkmen gas. The Turkmen government is eager to diversify its export market and thus has been eager to seek financing for the TAPI project so that Turkmenistan is not reliant upon a single partner for the export of its natural gas, as Turkmenistan fears being economically dependent upon China (Micha’el 2015). In November 2015, the President of Turkmenistan announced that his country would begin building its portion of the pipeline to transmit gas to the Afghan border. This marked the first step in the completion of the pipeline.

In October 2011, Turkmenistan criticized Russia’s objections to the construction of a Trans-Caspian pipeline (TCP). Turkmenistan was eager to build the pipeline to ensure export of gas to European markets. Turkmenistan’s access to European and other markets would come at the expense the near-monopoly Russia had enjoyed over Turkmen gas. In response to Turkmenistan’s criticism of Russian interference in the creation of the TCP, the Vice-President of the Russian Parliament and head of the Russian Gas Society threatened Turkmenistan with an incitement of an “Arab

Spring" through direct involvement in domestic Turkmen politics, if it did not renounce its neutrality in foreign policy and participate in a Russian-sponsored pipeline project (Kim and Blank 2014, p. 100).

Vast Turkmenistan gas resources have played an important role in the decision of China to explore its own shale gas resources. Of those countries that possess shale gas, China has extraordinary potential despite the fact that exploration of shale gas in China has only just begun. Unlike the US, where access to water resources and expertise in horizontal drilling are both abundant, both of these important factors have hampered the development of shale gas in China. After Turkmenistan fell out in its relations with Russia, its most important importer of Turkmenistan gas, the Chinese government made a concerted effort to court Turkmenistan and secure the construction of pipelines that would bring Turkmen gas to the Chinese markets. In addition, China is also relying heavily upon Australia, a country that is on track to become the world's largest producer of liquid natural gas by 2020 (Jong et al. 2014, pp. 129–170).

China faces a 45 % supply deficit of natural gas compared to demand, and its shale gas developments are not achieving sought after production targets. With 4000 wells drilled, China can only produce somewhere between 35 and 53 Bcf of shale gas in 2012, hardly enough to forego conventional gas imports. Although Russia, a major gas exporter, long threatened European countries that relied on Russian gas imports that it would sell its gas to China unless it received favorable deals. Russia was never able to secure deals with China that were as lucrative as those with Europe (Collins 2014).

At the beginning of the US shale boom, Turkmenistan, for instance, did not seem phased by the so called "shale revolution." Instead, the country's leadership began negotiating deals to build pipelines across the Caspian Sea that would allow the gas-rich country to export to Europe, Russia, India, or China (Gorst 2010). Turkmenistan's gamble with Russia has begun to pay off, at least with respect to China. China has now begun to engage very heavily to build pipelines with Central Asian countries, especially Turkmenistan, Uzbekistan, and Kazakhstan. To facilitate this, the Turkmen government has almost completed the East–West pipeline, which will improve domestic transport of energy as well as facilitate export to Uzbekistan, by linking the largest gas fields in the south east of the country to the Caspian Sea.

Although Turkmenistan would like to export its natural gas to markets in the EU, formidable challenges remain. First, there are disputes between the littoral states of the Caspian Sea regarding its legal status, which in turn places into question where each country has exclusive economic and territorial rights. Second, Turkmenistan and Azerbaijan have disputed sovereignty over several gas fields near the unrecognized median zone between the countries. The EU has not been able to resolve these disputes. Finally, by engaging in partnership with the EU, the very reclusive and authoritarian Turkmen regime puts itself at risk. This is because as an export partner, the EU can pressure the Turkmen government to liberalize its tightly controlled energy sector, which would put pressure on the tight cadre of officials that run the energy sector. In stark contrast, China poses no threat to Turkmenistan's domestic political or economic practices and would have no problem forging closed energy deals that defy regulation (Katsaris 2015).

To solve its energy deficit, Pakistan has long pursued the construction of a natural gas pipeline from Iran, as gas from Iran would be one of the easiest ways to get gas into the country. Pakistani officials have called this pipeline the "peace pipeline." The framework agreement reached in April between the US and Iran breathed new life into the hopes of a Pakistan–Iran pipeline. Almost immediately after the deal with the US had been inked, China announced that it would finance and build the pipeline, in a deal signed in Islamabad in 2015. Iran has stated that the 560 mi of the pipeline on its territory had already been built and was pressing the Pakistani government to build its side. The Pakistani government has been negotiating with a subsidiary of CNPC to build the 435 mi of pipeline on its side of the border (Shah 2015). Russia is also eager to participate in the construction of part of the pipeline in order to "not to give the Pakistani market to China" (Kuchma 2015).

In contrast to the excitement over the pipeline coming from Islamabad, the US State Department said any efforts by Pakistan to build the pipeline to Iran were premature as the sanctions against Iran had yet to be lifted, and as a result, Pakistan was not free to negotiate the pipeline deal with Iran without suffering repercussions from the US (Daily Times 2015). The US has discouraged Pakistan from building the pipeline with Iran and has instead encouraged Pakistan to pursue the TAPI pipeline. The TAPI alternative would provide the economic benefits to Afghanistan through the collection of lucrative gas transit fees as well as help solve Pakistan's energy crisis. The economic gains made in Afghanistan as a result of the pipeline would help the US in its efforts to stabilize the country. The US had threatened Pakistan with economic sanctions if it decided to go ahead with the Iranian pipeline.

Another important regional initiative seeking to solve the South Asian energy crisis strives to bring excess hydroelectric power generated during the summer months across south through Afghanistan into Pakistan and India, when electricity is at peak demand. This initiative, the Central Asia South Asia Electricity Transmission and Trade Project (CASA-1000), seeks to export 1300 MW of excess electricity produced in Tajikistan and Kyrgyzstan to Pakistan and India (1000 MW to Pakistan; 300 MW to Pakistan). An agreement between government representatives from Tajikistan, Kyrgyzstan, Afghanistan, and Pakistan met in late 2014 to formally sign the agreement. If completed, the transmission lines will move electricity between Kyrgyzstan and Tajikistan (the first 477 km) and then from Tajikistan to Afghanistan and Pakistan (the final 750 km). CASA is a $1.2 billion project that has received pledges of $4530 in grants and loans from the World Bank along with $15 million from the US Department of State.

Architects of the program argue that "all of the necessary power generation infrastructure needed for CASA-1000 is already in place."[6] Furthermore, they maintain that unless transmitted to another place such as South Asia, the energy will be wasted. Project planners envision CASA-1000 as an important first step in a broader Central Asia-South Asia Regional Electricity Market (CASAREM).

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[6]See CASA-1000 official website: http://www.casa-1000.org/mainpage [accessed October 1, 2015].

The plan is controversial because of the electricity shortages experienced by Kyrgyzstan and Tajikistan, who under this plan will be exporting electricity to South Asia. Supporters of CASA-1000 maintain that domestic electricity consumption in these countries will not be affected because most energy is exported during the summer periods, when electricity is widely available in Central Asia. The funds generated by exporting electricity to South Asia would allow Kyrgyzstan and Tajikistan to raise revenues from exports that could be then invested to limit electricity shortages during winters.[7] In addition, Afghanistan is due to receive 1.25 cents from each kilowatt that passes from Kyrgyzstan and Tajikistan through Afghanistan territory on to Pakistan. The transit revenues could bring up to $45 million in revenues to the Afghan government (Kazimi 2015).

It is easy to see why these two programs hold enormous promise for the region and why they continue to be promoted by domestic policymakers as well as international and bilateral donors. Central Asian countries would benefit from export of energy resources (both electricity and natural gas) to their South Asian neighbors. South Asian countries, in turn, will have successful implementation of both TAPI and CASA-1000 that would alleviate potential domestic pressure on the governments of India and Pakistan to drill for shale gas as the resources brought in through a TAPI pipeline would help alleviate demand for natural gas. Electricity transmitted from Central Asia would alleviate pressure on domestic electricity producers in South Asia who are in search of domestic sources of natural gas to generate electricity.

Although these programs hold enormous promise, there are major obstacles facing the implementation of both projects. The first and most obvious concern is security. It is difficult to imagine a gas pipeline or power transmission cables constructed through the heart of Afghanistan during a period of time when the government of that country struggles to maintain control of its territory. Although some power transmission lines have been built that supply power from Uzbekistan to the Afghan capital Kabul, both TAPI and CASA-1000 would require the construction of pipelines and transmission cables that traverse the Afghanistan–Pakistan border areas. These are areas that governments of both countries struggle to control. Insurgents in Pakistan have targeted existing gas pipelines; thus, it is reasonable to expect that insurgents would similarly challenge the construction of new pipelines and pylons by the state into these contested areas. Towards the end of 2015, major unrest had shaken previously stable parts of northern Afghanistan. The Taliban had captured or contested territory both along the Tajikistan and Turkmenistan borders. Such instability continues to undermine the feasibility of these massive energy projects.

CASA-1000 faces challenges from neighboring states in Central Asia. In particular, Uzbekistan has publically challenged the construction of hydroelectric dams and has raised objections to the construction of two dams that will generate electricity supply for CASA-1000: the Kambarata Dam in Kyrgyzstan and the Rogun

[7] See http://www.casa-1000.org/Docs/CASA1000Brochure.pdf.

Dam in Tajikistan. Uzbek President Islam Karimov and his government have raised strong objections to the construction of the dams because of potential disruption to water supplies in downstream states (Lillis 2012). He has even said that the construction of the dam could provoke a war between the countries. Despite substantial natural gas resources, the economy of Uzbekistan remains heavily dependent upon agricultural production. Agriculture depends on water from the Vakhsh River, which is part of the headwater of the Amudarya River. The Rogun Dam is on the Naryn River, which eventually joins the Syrdarya River. The Amudarya and Syrdarya are the two main tributaries that support crops in Uzbekistan. This is exacerbated by the fact that Uzbekistan's economy is heavily dependent upon export of cotton, which is a very water-intensive crop.

Finally, the most significant challenge to the CASA-1000 project is the fundamental issue of whether there will be enough energy from Kyrgyzstan and Tajikistan to actually export to South Asia. Although CASA-1000 was designed to export electricity during the summer months, when the Central Asian republics traditionally experienced excess hydroelectric capacity, these dynamics have changed in recent years. In 2014, for example, Kyrgyzstan had to import electricity from Tajikistan during the summer to make up for energy deficits. These deficits were the result of inefficient Soviet-era power infrastructure as well as corruption and lack of reform in state-run energy monopolies.[8]

In the globalized economy, countries have myriad sources of energy to draw upon. Although the energy situation in many of the energy-starved countries in the region may seem dire, the countries in the region have several options for how they can access energy. The diverse options before them serve as the most significant impediment to the development of shale gas in the region.

Policy and Security Constraints on Shale Gas and Energy Sector Developments

The development of shale gas in the region, particularly in India and Pakistan, is a long way off. If such resources were to be developed, they would alleviate the need to rely as much on transit through Afghanistan, for instance, to secure natural gas or electricity from Central Asia. It could very well be that the prospect of natural gas and electricity imports from the former Soviet Republics in Central Asia provides incentives for both Central and South Asian countries to have an active economic interest in pursuing peace in Afghanistan. In other words, the development of shale gas in South Asia may divert attention from multilateral and bilateral trade through the region—the creation of a new "Silk Road"—as Afghanistan would no longer have strategic importance to India or Pakistan as an energy transit route upon which

[8]*The Economist*. 2014. "Mi CASA No Es Tu CASA," July 26. http://www.economist.com/news/asia/21608806-plan-export-electricity-looks-cursed-mi-casa-no-es-tu-casa.

those countries could depend for energy imports. Although shale gas may offer long-term domestic benefits, they may come at investments in stronger bilateral relations with neighboring countries. Oddly, the hope of importing energy through Afghan territory gives all the countries in the region a stake in peace in that country.

The shale gas revolution in the US has had major reverberations in Europe and Central Asia. Prior to the heavy development of shale gas in the US, it was heavily dependent upon imports of gas, particularly from Qatar. Increased domestic production of gas in the US has diverted gas supplies from Qatar into both Europe and Asia and as a result has hurt the market share as well as the prices demanded by the Russian gas giant Gazprom. Thus, Russia has lost control over European gas markets, as the Europeans can look to other sources once dominated by the US. Annually, Russia has earned up to $60 billion from selling gas to European markets. Lower prices, along with fewer demand for exports, will drastically slash Russian revenues and have a long-term impact on the regime in Moscow. In this way, the shale gas revolution has directly harmed the power of Russian government at a time when it is also facing major economic sanctions as a result of its military escapades in Ukraine and annexation of Crimea (Kim and Blank 2014).

The energy crisis in South Asia fuels the potential for conflict. Both India and Pakistan are confronted with major electricity and energy shortages that threaten not only long-term economic growth, but political stability. The development of shale gas has the potential to alleviate serious economic and security concerns in the region.

Shale gas could play an important role helping India diversify from its dependence on coal, which fuels more than half of the country's power stations. Although the country does rely on some hydropower sources, these are dependent upon monsoon rains, which have been unreliable in recent years. In 2012, there was a major energy blackout that left 600 million people without electricity, causing damage to the country's economy but was also a warning sign to potential foreign investors.

India has a long history of local populations voicing concerns about government projects that infringe on local land use. So it is likely that any efforts by the state to gain access to the large tracts of land necessary to extract shale gas would be met by significant citizen opposition (Economist Intelligence Unit 2011, p. 24). Like many other countries in the region, the government of India maintains very tight control over the energy sector. In 2013, the Petroleum and Natural Gas Ministry announced that the country would begin work on a plan to make the country energy independent by 2030. This would be facilitated by, among other things, development of shale gas.

One of the most important political constraints to shale gas extraction in India lies in the fact that gas prices are subsidized by the state, in part to help poor populations. Shale gas is capital-intensive and resources to support the extraction of the resources will have to come from increases in user rates, which is a politically tricky issue in the country. Thus, continued state domination of the natural gas sector along with political dynamics may lead the government to scale back some of its initial optimism about shale gas development.

Heavy government regulation of the country's energy sector means that there are few incentives for upstream development of gas resources in India. Raising gas prices would encourage gas firms with economic incentives to develop shale gas but to also explore the development of deep-water plays and other challenging fields (US Energy Information Administration 2014, p. 11).

In 2013, the Government of India approved of a shale gas exploration policy that gives permission for two state-run energy companies to drill for shale gas within conventional blocks already marked for exploration.[9] In 2015, the government promised a plan to introduce a revenue-sharing model with companies that would include a licensing policy that would allow operators to explore all forms of oil and gas resources, including shale gas and oil. This change in policy appears to have resulted from petitions from gas producers that current tariffs given to producers were too low to incentivize exploration and production costs. As a result, major energy companies, such as ExxonMobil, Chevron, and Royal Dutch shell, have not bid on India's exploration-block auctions (Chakraborty 2015). Government policy has thus been the primary constraint on the development of unconventional gas in India.

Without a strong policy foundation, India will not be able to deliver on the promise of unconventional gas. This is due to the fact that in the past two decades, the country has sought to transition from socialist-style energy sector towards one dominated by markets. This transition has been incomplete as the state plays an important role providing a set of "well-meaning policies designed to protect the poor, but that has resulted in a system of untargeted producer and consumer subsidies that prevent a more thorough implementation of a well-functioning and financially sound energy sector" (Ahn and Graczyk 2012, p. 7). This has meant that the government does not have sufficient revenue and capacity to manage its energy resources effectively, casting doubts upon future plans for state-managed extraction of unconventional gas.

In Pakistan, a domestic energy crisis in early 2015 threatened to bring down the government of Prime Minister Nawaz Sharif as gasoline shortages in the largest cities caused lines a half mile long. To deal with the crisis and abate public anger at the government, Sharif cancelled a visit to the World Economic Forum in Davos, Switzerland. Opposition parties in the country said that the gasoline shortages, along with prolonged gas and electricity shortages, illustrated the incompetence of the government (Nauman 2015).

During the summer of 2015, electricity shortages across the region led to prolonged electricity blackouts across the region–12 hour blackouts in rural areas and eight hour blackouts in urban areas., the result not just of energy deficits during a heat wave, but also the result of line losses and large scale theft (Dunya News 2015). Doctors attributed hundreds of deaths during the heat wave directly to power shortages, which meant that people did not have access to fans, let alone

[9] http://www.securities.com/emis/insight/india-%E2%80%93-shelving-shale.

air-conditioning, to help them cope with the heat. The energy shortage also placed pressure on the country's water supply (Hashim 2105).

The energy crisis in Pakistan stems from political factors. The government has mismanaged the energy sector that has resulted in serious problems of the electricity supply, which foments instability. Making matters worse, anti-government insurgencies frequently target the electricity supply of major cities causing prolonged blackouts. In January 2015, rebels from Baluchistan blew up a major transmission line that connected a privately run power plant to the national grid resulting in electricity being cut to 80 % of the country, including the capital Islamabad (Agence France-Presse 2015).

Security concerns also play a major factor in the development of unconventional gas. As discussed above, the US has been less than sanguine about the construction of the so-called "Peace Pipeline" that would bring natural from Iran to Pakistan. Instead, the US has offered to help Pakistan develop its shale gas resources as an alternative to the construction of the pipeline. The promotion of shale gas by the US in Pakistan has been met by a backlash, as some experts have accused the US of promoting shale as an opportunity for American companies to sell their shale expertise and equipment to Pakistanis or to facilitate the entry of US companies into the Pakistani market. Similarly, these critics have noticed that the cost of shale gas would result in far higher gas prices than if gas were imported via a pipeline with Iran (Bhutta 2015a).

Security is also a major impediment to the construction of the "Peace Pipeline" with Iran. The construction of the pipeline would have to travel through the heavily contested Pakistani province of Baluchistan, which has been fighting a major anti-government insurgency for many years in an attempt to gain greater sovereignty. The government of Pakistan has ruthlessly cracked down on insurgent for the past decade. It would be difficult to imagine the government reversing this strategy and making accommodations to the Baloch population in order to build a pipeline. It is unlikely that the Baloch population would benefit at all from the construction of the pipeline. This reason, and those discussed above regarding the sanctions with Iran, makes it difficult to imagine pipeline construction beginning in the near future (Notezai 2015).

Furthermore, the development of shale gas is limited by environmental concerns, such as the provision of water as well as economic concerns, such as the high cost of drilling. Some energy officials in Pakistan believe the country has sufficient water resources to supply wells, but would have a difficult time finding a place to dispose of the water waste from the wells (Bhutta 2015b).

Although shale gas holds enormous promise to boost the Pakistani economy, investments and extraction of these resources will be managed by the Pakistani government, who has shown very little capacity to govern its energy resources. Some early reports estimated that between 75,000 and 1,00,000 jobs would be created if the government embarked on a policy that supported shale gas extraction (Abbasi 2014). Furthermore, if Pakistan were to drill for shale gas, it would not only gain some energy independence from its neighbors, it might also be in a position to actually export gas to neighbors, including Afghanistan and China.

The government of Pakistan has not developed a policy framework for shale gas development but hopes to complete such a policy in the near future.

As discussed above, it is unclear whether Afghanistan possesses any shale gas resources. It will be impossible to explore resources available in Afghanistan until the security situation in the country stabilizes. This is not only true of potential shale gas discoveries, but is a factor in all discussions over exploration for conventional oil and gas, as well as other mineral resources in the country. Journalists exploring Afghanistan's energy potential have noted that Taliban attacks, for instance, appear to be tied to those areas where oil and gas have been developed in recent years (Juhasz 2013).

The decision of the Kazakh government pursue shale gas exploration has puzzled many analysts. There is speculation that the decision results from lessons learned from the country's experience with conventional gas. In the early 1990s, just after the collapse of the Soviet Union, the Kazakh government made a number of agreements with Western companies for the development of gas in the Caspian Sea that current leaders view as unfavorable to Kazakhstan. New shale gas development would be negotiated on new terms, allowing the government to retain higher levels of revenues from its extraction (Panfilova 2014).

There are also geopolitical dimensions to shale gas in Kazakhstan. The Caspian gas must be transported through Russia. Given that Kazakhstan's shale gas reserves are located in the eastern part of the country near china, Kazakhstan could easily export its neighbor, allowing Kazakhstan to bypass Russia and have direct access to outside markets. It is possible that Kazakhstan could export this gas southward to Kyrgyzstan or Tajikistan, and the low levels of gas consumption in these countries would not be worth the enormous investment required to produce shale gas (Panfilova 2014).

Turkmenistan maintains large reserves of natural gas. With low demands from its small population (approximately 4 million people), it is concerned with the nature of its export market. Shortly after independence in 2001, the country declared itself politically neutral, but found itself heavily dependent upon existing pipeline infrastructure with Russia, who was able to control most of Turkmenistan's gas exports. Turkmenistan has been eager to move beyond energy independence from Russia and has been eagerly building pipelines to export gas to China. By the end of November 2015, Turkmenistan had become the first country to begin construction of the TAPI natural gas pipeline. Although the viability of the pipeline remains under question as a result of rising instability in Afghanistan, the Turkmen government is betting on the pipeline to help it diversify exports.

Conclusion

Can shale gas save the economies and build political stability in Central and South Asia? The answer seems far from certain as none of the countries that possess substantial shale gas resources–India, Kazakhstan, and Pakistan—have yet to actively drill for shale gas in a serious way. The potential gains from shale gas in the region are a very long way off.

In the short term, especially while the costs of drilling for shale gas remain quite expensive, it seems more promising that countries will pursue new strategies to import energy from neighboring countries than pursue extensive development of shale gas plays. To illustrate the distance of shale dreams in the region, India and Pakistan appear more focused on the possibility of importing gas and electricity from Central Asia through volatile regions of Afghanistan, than they have been on the development of shale gas. If the costs of drilling technology decrease substantially and if countries are able to find solutions to water shortages and disposal of well-water waste, the countries in the region that have shale gas reserves may alter their calculus and start to drill. Although shale gas holds enormous promise to save the economies of the region, its realization remains a far away dream.

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Fracking in Africa

Caitlin Corrigan and Ilia Murtazashvili

Abstract Substantial environmental concerns have accompanied the shale boom in developed countries where the vast majority of fracking has occurred to date. There is more reason for concern in the developing world where nations enjoy far less governance capacity. This chapter presents a conceptual framework to address the governance situation in developing countries confronting hydraulic fracturing. The framework is applied to South Africa and Botswana, where shale exploration has recently begun in earnest. The chapter clarifies the governance capacity of these countries, as well as areas where institutional and regulatory quality can be improved in order to increase prospects for sustainable hydraulic fracturing.

Introduction

Unlike conventional oil and gas, natural gas trapped in shale formations cannot be profitably extracted by drilling downward and relying on geothermal pressure to force gas to the surface. The economic profitability of shale gas changed dramatically when drillers combined hydraulic fracturing with horizontal drilling. These techniques, along with figuring out how to chemically treat water used to fracture rock, had the effect of creating a new technology for use in shale production (Fitzgerald 2013). The result has been a worldwide boom in production of natural gas from shale deposits.

Economic studies of the shale boom in the USA suggest that shale wealth is a source of sizable economic benefits (Fetzer 2014; Hausman and Kellogg 2015; Maniloff and Mastromonaco 2014; Weber 2012). Yet substantial concerns have been raised regarding the environmental consequences of hydraulic fracturing, such as the consequences of fracking for groundwater quality, housing values, global

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warming, and maternal health (Drollette et al. 2015; Hill 2013; Howarth et al. 2011; Muehlenbachs et al. 2012, 2014; Vidic et al. 2013). There have also been a number of concerns raised regarding the quality of governance of hydraulic fracturing in the USA (Gamper-Rabindran 2014; Spence 2013a, b; Warner and Shapiro 2013; Wiseman 2009, 2010). One of the perceived challenges is that the response to hydraulic fracturing has varied so dramatically. For example, the state of New York imposed a long moratorium on fracking, while the neighboring state of Pennsylvania has been the site of a boom in shale gas production (Murtazashvili 2015; Richardson et al. 2013; Weber et al. 2014).

Despite these controversies, the USA benefits from a high-quality system of governance. The state governments have formidable regulatory authority, and property rights to minerals are well defined, which facilitates leasing of mineral rights for the purposes of hydraulic fracturing. In addition, the US Environmental Protection Agency is coordinating a massive effort to collect scientific information on the consequences of shale production. There are also many opportunities for citizens to voice their concerns regarding hydraulic fracturing at a local level.

Today, many developing countries are also exploring the merits of hydraulic fracturing. In these countries, the governance situation is less certain. The literature on the resource curse suggests that in these situations, resource wealth may not translate into improvements in economic livelihoods. More generally, this literature suggests that the "sustainability" of hydraulic fracturing, which in this chapter refers to improvements in economic growth, job creation, internalization of economic and environmental externalities, and legitimacy of public policies governing hydraulic fracturing, depends on the presence of high-quality governance institutions.

This chapter expands on our previous work (Corrigan and Murtazashvili 2015) considering the governance situation in South Africa and Botswana, two countries that have recently begun to explore in earnest the use of hydraulic fracturing. Although both Botswana and South Africa rank much higher than the regional average in terms of all governance and economic indicators (see Table 1), compared to the USA, both rank much lower in terms of GDP per capita and quality of governance institutions, regulation, and rule of law. Moreover, citizen ability to voice opinion and hold government accountable is much lower compared to the USA and levels of corruption are much higher. Thus, the findings and experiences of hydraulic fracturing in the USA may not be as applicable to southern Africa as they have been in other parts of the world where hydraulic fracturing has been considered. Therefore, it is essential to clarify basic features of the governance situation as African states confront the challenges associated with hydraulic fracturing.

To address governance, we draw upon insights from the social–ecological systems (SES) approach (Ostrom 2005, 2009, 2011). As Holahan and Arnold (2013) have recently shown, the SES perspective is useful in understanding the institutional environment within which hydraulic fracturing is occurring. We extend this recent work both conceptually and with an empirical application to two countries that stand upon the precipice of hydraulic fracturing.

Table 1 Economic and governance statistics

Average 2002–2012	USA	South Africa	Botswana	Sub-Saharan Africa
Control of corruption	1.49	0.25	0.96	−0.64
Government effectiveness	1.60	0.52	0.56	−0.79
Political stability/no violence	0.32	−0.07	0.98	−0.56
Regulatory quality	1.51	0.55	0.59	−0.74
Rule of law	1.56	0.09	0.63	−0.75
Voice and accountability	1.18	0.61	0.51	−0.63
State Fragility (2013)	2 (3)	5 (8)	3 (3)	15 (14)
GDP Per Capita (2013)	45,786 (53,042)	5513 (6618)	5562 (7315)	1850 (2670)

Worldwide governance indicators (control of corruption, government effectiveness, political stability/no violence, regulatory quality, rule of law, and voice and accountability) range from −2.5 to 2.5, with 2.5 being the highest levels of governance. For state fragility, higher scores indicate higher levels of fragility, i.e., 1 equals least fragile. Averages from 2002–2012 are reported, where available 2013 scores are in parentheses
Source World Bank (2013)

To facilitate analysis of the institutional environment of hydraulic fracturing, we discern several governance variables that are expected to influence prospects for sustainable hydraulic fracturing, including equity of distribution of benefits and costs of hydraulic fracturing, information and monitoring capacity, accountability, polycentric decision making, democratic inclusiveness, dispute resolution mechanisms, and adaptability and flexibility. We then use the framework to consider the extent to which South Africa and Botswana fare well on each of these dimensions, and to better understand areas where improvement is necessary in order to improve prospects for resource wealth translating into sustained economic growth, facilitating job creation, and minimizing the chances of socially costly economic and environmental externalities.

The analysis, which draws on secondary sources, legislative documents, and fieldwork undertaken in South Africa and Botswana in July and August of 2014 for the purpose of understanding the regulatory context concerning the extractive industries and the pressures and processes for corporate social responsibility in both counties, provides insights into institutional weaknesses concerning extractive industries in South Africa and Botswana. Confidential in-depth semi-structured interviews (lasting anywhere between 20 min and 3 h) were conducted with 44 individuals, 34 in South Africa, nine in Botswana, and one phone interview. Interviewees included government officials, academics, mining company public affairs representatives, and people from nongovernmental organizations and research institutes. Additionally, many informants worked as consultants to governments or companies for mining community consultation and impact assessments. Many of the interviews touched specifically on hydraulic fracturing in the two countries, but also spoke more generally to the extractive industries' regulatory context in Botswana and South Africa, community consultation requirements for licensing, and the role of local government actors near operations.[1]

The conclusions can be stated briefly as follows. Although each country has strong regulation in place that allows the national government to extract rents from gas or mining activities, there is less evidence that local government and communities are benefiting in the same way. Furthermore, regulatory agencies lack capacity to monitor operational compliance with regulation and provide very little information to local governments and communities that would allow for informed deliberation regarding shale extraction at the local level.

The chapter is organized as follows. Section "Governance of Hydraulic Fracturing: A Conceptual Framework" introduces the conceptual framework that we will use to characterize governance of hydraulic fracturing in South Africa and Botswana. Sections "Governance of Hydraulic Fracturing in South Africa" and "Governance of Hydraulic Fracturing in Botswana" consider governance of hydraulic fracturing in Botswana and South Africa, respectively, and Section "Improving Prospects for Sustainable Hydraulic Fracturing" considers the policy implications, in particular how governance can be improved. Section "Conclusion" concludes.

Governance of Hydraulic Fracturing: A Conceptual Framework

In a broad sense, governance of shale is important because it determines the extent to which there is a resource curse associated with shale production. Evidence from the USA suggests that there are gains from hydraulic fracturing in terms of economic growth. However, an abundance of resources need not make a country better off. The resource curse refers to situations in which increasing production or prices of a country's abundant resources makes the country worse off because of a misallocation of resources to booming sectors or because resource wealth contributes to conflict to control resources (Colgan 2013; Collier and Hoeffler 2005). Collier (2010) suggests there are several factors that are expected to influence the resource curse, including governance, property rights, and technology. Technology provides opportunities for resource extraction. Governance and property rights are necessary to ensure technology transfers into opportunities for prosperity.

While it is fairly uncontroversial to assert that governance matters for sustainable resource use, defining governance is quite challenging. A long tradition of literature considers governance mainly in terms of administrative capacity (Barnard 1938; Fukuyama 2013). In contrast, studies of natural resources tend to adopt a more

[1]Fieldwork interviews were approved by the Institutional Review Board at the University of Pittsburgh (PRO14040328).

encompassing notion of governance. In particular, Ostrom adopts a notion of governance that reflects the complexity of governance systems and also their diversity.[2] Based upon the literature on governance of the commons, we identified seven key variables that are expected to influence prospects for sustainable hydraulic fracturing, which here refers to economic growth, job creation, internalization of economic and environmental externalities, and legitimacy of public policies governing hydraulic fracturing. There are certainly other dimensions of governance that are important. Rather than a comprehensive list, we view this list as a useful starting point to consider governance of hydraulic fracturing.

The first governance variable is equity of distribution of the benefits and costs of use of resources. Ostrom (1990) argued that a system of governance that attempts to more equitably distribute the benefits and costs of extraction of natural resources may be more likely to sustain the benefits stream associated with extraction of these resources. For example, when resources are inequitably distributed, the system of governance may produce conflict over the gains or foster illegitimacy regarding policies governing resources.

In the context of hydraulic fracturing, realizing the benefits depends on the ability of the state to impose fees or severance taxes. In developing countries facing the prospects of a shale boom, governments may not have the ability to implement some sort of tax upon extraction of resources. In addition, there may be few mechanisms to ensure a relatively equal distribution of the environmental and ecological costs of hydraulic fracturing. A key question is whether the government has in place mechanisms to ensure that society bears these costs as a shared responsibility.

A second governance variable is information and monitoring capacity, which includes capacity to gather information on the benefits and costs of resource use, to monitor resource use, and the presence of feedback mechanisms for decision makers to learn about the consequences of policies and programs. Monitoring and evaluation provide insight into when it is desirable to change institutions and governance policies, yet the presence of such capacities cannot be taken for granted in developing countries (Andrews 2013; Andrews et al. 2013).

For hydraulic fracturing, success on the dimension of information and monitoring is a question of the extent government organizations are able to record and disseminate information regarding hydraulic fracturing, the monitoring capacity of organizations charged with regulating shale extraction, and the presence of institutionalized mechanisms that disseminate results of monitoring to key decision makers. Information and monitoring capacity may include the extent to which the state has ability to conduct baseline studies of groundwater, to disseminate information to concerned citizens, and presence of agencies that are capable of conducting scientific studies of hydraulic fracturing. If the state lacks such

[2]Cole et al. (2014) offer a more nuanced theoretical perspective on governance of natural resources.

organizational capacities, then socially responsible firms may provide this information, thereby contributing to more effective governance through private action.[3]

A third variable is accountability, which refers to the extent to which users of a resource bear some of the costs of governance and are accountable for their actions. Accountability, in turn, depends on establishing fairly clear boundaries of responsibility for policies and actions (Gauri and Lieberman 2006; Lieberman 2009, 2011). Accountability is also expected to depend on the ability of the state to enforce the rule of law.

In considering governance of hydraulic fracturing, accountability asks whether the companies who are extracting shale bear the costs of their actions and whether those who violate norms and rules are held accountable for their actions. This in turn leads us to ask whether the state is capable of enforcing its rules. One of the indicators of enforcement is the extent to which the rule of law operates.

A fourth variable, polycentric governance, refers to overlapping systems of jurisdictions. Centralized state action has often been implicated in development failures (Scott 1999, 2012). Polycentric governance is also expected to produce a more inclusive system of governance that includes key stakeholders (Sovacool 2011).[4]

In terms of governance of hydraulic fracturing, the question is whether or not there are multiple units of governance with authority. Some systems of governance are highly centralized, with most authority exercised at the national level and local units as merely administrative bodies with no autonomy. Others are more fully decentralized, with substantial sharing of authority between multiple levels of governance.

The fifth variable, democratic inclusiveness, is expected to improve prospects for sustainable use of natural resources by bringing many different groups into the political process. Increasing participation should improve the quality of institutions and prospects for economic development (North et al. 2009). Democracy at the local level can also ensure the rights of communities are respected vis-à-vis the central government (Myerson 2014).

With shale production, one of the key dimensions of governance concerns the process for deciding on whether to allow hydraulic fracturing. In the USA, for example, there have been major debates about the authority of local governments to decide whether to allow hydraulic fracturing. Citizen participation through elections or referendums and the extent to which the political regime is democratic and encourages or allows groups to participate in the political process are each important to understanding the legitimacy of rules governing hydraulic fracturing, as well as the ability to implement these rules.

[3]Corporate social responsibility, in this sense, can be thought of as a component of governance.

[4]In the case of disease in Africa, polycentric governance is viewed as a source of implementation failure (Lieberman 2009, 2011). However, for natural resource governance, polycentricism is usually viewed as a strength.

Table 2 Governance variables and hydraulic fracturing

Governance dimension	Indicators for governance of hydraulic fracturing
Equity of distribution of benefits and costs	Extent to which the government is capable of redistributing the rents from hydraulic fracturing
Information and monitoring capacity	Capacity of the government to record activities of gas companies, to establish baseline environmental and health readings, citizen access to information from government, and ability to monitor the consequences of hydraulic fracturing
Accountability	Extent company officials responsible for hydraulic fracturing can be held accountable
Polycentric governance	Extent governance of hydraulic fracturing is shared with multiple jurisdictions, both vertically and horizontally
Democratic inclusiveness	Extent to which political processes involving hydraulic fracturing are democratic and inclusive
Dispute resolution	Extent to which the legal framework is capable of resolving conflicts that arise over hydraulic fracturing, including conflicts over land and land use and the environmental and ecological consequences of hydraulic fracturing
Adaptability and flexibility	Extent to which the regime governing hydraulic fracturing can respond to new circumstances

A sixth variable is dispute resolution. Conflict is bound to arise as resource extraction proceeds. When conflict arises, it is essential that there are mechanisms in place that perform the functions of dispute resolution (Ostrom 1990, 2005). These may be both formal and informal, as legal pluralism is common, in particular in developing contexts (Meinzen-Dick and Pradhan 2002). We consider the extent to which a regime governing shale extraction includes provisions for dispute resolution.

Finally, adaptability and flexibility are important features of governance. It is important to understand whether the system of governance has provisions to respond to new challenges since adaptability and flexibility are not guaranteed. To the contrary, one expects that governance will be constrained by past choices and more prone to incremental problem solving or solving the “wrong” problems (Pierson 2000). In analyzing shale, we consider the extent to which rules can be modified in response to changing conditions. Table 2 summarizes the governance framework.

Governance of Hydraulic Fracturing in South Africa

The Karoo Basin in South Africa (see Fig. 1) is estimated to hold up to 390 trillion cubic feet (tcf) of technically recoverable shale reserves, making it the 8th largest shale reserve in the world and the largest in sub-Saharan Africa (US Energy

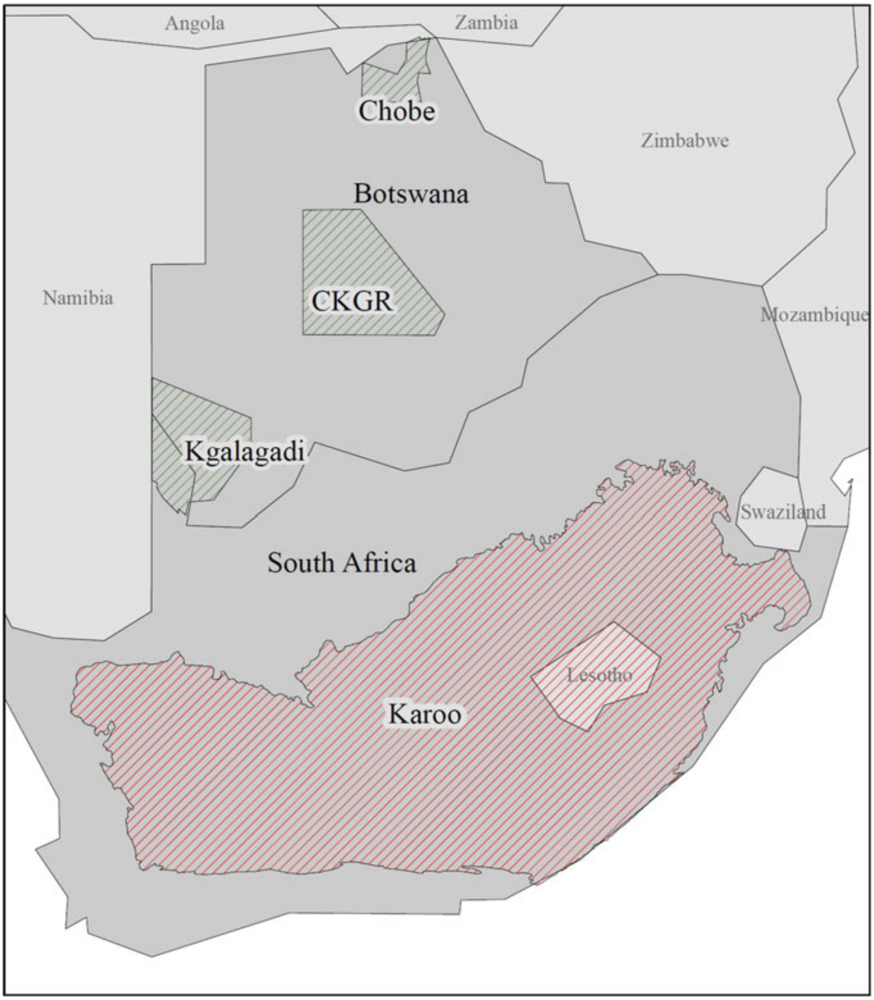

Fig. 1 Potential hydraulic fracturing areas in Southern Africa

Information Administration 2013). This has major energy implications for the region since South Africa is currently a gas importer and only 3 % of energy consumption comes from natural gas (African Development Bank Group 2013; US Energy Information Administration 2014).

South Africa relies on coal for 70 % of primary energy consumption, 93 % of electricity generation, and 30 % of petroleum liquid fuels, while importing around two-thirds of its natural gas. Rolling blackouts are common occurrences, used to deal with excess electricity demands. Shale production has the potential to reduce reliance on coal and increase energy independence. Furthermore, the industry will create estimated 350,000–850,000 direct and indirect jobs (African Development Bank Group 2013; Eberhard 2013).[5] Shale production also promises government revenue, as the Minerals and Petroleum Resources Development Act (MRPDA) (2002) stipulates that the rights to any resources found in the subsurface belong to the government of South Africa.[6]

Despite the potential promise of hydraulic fracturing, there are a multitude of risks associated with shale extraction, particularly for local communities. These risks generally include increased pressures on local infrastructure and water, health, and environmental consequences (Weber 2012). Specifically, the Karoo Basin in South Africa is an extremely water-stressed region. Domestic and agricultural competition for surface and groundwater in the region represents a major risk (Reig et al. 2014). Additionally, geological characteristics of the shale indicate that hydraulic fracturing cannot be done safely the same ways as it has been done in other regions. The potential for ground water contamination suggests a need for more precise regulations on extraction of shale (Van Tonder et al. 2013).

Furthermore, the economic benefits associated with shale extraction in other regions of the world may be harder to realize in South Africa. South Africa has virtually no natural gas sector infrastructure. Due to the absence of this industry in the past, it will also be difficult for companies to reach local content requirements, as specialized capital is needed at start up (Econometrix (Pty) Ltd. 2012). Thus, initial positive economic impacts may be less than expected, due to high upfront costs and low up front benefit.[7] These economic and ecological risks suggest that the potential for sustainable shale production (where mechanisms exists to ensure that the benefits fully outweigh the costs) will be contingent upon the structure of governance in South Africa, which we now consider.

Equity Distribution

The main potential for equity distribution in South Africa would be through government collected taxes and fees since subsurface mineral rights belong to the state. The MPRDA was promulgated in 2002 and attempted to correct much of the exploitation associated with the mining industry during apartheid. The act covers

[5]Other reports argue most jobs will be indirect ancillary services, mainly because there is lack of skills necessary for the directly related jobs (Fakir 2015).

[6]Republic of South Africa, Mineral and Petroleum Resources Development Act (2002).

[7]There is still a wide debate over how feasible shale gas extraction is from an economic standpoint in South Africa as geological and infrastructure conditions are different from the case of the US (Fakir 2015).

the regulation of gas, oil, and mineral extraction and provides a framework for equity of distribution in several ways.[8]

First, the government has the right to levy fees and taxes on operations. Companies are required to submit their financial information to the national government for this purpose. As far as authority is concerned, the government of South African has a clear framework in place to distribute the rents associated with hydraulic fracturing.

Second, all operations must conduct an environmental impact assessment, create an environmental management plan, and submit a Social and Labor Plan (SLP) in order to obtain a license. These requirements were put in place specifically to ensure that the negative social and environmental externalities from natural resource extraction were not solely felt by the local community and, additionally, that local communities received some direct benefits from petroleum and mining extraction. Therefore, the MPRDA not only calls for mitigation of externalities, but also positive development implications. SLPs, specifically, are binding documents that stipulate the ways in which an operation will invest in the surrounding community and workforce and how much they will spend on these projects. Companies consult with local government when designing their SLP. This helps ensure local communities benefit from gas extraction, but also that they have opportunities to challenge what may be perceived as an inequitable distribution of the costs of hydraulic fracturing (Republic of South Africa 2010a). However, there remain many challenges in this process, which will be discussed more in the following sections.

Third, the broad-based socioeconomic empowerment charter, required by the MPRDA, stipulates that 26 % of operations be owned by historically disadvantaged South Africans (HDSA) (Republic of South Africa 2010b). This is another mechanism for spreading the wealth generated from the extractive industries domestically. While the intension of this act was to create broad poverty alleviation and empowerment, it has been criticized for benefiting those in important political positions at the expense of the majority of HDSAs (Fig 2007). Therefore, the way in which shale extraction companies design their ownership will determine how well benefits are actually being spread to HDSAs.

Despite these provisions to attain equity of distribution in South Africa, there are no mechanisms for intergovernmental transfers to different localities based on where shale production occurs. In fact, unconditional transfers to local governments are based on five factors, which include revenue-raising capacity. Therefore, resource-rich localities may even be at a disadvantage for intergovernmental transfers. While local governments can also collect their own taxes, they are often under capacity in this regard. In 2009/2010, local government collections made up only 7.5 % of government revenues (Republic of South Africa 2008, 2011). Thus, the current governance framework for equitable distribution of wealth has

[8]The MPRDA has been criticized because it was not created specifically with shale gas extraction in mind (Vermeulen 2014).

promising structures in place, but faces significant shortcomings in terms of ensuring equity locally and to HDSAs.

Information and Monitoring

There is a framework to monitor extraction of resources in South Africa, as well as a mechanism to disseminate information to the national government. The majority of the authority and responsibility for monitoring production, revenues, and compliance rests with the national government and the Department of Mineral Resources (DMR), according to the MPRDA. The national DMR office approves licenses and the regional DMR offices monitor compliance with SLPs. The MPRDA stipulates that all financial information be provided to the national government.

Despite the presence of a basic framework to disseminate information at the national level, information sharing between national and local governments is weak and often the onus is on the companies to disclose at the local level.[9] There are no requirements for distribution of information concerning SLPs or revenues to local governments. The lack of a mechanism to distribute information to lower levels of government reduces opportunities for local governments and citizens to gather accurate information about the potential financial impacts of a project. Financial limitations in local government also mean that they often unable to fully comply with their directives to institutionalize public participation (Picard and Mogale 2015, p. 171). While citizens could gather information through the Public Access to Information Act, this is an arduous process that places the burden of information collection on citizens. As a consequence, local governments and community members often know very little about the profitability of an operation or the SLP promises, even if the national government is well informed.

Accountability

The government has the ability, through the DMR, to hold companies accountable to the standards of the MPRDA. Environmental or worker-safety non-compliance with regulation is seen by the companies as a major threat to operations, as this can result in a shutdown. However, social investment non-compliance has not been a major issue to date.[10] During fieldwork, informants were asked about the issue of

[9]Interviews, July 2014, Regional Expert, National Government Official, Local Government Official, CSR Expert South Africa.

[10]Interviews, July 2014, Industry Spokesmen, South Africa; July 2014, Legal/CSR expert, South Africa; July 2014, Government Official, South Africa; July 2014, Researcher, South Africa.

compliance with social investment promises. The following, from a legal and corporate social responsibility expert, was representative of the comments:

The fact of the matter is that these social and labor plans (or) mining rights are given on the basis of (social investment) promises… (But) I have never heard of one mining right being pulled because of not fulfilling a social and labor plan commitment.[11]

Capacity constraints in monitoring compliance are especially troubling at regional DMR offices. According to a government official interviewed, companies are aware of the lack of capacity to monitor compliance at the regional DMR level and, due to the reduce threat of sanction, may not pursue social investments as promised:

With the limited capacity that we (the DMR) have… we are lucky in a region where we have two social plan people who can do actually the (compliance) assessment… So, companies are aware that we don't have the capacity, we are thin on the ground. So, some of them get away with (non-compliance), because they know … even if you (the DMR) find non-compliance, chances of you coming back are very slim.[12]

Thus, while mechanisms are in place to monitor compliance with promises and externalities, lack of capacity often undermines the ability of government agencies to properly sanction harmful activities.

Polycentric Governance

South Africa has elements of federalism built into its constitution. There are also provisions for political representation of traditional authority.[13] In practice, however, policy making is highly centralized. Local governments and traditional authorities have far less capacity than higher levels of government[14] and, as one informant suggested, local governments face challenges in retaining administrative talent:

If you remotely perform at the municipal level you get pulled up to the provincial or state level. So there is just a dearth of skills of the municipal level. Not because we don't have good policies in South Africa. It is on the implementation level that we fall down.[15]

[11]July 2014, legal/CSR expert, South Africa.

[12]July 2014, Government Official, South Africa.

[13]Constitution of the Republic of South Africa, Chapter 12.

[14]The majority of provincial or local government functions are aimed at service delivery and not decision making. Even with regards to service delivery, local structures are under financed (Picard and Mogale 2014, 2015).

[15]Interview, July 2014, Regional expert South Africa.

In addition, the majority of organizational structures are at the national level. The Ministry of Finance gathers information for royalties and taxes. The DMR has a national office with duties such as licensing, policy making, and gathering of production statistics, while DMR regional offices have monitoring duties.

Despite a theoretical decentralization of authority, there are oftentimes substantial coordination problems between levels of government. One issue is confusion over the respective duties of the provincial DMR and local governments which can result in redundant activities or certain duties not being filled. Furthermore, companies may be preforming similar tasks in similar areas, yet the various companies or local governments are unable to coordinate to capitalize on the economies of scale of a project.[16] As one interview remarked: "there is not a very clear line between what government's responsibilities are, in terms of service provision, and what the mines' responsibilities are."[17]

The Department of Environmental Affairs and Tourism is responsible for environmental impact assessments required by the MPRDA (Walmsley and Tshipala 2007). However, MPRDA does not directly address the effect of hydraulic fracturing on groundwater supplies. After the moratorium on hydraulic fracturing in 2011, an inter-departmental task team was created to establish new guidelines on drilling in the Karoo and, more broadly, in South Africa (South African Government News Agency 2013). Because hydraulic fracturing is tied closely to water usage and a major concern is water contamination, in addition to dealing with the DMR, the new guidelines on petroleum exploration and production (yet to be formally approved) call for the involvement of the Department of Water Affairs (Department of Mineral Resources 2013). Additionally, the Treasure the Karoo Action Group argues that many government department with relevant stakes in the debate over shale extraction have not been consulted (such as the Department of Agriculture, Department of Health, Department of Rural Development and Land Reform, Department of Tourism, and the Department of Transport) (Karoo Action Group 2015). Thus, the nature of shale extraction requires increased participation across agencies.

The Kgalagadi Transfrontier Park (see Fig. 1) is one area where organizational complications could become evident for both Botswana and South Africa. This nature reserve has potential for unconventional gas extraction and stretches across the borders of South Africa into Botswana. The park is jointly managed by the two governments and the wildlife populations migrate openly between the countries (Republic of South Africa 2015). Reports indicate that Botswana has already issued exploration licenses on their side of the park (News24 2015). Since South Africa has not granted any exploration licenses for hydraulic fracturing, and environmental externalities generated by exploration in Botswana have the potential to affect the

[16] Interview, July 2014, CSR Expert, South Africa; July 2014, CSR Expert, South Africa.

[17] July 2014, CSR expert, South Africa.

wildlife in South Africa, this is an area where governance is polycentric, but coordination problems may arise because governance transcends national boundaries.

Despite nominal federalism in South Africa, governance remains centralized. In addition, where there is decentralization of governance, local agencies often lack skill or capacity and there are a number of coordination problems (domestically and internationally) that could potential affect governance of hydraulic fracturing.

Democratic Inclusiveness

While South Africa has made obvious strides in establishing a more democratically inclusive political regime since the Apartheid era, there remain several challenges on this dimension as far as governance of natural resource extraction is concerned. First, while communities are supposed to be consulted with in terms of the creation of SLPs via their municipal government, there is little in the way of community consultation or opinion gathering in terms of the technical cooperation permits which are being issued (which allows companies to do feasibility studies prior to exploration) (Fig 2012). Even when exploration and production licenses are generated under the MPRDA, community consultation is often inadequate.

Second, even though local governments and companies may be required to consult communities at the beginning of a project, there is often little engagement after operations begin. As a NGO official explained:

I have pictures that I took last week in Limpopo, where they consulted with the community in 2004. Lots of meetings, making all kinds of promises. So I go there and I take pictures of the noticeboards of the community meeting place… all the notices are dated 2004, so that's the last time they did anything with the community. So I went and I asked the community, when did you last see these people? In 2004. That's when they needed a mining license. Once they got their mining license the CSR (corporate social responsibility) is gone, out the window.[18]

Third, it is up to a company to determine who is in their "community." Although MPRDA and SLP guidelines stipulate that all local governments and communities be consulted about operations, there are no guidelines for how an operation should consult communities or a list of the types of stakeholders they should include.[19] The landmark case, concerning Genorah Resources, exemplifies this confusion. The company was granted a prospecting license under the MPRDA on Bengwenyama traditional community land. However, the community never signed the consent form, was never formally consulted, and even applied for their

[18]July 2014, NGO Official, South Africa.

[19]July 2014, Government Official, South Africa.

own prospecting license (which was refused). The case was appealed several times and finally the Constitution Court of South Africa ruled in favor of the community (Christiansen 2013). While this decision was a win for communities, legal conflicts such as this reflect an underlying lack of clarity regarding standards for community consultation.

Finally, local governments and communities can often be at a disadvantage in terms of participation because they are getting most of their information from the companies in question and may not fully understand the process. Because of this informational imbalance, communities and local governments have less bargaining or decision-making power compared to the companies.[20] One of the informants stressed the lack of information as particularly challenging:

So you are talking about a power imbalance, a massive power imbalance where most mine affected communities are in a rural set up. …You have mining companies coming in with a lot of money and a lot of knowledge and talking very technical stuff, throwing a lot of information at communities, that they can't digest, and the time frames in which consultations take place just do not amount to a sufficient interrogation of the facts. And meaningful consultation means taking the facts into consideration and making up your own mind about it. There is no way that meaningful participation happens…it just does not happen.[21]

On the other hand, civil society groups have played a noticeable role in this particular debate. Groups such as the Treasure the Karoo Action Group (TKAG) have led the charge against hydraulic fracturing in South Africa and created their own community voice that led to a moratorium on fracking for over a year (Karoo Action Group 2015). Civil society thus appears to be a possible engine of increasing inclusiveness in the debate over hydraulic fracturing. However, the TKAG is made up predominantly of the more wealthy white land owning farmers in the region, mainly concerned about the scarcity and contamination of water.[22] The Khoisan people and other black Africans, many of who live in extreme poverty in the region, may have very different concerns and priorities with regard to shale extraction, but also may have a harder time coordinating civil society. For instance, the founders of TKAG spent over 60,000 dollars of their own personal wealth to bring their issues to the forefront.[23] Impoverished communities do not have that opportunity. Therefore, while civil society groups provide an opportunity to increase inclusiveness in the discussion about fracking, it will not necessarily increase inclusiveness equitably across the populations in the region (Cropley 2013; Pitock 2011).

[20]Interview, July 2014, legal/CSR expert, South Africa.

[21]July 2014, legal/CSR expert, South Africa.

[22]Since the landowners in the region own only surface rights, while the government owns sub-soil rights, they will not receive any direct benefit from extraction, but may face higher competition for surface water use vital to agriculture.

[23]The richest man in South Africa, Johann Rupert is also one of the effort's biggest supporters.

Dispute Resolution

As Table 1 in the introduction displayed, South Africa is relatively strong in terms of the rule of law compared to the rest of the region. There is also evidence for the population's confidence in legal institutions, provided by the actions of groups like the TKAG, which have taken the government to court to release information on shale gas extraction.

The MPRDA also has provisions for dispute resolution concerning extraction activities. It spells out the process of dispute resolution for "any person whose rights or legitimate expectations have been materially and adversely affected" (Republic of South Africa 2002). Individuals have the opportunity to appeal to the director general or minister of the designated agencies when a dispute occurs. If these options are exhausted, then judicial review under the South African court system is allowed.

Unfortunately, the system appears to be quite backlogged. As of August 2012, there were approximately 2000 unresolved internal disputes under the MPRDA (Mavuso 2013). Many disputes have also gone beyond the DMR and have appealed to the High Courts, Supreme Court, or Constitutional Court to rule over disputes regarding the extractive industries. Most disputes occur around mining activities, and of these, many involve environmental issues. For example, in April 2015, a coalition of eight civil society and community organizations legally challenged a DMR' decision to grant a mining right to a mining company inside the Mabola Protected Environment (Center for Environmental Rights 2015a). At least 16 finalized cases have been brought before higher courts since the MPRDA came into force and there are at least 16 cases still pending judgment (Center for Environmental Rights 2015b).

The presence of institutions providing citizens with legal recourse, and the willingness of courts to exercise judicial review over issues involving extraction of natural resources, is cause for optimism regarding fracking. However, it is axiomatic in legal studies that those with resources have advantages in adversarial legal processes.[24] For this reason, one expects gas companies to have structural advantages in dispute resolution processes. In addition, the large number of pending disputes suggests the process may be inefficient.

Adaptability and Flexibility

Regulation over natural resources has changed dramatically since the introduction of the new democratic government. However, this process has been slow moving. It took almost a decade to formally establish the new mining and petroleum laws.

[24] Indeed, even in a highly institutionalized legal system, the 'haves' tend to come out ahead (Galanter 1974).

Nonetheless, these documents account for the welfare of the broader population more than previous regulations.

The creation of The Petroleum Agency of South Africa (PASA), the recent addition of the Gas Utilization Management Plan (GUMP), and the draft proposal on technical regulations on petroleum exploration and development demonstrate the government's public commitment to specifically regulating the gas industry in the future. Additionally, the moratorium that was placed on shale gas exploration from 2011 to 2012 and the fact that only technically cooperation permits, and not exploration permits, have been granted (Reig et al. 2014), points to the government's priority of making sure that some sort of consensus can be reached.

Despite the formal governance structures in place in South Africa noted above, decision making and implementation, as well as information dissemination, remain highly centralized. Even though institutions are in place on paper, their effectiveness and equity are often challenged in practice. Furthermore, at the local level, it is not clear that community consultation or engagement mechanisms have been standardized in any way. Thus, the extent to which regulations are tailored to the new demands of hydraulic fracturing, in particular mechanisms to elicit feedback from communities, remains unclear.

Governance of Hydraulic Fracturing in Botswana

Directly to the north, Botswana is also licensing exploration permits for the underground exploitation of the coalbed methane (CBM), which would also involve hydraulic fracturing processes. While estimates for reserves are unclear, exploitation of these reserves would be taking place within valuable wildlife areas in the country (see Fig. 1), the Central Kalahari Game Reserve (CKGR), Chobe National Park and the Kgalagadi Transfrontier Park (shared with South Africa) (Barbee et al. 2013; Lee 2014; News24 2015).

In terms of unconventional gas extraction, the rights to exploration and exploitation rest with the national government in Botswana (Government of Botswana 1967, 1981, 1999). Botswana is now in early stages of granting exploration licenses for CBM in the CKGR, as well as in Chobe National Park and the Kgalagadi Transfrontier Park (Barbee et al. 2013; Lee 2014; News24 2015).

Botswana has long been viewed as a success case compared to its neighboring countries (Picard 1987). Explanations for Botswana's success focus on the long history of participatory democratic institutions, in combination with vast diamond wealth (Acemoglu et al. 2003; Picard 1979). The effective use of diamond revenues has led to high rates of economic and social development since independence in 1966. However, even concerning the diamond industry, transparency about the extractives sector remains a problem at national and local levels.[25] The more recent

[25]Interview, July/August 2014, Regional Expert, NGO Official, and Industry Expert, Botswana.

debates about allowing CBM extraction to occur have also been shrouded in secrecy. Given that extraction has many risks (the fragile nature of the biological environment (large animal populations and extreme water scarcity) and threats to indigenous populations that live around the potential extraction sites) and benefits (energy independence), it is useful to consider several aspects of the prospects for CBM governance before extraction begins.

Equity Distribution

Because unconventional gas exploitation in Botswana results from coalbed methane, it is covered by mineral mining laws and not petroleum mining laws. The Mines and Minerals Act of 1967 vest mining rights in the State. The 1999 Mines and Mineral Act reaffirmed this right with the exception of the rights under the Tribal Territories Act. Under the act, the government has the right to acquire a 15 % working interest in any mining operation granted a license. Moreover, licenses are only granted to non-citizens as an exception. Additionally, operations are required to pay a 3 % royalty of gross market value on mineral products to the government and an annual charge. Thus, the national government is able to extract revenue from an operation through ownership, as well as through taxes.

In general, the Botswana Government has a policy that natural resources, including mineral resources, benefit all (Collier 2013). In the case of diamonds, there has been a clear government policy of revenues from diamonds benefiting the whole country and not just the mining regions. Thus, local governments may not benefit from the new wealth creation to the same extent that they are suffering from the negative externalities. While transfers are not made to local governments based on natural resources, local governments have the opportunity to levy taxes themselves (Government of Botswana 1965). However, the capacity to do this is low and will vary depending on the capacity of local government.

The Botswana government does require environmental impact assessments (EIAs), administered through the Department of Environmental Affairs. However, in contrast to South Africa, there are no specific requirements for social impact assessments or something similar to SLPs. As one interviewee explained.

(CSR for companies in Botswana) is probably 30 years behind how big companies work in South Africa. It is very random. What you would get there (Botswana) is what I always call chairman’s follies. Where you have the wife of the chairman or an executive’s favorite pet project … there are no safeguards against it. Zero.[26]

[26]Interview, July 2014, CSR expert, South Africa.

Therefore, within the licensing process, there is no promise of local community development benefits. While most major companies in Botswana have some sort of corporate social investment program, there are no regulations surrounding these investments.

Information and Monitoring

In terms of reporting and monitoring, Botswana ranks quite low among resource-rich states. The Resource Governance Index (RGI) ranks Botswana as the 9th worst country (out of 58) for reporting practices. This is by far the Botswana's worst resource governance score (Natural Resource Governance Institute 2013).

The government itself does have information regarding production of natural resources and is thus able to tax at a national level. However, it only reports these amounts, as well as export statistics, in aggregate to the public. EIAs are not published publically and there is no freedom of information act in the country. Thus, it can be very difficult for local governments or communities to have accurate knowledge about the benefits they should be receiving from resource extraction or to be able to monitor actions on the ground.

Accountability

Because the government has the possibility of investing up to 15 % in any operation, it can directly hold companies accountable to their responsibilities, as government officials are often part of the decision-making process. The reporting requirements at the national level allow for the national government to hold companies accountable in terms of revenue generation. However, without a mechanism for local information gathering it can be hard for local governments and citizens to directly hold companies accountable. There also appears to be some confusion regarding the responsibility of mining companies. As one of the informants explained:

The people in those villages (near the mines) are not aggressive. They are not politically inclined. They go on with their normal lives. So sometimes you cannot really know if there is an issue… or they [the villages] are not sure that you're supposed to do something for them. So even (if) you ask them, what do you think of the mine, they will say, no, it is not the mine's responsibility.[27]

[27]Interview, July 2014, Debswana Representative, Botswana.

One possibility is that citizens do not want to hold the mining companies accountable. However, it may be the case that villagers do not hold them accountable because they lack information, which makes them less politically "aggressive."

Polycentric Governance

Politically, Botswana is a one-party state and is extremely centralized with the elected local government having very little formal authority (Poteete et al. 2014). However, at the national level there several governmental departments that must coordinate in terms of resource governance. The Department of Mines is charged with issuing licenses and permits for mining activities and producing information about revenue generation. The Botswana Unified Revenue Service and the Bank of Botswana gather information on revenue generation. The Department of Environmental Affairs is responsible for administering and controlling EIA activities. Because CBM extraction could occur inside a national park, Ministry of Environment, Wildlife, and Tourism would be involved for that reason as well (Natural Resource Governance Institute 2013; Walmsley and Tshipala 2007).

Local governments are comparatively under capacity in terms of generating their own revenue. Local government's entire development expenditure and 80–97 % of recurrent expenditures are met by central government. District councils in rural areas only collected between 4.4 and 9.3 % of their own revenue in 2009/2010. However, even if dependent on the central government, there are varieties of relevant structures that make up local governance. Rural areas have district councils and district administration, and each area is represented in the central government by a district commissioner. Local areas also have a Land Boards, which administer the tribal land in trust. They are half appointed by the traditional village assemblies, known as *Kgotla*, and half by the minster of Land. Lastly, traditional local chiefs still play a role in governance in two ways, they are the chairmen of the *Kgotla*, connecting the community to the government, and they preside over traditional courts (Poteete et al. 2014; Sharma 2003, 2005, 2009). Thus, there are many local government institutions that citizens and companies can potentially use in terms of governance of CBM extraction.

While decentralization has many benefits for natural resource governance, it is often derailed by ideological and jurisdictional conflict (Agrawal and Ostrom 2001). In Botswana, political conflict has often undermined meaningful decentralization (Poteete and Ribot 2011). In fact, in the natural resource sector, political conflict led to recentralization of natural resource governance in Botswana (Poteete 2009). To the extent the experience with other natural resources is a guide, the commencement of hydraulic fracturing may lead to political pressure to limit the role of local government in regulation and taxation of hydraulic fracturing.

Democratic Inclusiveness

As was mentioned above, Botswana's economic success has been largely attributed to strong institutions, in particular integration of customary governance into the political regime (Acemoglu et al. 2003; Picard 1979). The Tswana tribes that make up the majority of the population in Botswana are known for their mechanisms of local democratic participation (Acemoglu et al. 2003). This system allows for normal citizens to express their concerns in the *Kgolta* and to trust that these concerns are relayed to the proper authorities (Sharma 2009).[28]

Despite important mechanisms in place locally to ensure participation, these institutions cannot be effective if there is low transparency. One of the major complaints by foreign media has been that licenses for CBM exploration have been distributed by the government with little transparency and in environmentally and culturally important areas, such as Chobe National Park (home to the world's largest elephant herds) and the CKGR. Furthermore, there are accusations that these licenses infringe on the rights of the traditional populations of the Basarwa (or San) in the CKGR with whom the government has long been in a legal battle concerning access to land. Such reports indicate challenges to citizen participation in conversations about CBM extraction. It is reportedly hard to find experts on hydraulic fracturing and CBM in the region and NGOs and communities have little knowledge about the processes and possible negative externalities of shale exploitation.[29] For example, the government only revealed that several CMB licenses were granted after media accusations (Ramsay 2013).

Dispute Resolution

Botswana fares well in terms of rule of law. The success of the Basarwa (or San) in taking the government to court over their illegal removal from the CKGR demonstrates the ability of the public to hold the government and extractive industries accountable in courts. The fact that the Basarwa removal had to do with allegations that the government was making room for diamond mining and tourism indicates that similar incidents may occur with the extraction of CBM.[30] While the Mineral and Mines Act does not specify the process for dispute resolution, it does mention that anyone who feels dissatisfied with agreements made under the act is entitled to arbitration under the Arbitration Act (Government of Botswana 1999).

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[28] Interview, August 2014, Academic, Botswana; August 2014, NGO Official, Botswana.

[29] Interview, July 2014, NGO Official, Botswana. See also Barbee et al. (2013).

[30] Basarwa (or San) took the government to court in 2002 over a dispute of illegal removal from their traditional area inside the CKGR, which they won in 2006. In 2010, they took the government to court again because they were being denied access to water inside the CKGR, the courts ruled in their favor again in 2011 (Survival International 2014).

Another aspect that potentially bodes well for Botswana is integration of de facto mechanisms of legal decision making into the formal legal regime. Traditional courts, which handle about 80 % of criminal and 90 % of civil cases in the country, are an added layer of legal protection (Sharma 2003, 2005, 2009). There are possible organizational complications or conflicts that could arise at the local level over the dual court system since the traditional court is often preferred by citizens because it is cheaper and more approachable. Regardless, more options are often better as far as adjudication is concerned, although the extent to which such de facto tribunals operate depends on the extent that the state provides them with autonomy (Meinzen-Dick and Pradhan 2002; Stringham and Zywicki 2011).

Adaptability and Flexibility

A strong tradition of democracy, though one-party dominate, with free and fair elections, both at the local and national level, in combination with mechanisms for local democratic participation, indicates that the government will be able to adapt to changing perceptions and preferences as they arise. This will occur either naturally, though elections and citizen expressing preferences to district councils and commissioners, or thought court action, as we saw with Basarwa in the CKGR.

On the other hand, citizen access to relevant information is key to making sure that the government is responding to the CBM issue in a way that benefits the citizens of Botswana. The secrecy of the exploration process up to this point has left many citizens unaware of both the positive and negative effects of CBM extraction. The government has been slow to react to a call for a freedom of information act which would increase the amount of information that NGOs and communities have on the extractive industries in the country.[31] There has been little indication that new legislation is being discussed for unconventional gas exploration and this could be because there has been little outcry from normal citizens, who do not understand the nuances of CBM extraction.

Improving Prospects for Sustainable Hydraulic Fracturing

In South Africa, national legislation concerning minerals and petroleum is strong, yet it is unclear whether companies and national government are sufficiently accountable to communities where hydraulic fracturing will occur. Additionally, while legislation has created governance institutions for the resource extraction sector, there remain capacity and coordination problems that decrease the ability for

[31]Interview, July 2014, Botswana Expert, Botswana; Interview, July 2014, NGO Official, South Africa.

government institutions to sanction wrongdoing. Increasing the capacity for local communities and local governments to participate in the debate about shale gas extraction and to gather more information on the process could better ensure that the government and the shale industry are adapting to the needs and demands of the population. Shale-specific regulations and increasing regional capacity to monitor compliance will also improve prospects for sustainable hydraulic fracturing.

Botswana is something of a contrasting case. Overall, while the institutions are in place to create inclusivity and accountability in the CBM extraction process, increasing the ability for citizens and local governments to gather information and monitor exploration would be vital to making sure that the strong democratic institutions in Botswana are effective in terms of resource governance. Moreover, given the different nature of the externalities that result from CBM extraction, legislation specific to this type of activity should be considered and the relevant authorities should be brought into the process. Given the one-party "administrative" state at the national level, increasing government oversight would increase the chances of an open debate with relevant authorities seeing as though transparency has been an issue with CBM exploration licensing up to this point. Lastly, organizational conflict could become evident in the case of the Kgalagadi Transfrontier Park, where there are cross border externalities with South Africa. Therefore, a mechanism for clarifying the rules concerning exploration along shared boarders needs to be established as well. Table 3 below summarizes how each country fares on the various governance dimensions.

These findings suggest several ways to improve prospects for sustainable hydraulic fracturing. First, because in the context of South Africa and Botswana the national government is the main actor collecting rents from shale operations, it is important to ensure the state extracts its fair share of the scarcity rent from hydraulic fracturing. A challenge with African state is that it is attenuated in the sense it has vast authority and limited capacity to implement its rules, including rules that would ensure its scarcity rent is not carried away (Bromley and Anderson 2012). In addition, the state must be able to commit credibly to its state-owned minerals in order to profit from them. When the state is unable to commit to exerting its ownership of minerals, the state may capture only a very small amount of the scarcity rent associated with these resources (Murtazashvili 2013). The challenge is that such commitments generally require strong political institutions to ensure that the state can avoid giving away the state's precious mineral resources to powerful groups. Thus, while our framework clarifies the importance of clarifying the state's interest in securing rents from hydraulic fracturing, there are formidable challenges to asserting control over natural resource wealth.

An additional challenge is ensuring local government profit from shale production. In both South Africa and Botswana, it far from clear that local governments will share in the benefits of shale production, yet they are certain to bear the costs (more precisely, communities are sure to bear the costs). Thus, the challenge of equity is likely to play out locally, where changes may be necessary in order to ensure greater legitimacy with shale production.

Table 3 A comparison of governance regimes

Governance dimension	South Africa	Botswana
Equity of distribution	• Laws allow for gathering of revenues at national level • Local governments have limited ability to collect revenues or fees	• Laws allow for gathering of revenues at national level • Local governments have limited ability to collect revenues or fees
Information and monitoring capacity	• National government can gather needed financial information • Citizens and local government have some information gathering capacity	• National government can gather needed financial information • Citizens and local government have very little information gathering capacity
Accountability	• Low governmental capacity to monitor operations at all levels	• National government can directly and indirectly hold industry accountable • Local governments and citizens must rely on indirect accountability
Polycentric governance	• Highly centralized and somewhat horizontally dispersed governance structures • Local and traditional structures only included during SLP consulting and are under capacity • Cross border jurisdiction could become a problem with Botswana	• Highly centralized and somewhat horizontally dispersed governance structures • A variety of local institutions for managing citizen concerns • Cross border jurisdiction could become a problem with South Africa
Democratic inclusiveness	• Need for standards in community consultation process • Need for more local information from credible sources • Strong NGO action on topic of shale	• Strong institutions for local democratic participation and inclusiveness • Lack of information makes these institutions less useful for decision making • Problem of secrecy over licenses
Dispute resolution	• Strong trust in court system • MPRDA conveys information regarding the dispute resolution process • System is backlogged	• Strong trust in court system • Right to arbitration under mining law • Local level traditional courts often preferred by locals
Adaptability and flexibility	• Post-Apartheid resource extraction legislation that prioritizes public benefits • Government is beginning to tailor legislation to gas industry • Slow moving but progress is being made	• Strong democratic institutions indicate the government is adaptable to changing attitude in the country • Lack of information on CBM hampers the democratic process • Little indication of creating a specialized law for CBM

Second, improving information gathering at the local level is critical for sustainable hydraulic fracturing. The information must also be available to interested stakeholders, which requires thinking about transparency. Transparency must also go beyond disclosure to include efforts to ensure the message and information is received and utilized. Transparency can and should enhance democratic participation (Fung 2013; Fung et al. 2007).

Both countries have rudimentary mechanisms in place to gather information at the national level. At the same time, in both countries, there are fears that the information will not work its way down to citizens. Once the government has information, the next step is to package it in a way that is easy for citizens to digest. Government should also play an active role in dissemination rather than relying on companies to give local populations the pertinent information.

Third, it is important to focus on accountability mechanisms. Monitoring capacity is important for inducing changes in behavior, and it is necessary to establish accountability mechanisms. Without accountability, which requires strengthening to an extent rule of law institutions, there may be few ways to hold companies accountable or to penalize politicians who may have been lax in oversight of these companies.

Fourth, it is critical to address the coordination problems that arise in polycentric systems of governance. Polycentricity can be a strength, provided there is good coordination among local governments and between local and national governments. Yet in both countries in this study, it is far from clear whether the coordination mechanisms that are in place are adequate.

Conclusion

Refinements in hydraulic fracturing technology promise many economic benefits. However, the countries at the forefront of the shale boom are developed countries with high-quality governance. Whether developing countries experience a similar and sustainable boom will depend to an extent on the quality of governance in these societies. The tremendous variation in the institutional environment of hydraulic fracturing requires thinking about the governance situation in developing countries that are now considering seriously the use of these new techniques.

This chapter addressed the issue of governance by providing a framework to consider the potential for improving the sustainability of hydraulic fracturing. The empirical studies explored how South Africa and Botswana fare on several governance dimensions. The central findings are that on some dimensions, there is cause for optimism regarding the prospects for sustainable hydraulic fracturing, including strong legislation over the extractives sector and accessible and legitimate (even if backlogged) dispute resolution institutions. At the same time, there are a number of areas for which governance can be improved to increase the chances of shale wealth translating into a blessing rather than a curse. These generally include increased information transparency, accountability, monitoring capacity, and effective local level and civil society participation. Increasing governance in these areas will further ensure the legitimacy of the policies that are created to regulate the shale industry. More generally, this chapter illustrates the importance of considering carefully the governance situation as countries balance the benefits and costs of hydraulic fracturing in their effort to improve economic livelihoods and economic development prospects.

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Shale Development and Mexico

Thomas Tunstall

Abstract The opportunities for unconventional or shale oil and gas production in Mexico remain at the earliest stages of development. The bulk of Mexico's shale prospects appear to lie in the North and Northeastern sections of the country, where the infrastructure is often largely undeveloped. While significant hurdles remain with regard to the ultimate success of energy reform in general, and shale oil and gas development in particular. If these issues can be addressed, Mexico will be in a position to recapture its role as an energy leader in America.

Opportunities for unconventional or shale oil and gas production in Mexico remain in the earliest stages of development. While shale gas production increased significantly in the USA since 2000, and shale oil production since 2008, no other country in the world has yet to replicate that success. Due to its close proximity to major shale field development in South and West Texas, Mexico is particularly well positioned to take advantage of unconventional extraction techniques. However, significant challenges will have to be addressed.

Mexico already imports refined products and natural gas from the USA. In 2013 and 2014, for example, Mexico imported over 650 billion cubic feet of natural gas each year from the USA, up from only 333 billion cubic feet in 2010. New natural gas pipeline projects will transport additional supplies to Mexico in future years. All of this while Mexico sits on top an estimated 545 trillion cubic feet of natural gas reserves. Estimates for unconventional oil reserves in Mexico are estimated to be 13 billion barrels (EIA 2013), though in both cases, the lack of available geological information remains an issue.

The importance of energy reform in Mexico should not be underestimated. Despite increasing amounts of investment on exploration and production (E&P) by Pemex, oil production in the country peaked in 2004. Were it not for the prospect of energy reform implementation, Mexico would likely transform from a net exporter of crude oil to a net importer within a few years.

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While some tentative steps at energy reform in Mexico were undertaken in 2008, they amounted to little more than the ability of private companies to work as subcontractors for Pemex. It was not until 2013, when President Enrique Peña Nieto ushered in an overhaul across several sectors of the economy that the prospect for change began to get significant traction. Private companies are being allowed to bid on blocks of mineral rights that formerly were under the exclusive purview of Pemex.

The bulk of Mexico's shale prospects appear to lie in the north and northeastern sections of the country, where infrastructure is often largely undeveloped. This means that in order to tap the country's bounty of shale oil and gas, infrastructure such as roads, housing, rail, pipeline, and many others will have to be built out first. The ability to develop a suitably skilled workforce will be essential to long-term success. Security issues must also be addressed. As such, the potential unconventional oil and gas production in Mexico poses many interesting challenges in the wake of recently enacted energy reform.

On the other side of the Rio Grande River, South Texas has seen extraordinary economic activity as a result of the Eagle Ford Shale. The economic impact in 2013 was estimated to be $87 billion, supporting over 150,000 full-time jobs (Tunstall et al. 2014). Yet it is interesting to note that while the Eagle Ford formation continues well into Mexico near Monterrey and over to the east along the Gulf Coast, the production activity literally stops at the river border. In the Eagle Ford, over 10,000 wells have been completed to date. In Mexico by contrast, there have been only a handful of test wells developed.

It is interesting to compare and contrast the prospect for shale development in Mexico with the experience of the USA, particularly with regard to the Eagle Ford in South Texas. In the NASA night photograph below (Fig. 1), the Dallas–Fort Worth Metroplex can be seen at the top. Lower down, to the right is the Houston area. In the center of the photograph due west of Houston are the Austin and San Antonio metropolitan statistical areas tied together by the heavily trafficked Interstate Highway 35 corridor. Closer examination below San Antonio reveals a crescent of light south of the city. This is the 14-county area that has comprised the bulk of the Eagle Ford activity to date. The rigs operating in the area run on a round-the-clock 24 h-a-day, 7 day-a-week schedule. In addition, some natural gas flaring is occurring where pipeline networks have not yet reached the well sites. Taken together, the exploration and production activity in South Texas has been visible from space.

Fig. 1 State of Texas at night from space. *Source* NASA

The Eagle Ford formation actually continues on into Mexico. On the Mexican side of the border, there are apparently several formations, with the Burgos Basin as perhaps the best known of all. These preliminary maps provided by the EIA suggest that shale formations in Mexico extend south, well into the state of Veracruz and perhaps even beyond (Fig. 2).

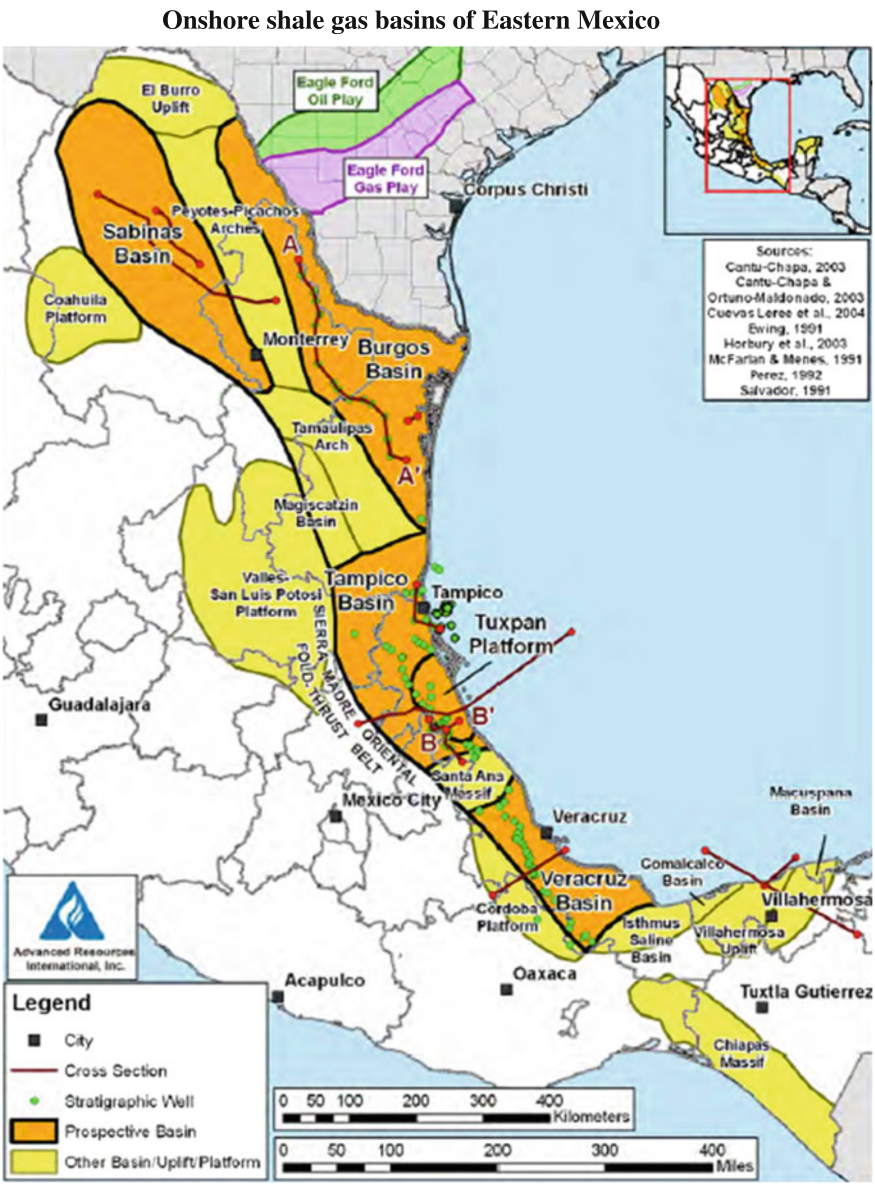

Fig. 2 Shale basins in Mexico. *Source* World Shale Gas and Shale Oil Resource Assessment–U.S. Energy Information Administration

If we return to the NASA photograph and zoom out so that the outline of both Texas and Mexico is visible, we see an interesting story (Fig. 3). On the Texas side of the border, we can still see the crescent outline of the Eagle Ford activity. Yet

Fig. 3 Texas and Mexico at night from space. *Source* NASA

despite the likely potential for development in Mexico, it is clear that the oil and gas production literally stops at the border on the Rio Grande River. This speaks volumes about the importance of political economy on economic development.

The reasons that shale development has flourished in the USA and not elsewhere to date have to do with a couple of key issues. First, the USA is one of the few countries in the world that allows private individuals to own mineral rights. In most other countries, private individuals may only own the surface rights to the land. Mineral rights in most countries are either owned by the state (as is the case in Mexico) or the monarch (as is true for the UK) or perhaps by the currently reigning dictator in developing countries with despotic regimes.

Private ownership of mineral rights creates a powerful incentive to develop the oil and gas resources belowground. One of the reasons the Eagle Ford could be developed so quickly was because E&P companies could negotiate and close lease and royalty agreements in a timely manner and begin drilling operations. Working with state bureaucracies, by comparison, is often a time-consuming process.

The other reason that shale development in the USA came about at all—and probably the key factor—was due to the nature of companies that pioneered the unconventional techniques. Shale oil and gas production techniques were not pioneered by the major oil companies. Rather, development occurred due to the persistence of independent oil and gas companies such as Mitchell Energy headed by George Mitchell—initially in the Barnett Shale near Dallas–Fort Worth targeting natural gas formations (Hinton 2012). These independent companies experimented and risked capital until they figured out how to unlock the shale oil and gas trapped inside the rock.

As Mexican energy reform progresses, Pemex is unlikely to aggressively pursue shale oil and gas opportunities, largely because its business model is more closely aligned with the major energy companies. Pemex has instead targeted shallow and deep water fields, which are large-scale projects that require significant capital expenditures over an extended period of time. As in the USA, the unconventional fields in Mexico will almost certainly be pursued by independent producers that are more nimble and have lower cost structures.

A key issue that surfaced in late 2014 was the unexpected drop in oil prices. The precipitating event for the huge price decline in oil occurred at the OPEC meeting held in November 2014. At that conference, the cartel confounded global expectations by deciding not to curb production, which would have been expected to stabilize prices. Non-OPEC members, such as Russia, also indicated that they were unwilling cut crude oil production. Market reaction was swift. After the OPEC meeting, prices for Brent and West Texas Intermediate crude oil—which had already been falling from as high as $107 per barrel in June—began to slide further. By January 2015, the WTI benchmark closing price briefly dipped below $45. WTI prices rebounded somewhat, but fell below $45 again in March. During the heavy demand season in summer, WTI prices moved up to around $60, but by August had once again dropped to the lowest level in six years, below $40 per barrel.

The resulting persistent low oil prices have introduced a degree of uncertainty in the energy industry overall that has caused the Mexican government to push back its initial timelines. As of this writing, planned bids on shale blocks will likely not occur until 2016.

The situation in Mexico in 2015 remains a work in process, with many issues yet to be resolved. An important difficulty has been obtaining detailed geological information on prospective shale formations. It is unclear as to the quality of Pemex's shale-related geological information that the Mexican National Hydrocarbons Commission (CNH) has made available to prospective bidders. Having that said, the situation in Mexico may be analogous to the way shale development evolved in the USA.

Shale formations in the USA, for example, were not apparently of significant interest to the Energy Information Administration (EIA).[1] Examination of the nearby US Department of Energy map from 2009 (Fig. 4) reveals that many significant formations are missing—most notably the Eagle Ford and Bakken fields.

[1]The EIA falls under the US Department of Energy.

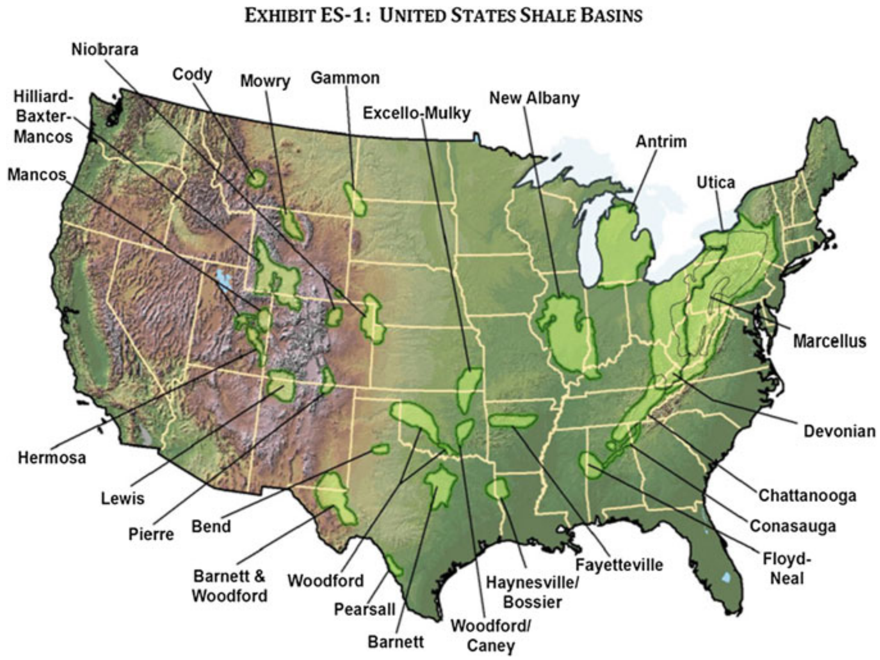

Fig. 4 Identified shale basins in the U.S. as of 2009. *Source* Department of Energy

Fast forwarding just two years later to the EIA shale map from May 2011, we can see much more detail on the map of the lower 48 states (Fig. 5). Simply put, until recently, shale formations were not of great interest from an exploration and production standpoint because while they were known to contain oil and gas, the formations were believed to be largely impermeable. Conventional wisdom assumed that reserves were not economically recoverable.

Data lacking on Mexican shale formations may have less to do with Pemex dragging its feet regarding the release of information than with the lack of reliable geological surveys. Either way, the risk for E&P companies with regard to not only shale, but also onshore conventional, shallow water, and deep water fields because of uncertainty of recoverable oil and gas will remain an issue for the next few years.

The story of the prospects for energy reform in Mexico necessarily relies on the experience north of the border, as the USA has been the only country to exploit unconventional techniques, even though shale oil and gas reserves appear to be in abundance throughout the world. The significant shift in fortunes in the USA oil and gas industry as a result of the use of unconventional techniques has been an epochal event that has literally transformed the global energy market.

As but one example of the nature of the transformation, prior to the development of the Barnett and other shale gas fields, billions of dollars was being invested along the Gulf Coast to develop import facilities designed to receive LNG (liquefied natural gas) tankers from other countries and regasify the LNG at US ports. Once the shale gas fields began development in earnest in the USA, starting with the Barnett, the expected shortages of natural gas failed to materialize. Quite the opposite in fact. The new significant sources of US natural gas coming from the shale fields in the Barnett, Haynesville, Marcellus, and Eagle Ford created an abundance that was altogether unexpected. Prior to these discoveries during the 2000s, natural gas prices in the USA had fluctuated significantly, often in the range of $8–12 per thousand cubic feet (mcf). Since that time, as a result of new shale gas discoveries in USA, natural gas prices have remained consistently in the $3 mcf range. The now predictable, low price for natural gas has generated a host of follow-on impacts.

The landscape has changed so significantly that now additional billions of dollars is being invested to convert import terminals into ones capable of export. This means that instead receiving LNG and regasifying it, the terminals must instead liquefy the natural gas. Liquefaction facilities are designed to supercool natural gas to minus 260 °F. Once liquefied, LNG can be loaded onto tankers and exported to other countries that pay much higher prices. European customers must pay $11–12 mcf due to their heavy reliance on Russia's Gazprom monopoly.

Hence, there is ready demand in many countries for now plentiful US natural gas. The USA now produces more natural gas than it ever has, amounting to over 25 trillion cubic feet annually. The fact that the USA has the second-lowest cost for natural gas worldwide (Qatar sells natural gas for $0.75) has resulted in a plethora of global manufacturers setting up facilities in the USA, representing billions of dollars more of investment.

Similarly, oil production in the USA has risen from around 5 million barrels per day in 2008 to over 9 million barrels per day in 2014—almost exclusively as a result of unconventional techniques. In a single year—from 2013 to 2014—oil production in the USA increased by 1.2 million barrels per day. This marks the largest volume increase ever, going back over 100 years.

Given these recent developments in the USA, it is not hard to understand why there is significant global interest in shale oil and gas development. With close proximity to the USA, particularly the Eagle Ford in South Texas, Mexico may

Fig. 5 Identified shale basins in the U.S. as of 2011. *Source* Energy Information Administration

have the best near-term opportunities for shale development of any country if energy reform there can be successfully implemented.

Mexico Shale Prospects

Mexico is the largest Spanish language country in the world in terms of population with approximately 122 million people. In Latin America, Mexico is the second most populous country, trailing only Brazil. Mexico also retains the largest indigenous population, which consists of well-known groups such as Maya, Aztecs, and Zapotecs.

It is worth noting Mexico's past prominence on the world scene as an oil producer. In the early 1920s, Mexico was the largest exporter of oil in the world and the second largest oil producer after the USA However in 1938, when Mexico prohibited private investment in the oil and gas industry, the government set the country on a course that limited opportunities to innovate through an insular policy that protected Pemex. While energy reform in Mexico represents opportunities across the board that include shallow water, deep water, and onshore conventional, this chapter will focus primarily on prospects for unconventional shale oil and gas development.

The most promising areas for shale oil and gas development appear to be four states in particular: Coahuila, Nuevo León, Tamaulipas, and Veracruz (Tunstall,

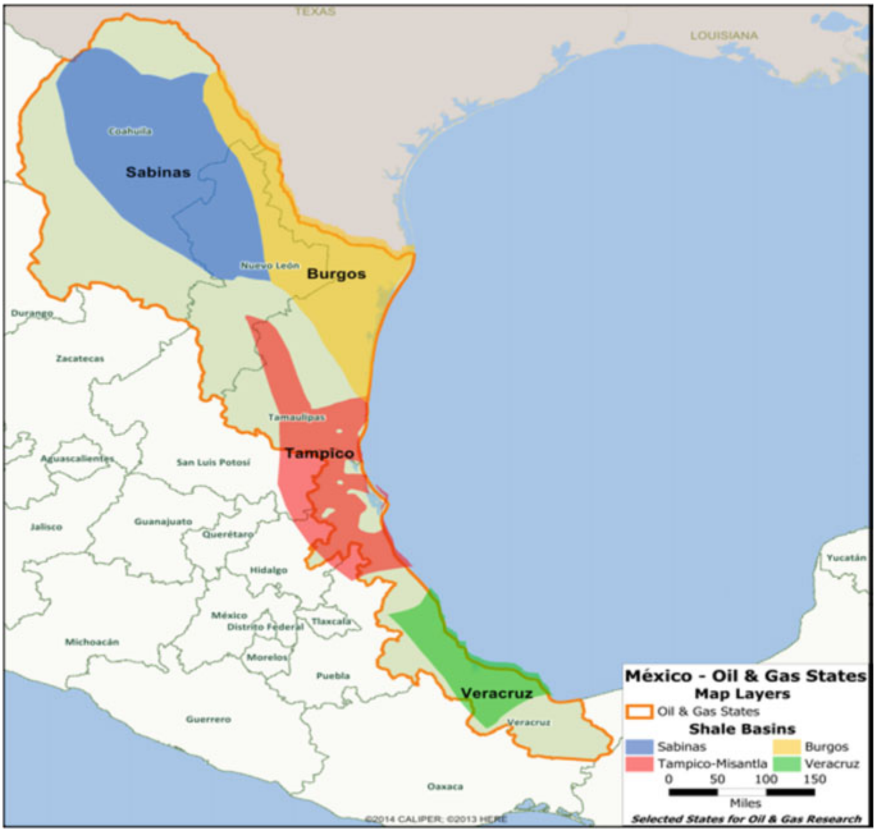

Fig. 6 Shale basins Northeastern Mexican states. Map courtesy of GIS specialist: Hisham Eid

et al., 2015). Across the border from Texas, the Eagle Ford Shale formation continues, where it is referred to as the Burgos Basin and stretches across Coahuila, Nuevo León, and Tamaulipas. Other basins located in the four states include the Sabinas Basin (Coahuila, Nuevo León), the Tampico-Misantla Basin (Nuevo León, Tamaulipas, and Veracruz), and the Veracruz Basin. As was the case in the USA, as better geological information becomes available, this picture will certainly become more robust and detailed (Fig. 6).

In Mexico, rail infrastructure tends to run north–south, so logistics operations from the country's eastern ports will present a challenge. Interestingly, this may present opportunities for the Rio Grande Valley in extreme South Texas, which has not participated in the Eagle Ford Shale oil and gas boom so far. Because their latitude is similar to and due east of Monterrey, Mexico, the population centers and ports in the Rio Grande Valley should be in a good position to provide workers and services to the reformed Mexican energy sector.

For Mexico in the near term, there may be a shortage of suitably skilled engineers, geologists, and other experts. The high level of unconventional oil and gas development in the USA currently limits supply. However, over the longer term, US expertise in shale technologies and techniques can be expected to be exported to Mexico, which will provide positive balance of trade benefits to the USA.

Security issues in Mexico will certainly have to be addressed. Due to the ongoing drug violence in Mexico, particularly in the border areas, the Mexican federal government and the northern states of Coahuila, Nueva León, and Tamaulipas will be challenged to address security concerns. From an industry supplier standpoint, this will create growth opportunities for security firms in Mexico as well.

Businesses and producers in the USA, particularly in Texas, are in a prime position to take advantage of the shale boom in Mexico because of their proximity just across the Rio Grande. As energy reform in Mexico continues, there will likely be opportunities on both sides of the border to benefit in a way not seen since 1994, when the North American Free Trade Alliance (NAFTA) went into effect over 20 years ago.

The Mexican state of Tamaulipas appears to be in a good position to capitalize on both conventional and unconventional activities in Mexico. Tamaulipas has an extended coastline, which is conducive to logistical support for both onshore and offshore drilling activities. Planned upgrades to the ports of Matamoros and Altamira will position the state to capitalize on energy reform.

Energy reform holds the prospect of enlarging the scope of activity between the Mexico and the USA. Mexico ranks as the third largest trading partner with the USA (after China and Canada). Annually, as of 2012, cross-border trade between the USA and Mexico was $536 billion in goods and services.

While Mexico is a net oil exporter, decreased production over the years has narrowed that margin. Mexico's oil consumption in 2013 was 2 million barrels per day, and production was only slightly higher at approximately 2.5 billion barrels per day. And as mentioned previously, Mexico's oil production peaked in 2004 and has been declining steadily in the decade plus since then.

In 2013 and 2014, Mexico imported over 650 billion cubic feet of natural from the USA even though the country has over half a trillion cubic feet of estimated shale gas reserves. Mexico also imports 570,000 barrels of refined products from the USA per day. Clearly, Mexico is in a position to capitalize on energy reform.

And yet, current US policy remains an impediment to further progress. The USA maintains a ban on the export of crude oil (except to Canada with a special license) that has been in place since 1975 as a result of the OPEC oil embargo. Greater integration between NAFTA partners such as the USA and Mexico would benefit both countries.

Right now, there is something of a mismatch between the type of oil produced in Texas and Mexico on the one hand and their respective refining facilities on the other. For example, shale oil is of an equivalent grade to West Texas Intermediate or light crude. The unexpected increase in US production caused unanticipated issues for US refineries, which were designed and optimized to process heavier crude arriving from OPEC countries or Canada via the Keystone XL pipeline. Instead, the Gulf Coast refineries have been inundated with light crudes from the US shale fields.

At the same time, Mexico's refineries are better suited in many cases to process light crudes, yet the country produces significant quantities of heavier oil. As a result, there has been serious discussion about the prospect of allowing the export of light US crude to Mexico in the form of an oil swap. As of mid-2015, approval for a swap by the US Department of Commerce was still pending.

In the meantime, energy reform implementation in Mexico is continuing more slowly than first planned. The focus of the series of Round One bids is on the activity for E&P firms. Private firms will have the opportunity to enter into a variety of contracting vehicles with Pemex if they so desire. These include license agreements, production-sharing, profit-sharing, and service contracts.

Shale Technology Diffusion

There continues to be much speculation as to how unconventional techniques will diffuse across international borders from the USA. In the early days of the Eagle Ford development, the cost to complete a well was as high as $20 million. By 2010, many operators could complete wells at a much lower cost of approximately $10–$12 million and take 40–45 days to do so. By 2012, operators had decreased completion costs even further to around $6–$8 million, with an average duration of 15–20 days to complete. In 2014, BHP Billiton announced that it had completed a well in only 7 days.

While initial unconventional operations in countries outside of the USA will likely also be expensive in the early phases of development, ultimate success of unconventional techniques will require similar cost reductions over time.

Along those lines, it is important to note that unconventional techniques vary significantly from more traditional conventional projects. The major E&P companies typically engage in capital-intensive projects such as deep water drilling that requires hundreds of millions of dollar invested into a single platform. This is a very different business model than the drilling-intensive operations associated with companies focusing on shale oil and gas opportunities. In fact, the use of unconventional techniques has been likened to a manufacturing process, as opposed to traditional wildcatting, where early oilmen relied not only on geology, but also on intuition. E&P companies using unconventional techniques continue to adopt more systematic approaches in order to drive their completion costs down.

As an example of how cost structures differ significantly between conventional versus unconventional operations, a single component such as valves can be instructive. According to Daniel Yergin at IHS, there are 328 standards within the oil and gas industry for valves alone. By contrast, unconventional operators drill wells that are comparatively small and inexpensive and use interchangeable, standardized parts (The Economist 2015).

Liberty Resources has implemented a factory-like approach in North Dakota, where it plans to complete 96 wells on a tract of approximately 10,000 acres. This method is expected to significantly lower completion costs by using a single utility corridor for heavy truck traffic and long pipeline runs. In addition, the site entire will utilize only one frac pond for water, instead a frac pond for each rig.

In North Dakota, natural gas pipeline infrastructure is often lacking, which means that associated natural gas resulting from oil drilling must be burned off. As a result of the inability to move the gas to market, flaring in the state has reached levels in excess of 30 % of production. This has led innovative companies to adopt techniques to capture the natural gas that would otherwise be flared. In the case of Liberty, the company plans to collect the natural gas and use it to power drilling rigs and other equipment that more typically use diesel fuel (Gold 2015).

The use of Generation 3 walking rigs to replace older Generation 1 and 2 type rigs holds interesting implications as well. Walking rigs are faster and more powerful, and can complete as many as a dozen wells from a single pad.

In addition, a myriad of new technologies that involve logistics, instrumentation, chemistry, and sensors and seismic imaging, among many others, are in the early stages of development and implementation (Mills 2015). Over time, these techniques can be expected to significantly drive down costs and make shale oil and gas development in challenging environments like Mexico more feasible.

Because of local content requirements, the use of improved, more efficient techniques will have to incorporate Mexican firms into the mix. The minimum local content threshold is 25 % immediately, moving up to 35 % in 2025. Content components are defined as goods, labor, services, training, technology transfer, and infrastructure.

Recent Developments

Pemex has been the monopoly state-owned oil and gas E&P company, as well as the *de facto* regulatory body in Mexico for 76 years. All of that began to end with the passage of energy reform. In 2013, President Enrique Peña Nieto initiated a wide range of constitutional reforms that include not only energy, but also finance, education, and telecommunications. The impact of these reforms is expected to be at least as far reaching as the North American Free Trade Agreement, which became effective in 1994.

Following constitutional reforms, the process of defining the secondary laws began. These secondary laws will define the specific rules for private companies interested in participating in the energy industry in Mexico.

The regulatory framework will be managed at the federal by the Ministry of Energy (SENER), the Ministry of Finance (SHCP), the Mexican National Hydrocarbons Commission (CNH), and the Energy Regulatory Commission

(CRE). Such a framework contrasts to some degree with the USA, where the individual states are the dominant regulatory body for oil and gas exploration and production. Mexico also created the National Agency for Industrial Safety and Environmental Protection (ASEA) for the hydrocarbon sector.

Several rounds of bids for prospective oil and gas fields in Mexico have been awarded to date. Round Zero awarded Pemex 83 % of the country's proven reserves and 21 % of its prospective reserves. Subsequent rounds of bids have or will include shallow water, deep water, and conventional and unconventional (shale) onshore blocks. The shale blocks have yet to be put out for bid; however, that is expected to occur by 2016. Opportunities for subcontractors and support services (as well as economic impact) will flow from the E&P activities.

Of perhaps equal significance, the CRE will begin issuing permits in 2016 to independent service stations, ending the Pemex monopoly on retail distribution of motor fuels. The following year in 2017, private companies will be able to obtain permits to import oil and gas. And by 2018, legislation calls for energy prices in Mexico to be set by the market.

The CNH had difficulties ramping up staffing since its inception. While the agency's goals were to maintain a staff of over 300 people, headcount was less than 80 in mid-2015.

The first round of bid results was announced in July 2015 and was clearly disappointing. Of the 14 shallow water blocks that were offered for tender, only half of the blocks received bids. Of those, only two of the bids were accepted by the government. The five bids that were rejected contained terms that were below the minimum thresholds set by the Mexican government. The two winning bids came from a consortium consisting of a recently formed Mexican company named Sierra Oil and Gas, along with Talos Energy based in Houston and Premier Oil.

According to Tony Payan of the Baker Institute at Rice University, the early, poor performance of the bidding process in mid-2015 made it clear that reform of the energy industry in Mexico was as much a function of necessity as anything else. Declining oil and gas production combined with a lack of technology has essentially simply forced reform upon the Mexican government, which had few, if any, other viable options.

Further complicating matters were that energy reform legislation was enacted in 2014, when oil prices still hovered around $100 per barrel. When the results of the first round of bidding were announced, prices had fallen to half that, around $50 per barrel. Through the majority of 2015, West Texas Intermediate oil prices ranged from lows near $40 per barrel to highs of around $60. As a result, the government of Mexico was slow to react to the fact that low oil prices have tempered enthusiasm of private investors in Mexico. After the reaction from industry following the first round of bids, it became clear that the government would have to make the terms of future tenders more attractive to energy and production companies.

In fact, on August 4, 2015, the CNH held an extraordinary meeting to modify the bidding rules for the second tender in Round One for shallow water blocks. Operators may submit bids both individually and as part of a consortium. Rules for other future tenders may undergo modification as well. Nonetheless, other issues associated with energy reform remain potentially problematic.

Throughout the reform process in 2014 and 2015, the Mexican government has been forced to revise terms for tenders in order to attract a larger number of bidders. Yet even so, the government of Mexico retains the right to rescind any contract under terms which are vague and provide federal bureaucrats with significant discretionary powers with regard to managing or terminating contracts. One positive development dealing with arbitration is that the appoint authority has been changed from the President of the International Court of Justice (ICJ) to the Secretary-General of the Permanent Arbitration Tribunal of the Hague. This should be an improvement, as evidence suggests that ICJ judges tend to favor the states that appoint them, as well as states that have wealth levels similar to their own states (Posner and de Figueiredo 2005).

In Congressional testimony on July 23, 2015, before the US House Committee on Foreign Affairs Subcommittee for the Western Hemisphere,[2] Tony Payan with the Baker Institute for Public Policy at Rice University indicated that energy reform in Mexico is not being pursued by the government as a complete market-driven reform. Rather, the government plans to manage the opening of the energy sector primarily because circumstances forced the government to opt for reform in the first place. In his estimation, energy reform in Mexico is more restrictive than other countries, which is likely to give the Mexican government excessive power over the energy sector.

The results of the first round of bids clearly indicate a sense of hesitancy with regard to the degree of control that the Mexican government intends to apply to the energy sector. E&P companies have corresponding responded with a cautious approach to bidding.

Deep water blocks that will come up for bid offer some interesting prospects if the terms can be made attractive enough for private investors to pursue them. Mexico's deep water reservoirs are essentially untapped, which contrasts starkly with US Gulf of Mexico deep water fields. E&P companies operating in the Gulf on the US side have years of experience, capital reserves, and extensive technology which can be readily deployed.

Unlike conventional and unconventional (shale) onshore opportunities in Mexico, deep water fields do not have to deal with issues such as security and workforce availability. Another factor in favor of the deep water projects is that they have been exempted from the domestic content requirements.

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[2]The US House of Representatives Committee on Foreign Affairs Subcommittee on the Western Hemisphere convened on July 23, 2015, to hear testimony regarding the topic "Pursuing North American Energy Independence: Mexico's Energy Reforms." Witnesses included Carlos Pascual, senior vice president for IHS and former US Ambassador to Mexico; Thomas Tunstall, research director for the University of Texas at San Antonio Institute for Economic Development; Tony Payan, director for the Mexico Center at the James A. Baker III Institute for Public Policy at Rice University; and Eric Farnsworth, vice president for the Council of the Americas and Americas Society.

Deep water rig logistics can be managed from US ports if necessary in the same way that rigs on the US portion of the Gulf of Mexico operate. These opportunities will be pursued by the major energy companies which require significant capital expenditures—often hundreds of millions of dollars per rig and a time horizon of 5–10 years. As discussed earlier, shale wells can be completed for $6–8 million in as little as 15–20 days (or less). Thus, the time horizon for companies operating in deep water fields is much longer and is not dependent on short-term moves in oil prices. The business models of each type of E&P companies are very different.

Energy reform will continue to play out over the coming years, and ultimate success is by no means guaranteed. While enacting constitutional changes and passing secondary laws was a significant achievement, the implementation phase will clearly prove equally or even more difficult.

According to Carlos Pascual, senior vice president for HIS and former US Ambassador to Mexico, lessons learned from the failed Phase I bids might consist of issues such as the:

- Field offerings were small and perhaps not of high interest to the larger international companies.
- Contracts were offered for four years with a two-year extension, but some companies may have wanted longer contract terms to perform more extensive exploration, such as whether there might be complex presalt formations that could be exploited at deeper levels.
- Government minimum bids may have been influenced by historic Pemex production costs, which may be lower than the costs estimated by potential investors.
- Fiscal terms may not have met investor requirements to mobilize capital given increased pressure from low international prices to cut costs and capital expenditures.

As of this writing, dates for shale field tenders in Northern Mexico have not yet been announced. However, as completion costs for unconventional wells continues to be driven down with a variety of innovative techniques, opportunities in Northern Mexico should become more attractive to private investment.

Small Business and Mexico's Energy Market

As mentioned previously, energy reform in Mexico provides the potential for small businesses operating in the USA, particularly in the Eagle Ford in Texas to extend their operations across the border as export opportunities. Yet many companies remain hesitant about expanding operations into Mexico. Toward that end, it will be worthwhile to examine that support structures in place in Texas and Mexico in order to understand what types of companies would be most likely to capitalize on Mexican energy reform and how they are apt to enter this new market.

The University of Texas at San Antonio (UTSA) Institute for Economic Development maintains a network of small business development centers (SBDCs) across 79 counties in South, Central, and West Texas. The best-known function of these centers is business consulting that include assistance with marketing, operations, and finance. However, the SBDCs also work with businesses on export opportunities.

Since Texas is the leading oil producing state in the USA by far, opportunities related to energy reform in Mexico for Texas-based companies should be significant. The SBDC network has also been replicated throughout Latin America, including Mexico, where university-based partners oversee the operation of 108 centers. The number of small companies that export from the USA is only about one percent of the total, so the opportunity to increase exports is substantial.

In order to aid the diffusion of the technology and a working knowledge of unconventional shale oil and gas operations, businesses and policymakers will need to better understand long-standing obstacles to export. Our research at the UTSA Institute for Economic Development indicates that the reason small businesses do not export more is because the process of capacity building in that regard is not well understood. Many capacity building approaches taken to date do not engage small businesses in a way that systematically generates results. For example, not all companies are in a position to export. Realistically, in order to enter the energy market in Mexico, the first basic criterion is that a company should be export capable. That is, the company must be established in some facet of the US shale oil and gas industry and has an exportable good or service that is or will be in demand in Mexico. This is a minimum, but insufficient prerequisite.

Equally important is that the organization must be committed to export, as entering the Mexican energy market will take time, during which the landscape will evolve. Resource investments required to successfully ramp up an export operation entail a time frame that could run 18 months or longer, with a working capital outlay of $50,000 or more.

Many operators in the USA will be reluctant to enter the Mexican market because they are successful in the USA, where they understand the regulatory environment and are familiar with the banking system. The prospect of exporting is often perceived as risky, which is not an unfair assessment of the current energy sector climate in Mexico. Given that Pemex has controlled the Mexican energy market for decades, small businesses will be operating in uncharted territory.

Company size and maturity are also key factors that can help ensure a successful export strategy. Experience strongly suggests that small businesses should have at least $1 million in annual revenues and maintain positive cash flow and have been in existence at least one year before considering export opportunities. Ideally, small businesses should have annual sales of at least $5–20 million.

Interestingly, export promotion agencies are not necessarily the best starting points for export-capable companies. While these agencies are good at providing information from their extensive network of foreign commercial posts, their ability to work on business strategy and operations is limited. Instead, export agencies tend to be better positioned for making introductions on behalf of small businesses to key contacts, as the agencies maintain commercial posts all over the world.

Ejidos and Quality of Life

The current form of Ejido was the result of the Mexican Revolution from 1910 to 1917, in which land reform returned communal farms to the indigenous and small-farmer populations. Land reform continued throughout the twentieth century to the point where 52 % of Mexico's total land area belongs to Ejidos (Klooster 2003).

From 1917 to 1992, state-led agricultural reform was the dominant approach to land reform in Mexico. Since 1992, the country has been attempting to implement market-led agrarian reform—a process still underway (Perramond 2008). These communal farms were granted legal status in 1917 by the country of Mexico and will play a key role in energy reform.

Landowners in Mexico own the surface rights to their property, not the mineral rights. Instead, as in most countries, mineral rights are owned by the state. As a result, the incentives for landowners are very different from those in the USA. While oil and gas discoveries for US property owners often mean unexpected wealth, for landowners in Mexico, energy development is, at best, a nuisance. The government of Mexico, both at the state and at the federal level, must consider appropriate incentives for landowners in order to ensure local cooperation, as well as an equitable allocation of benefits associated with energy production. These incentives could take the form of lease payments to landowners. However, more fundamentally, Mexico's government should invest to establish a base of infrastructure that will serve the needs not only of the oil and gas industry, but that will also provide the foundation for greater diversification of the economic base in the impacted regions.

Once again, the experience in South Texas may be instructive to areas in Northern Mexico likely to be the site of shale field operations. The oil and gas development in the Eagle Ford has been a transformative process in many ways, with several of the affected counties previously among the poorest in Texas, if not the entire USA. The sudden production of large quantities of oil and gas did indeed prove to be a windfall for many landowners.

Nonetheless, the region faced many challenges that came with the oil and gas production. Critical infrastructures such as roads, housing, water, wastewater, K-12 education, and medical facilities had been clearly lacking in South Texas relative to the rest of the state for many years. And in fact, these are precisely the same issues that many communities in Northern Mexico face as well. It will be the development of critical infrastructure that will hold the key to ensure future sustainability of the communities in South Texas and Mexico alike.

Equally importantly, community leaders in Texas have been urged to be attuned to the aesthetics of their towns and counties. Creating attractive, livable communities will be the catalyst that will serve to attract visitors, new residents, and diversified industry to the region. Aesthetics remain an important, yet underappreciated aspect of long-term sustainability.

In South Texas, expansion of the economic base has included such strategies as diversification into tourism, recreation, and higher-margin agricultural products. Agricultural diversification can take a variety of forms, and opportunities will depend on the particular attributes of a given region. In South Texas, one promising crop is olives and olive oil production. Another related opportunity may be water desalination, particularly in light of a lengthy drought and forecasts of increased population growth. For the longer term, the ability of small towns to draw knowledge workers may hold promise as well.

Quality of life encompasses a wide variety of components. While it includes basic infrastructure highlighted above, a full definition is much more robust. Social relationships and culture are one example of an important, yet hard to measure feature of quality of life.

Certainly, quality of life encompasses key issues such as environmental stewardship. The use of unconventional techniques, which combines horizontal drilling, hydraulic fracturing, and a host of new technologies, continues to be the subject of ongoing research.

Several studies have examined the prospect for groundwater contamination from hydraulic fracturing processes (Siegel et. al. 2015; Darrah et. al. 2014). To date, research indicates that the reasons for groundwater contamination in unconventional wells occur for the same reasons that they occur in conventional wells. The two key factors identified are improper treatment at the surface level or, less frequently, faulty cementing of well casings.

Similarly, earthquakes appear to be caused by injection wells located near faults under tectonic stress. No study so far has established a link between neither water contamination nor earthquakes as a direct result of the hydraulic fracturing process, which occurs thousands of feet underground. Nonetheless, continued research will be necessary to ensure that unconventional extraction techniques are compatible with long-term community sustainability in both Mexico and the USA.

Looking Ahead

Shale energy development in Mexico is likely to proceed at a deliberate pace as E&P companies consider a variety of options. In part, this is because unlike the USA, Mexico has vast uptapped conventional hydrocarbon resources in shallow water, deep water, and onshore conventional fields that have remained unexploited because Pemex has lacked capital and technology. As such, these potentially more attractive near-term opportunities may take precedence over shale oil and gas fields.

Companies seeking to do business in Mexico will likely be selective about where and when to establish a foothold.

Energy reform has changed the landscape significantly, with equal parts of uncertainty and opportunity. As a result, the energy future for Mexico holds enormous potential, but holds significant risk as well. The country possesses substantial oil and gas resources across a variety of geologies that will take decades to fully develop.

With oil prices ranged from $45 to 60 for the first half of 2015, much of the urgency associated with energy reform has been tempered. All indications are that worldwide supply would continue to increase through 2015, perhaps even into 2016. Another factor that could depress oil prices is the economic situation in China, where in 2015 the country began to exhibit soft demand growth.

Energy reform in Mexico will continue to play out over the coming years, but ultimate success is by no means guaranteed. The passage of constitutional changes to allow private investment in the energy sector, coupled with the enactment of secondary laws, was a significant achievement to be sure. However, the next phase of implementation will certainly prove equally or even more difficult.

As of late 2015, the next steps for energy reform consist of the remaining four tenders in Round One. Many are considered more attractive than those offered in the first phase, and investor interest may be correspondingly greater for subsequent phases. Five blocks of shallow water fields are scheduled for the end of September 2015. Onshore conventional opportunities that include 26 fields will open for bid on December 15. Deep water and unconventional shale and other blocks are expected to be tendered in 2016.

The prospects for full implementation for energy reform in Mexico continue to remain promising, but the landscape will remain one of continuous change. Previous experience in another industrial sector may be instructive. For example, it is worth noting that in the automotive industry, Mexico now ranks as the number four manufacturer worldwide and continues to expand. Production in light vehicles has grown from 2.1 million units in 2008 to 3.2 million units in 2014. By 2020, that number is expected to reach nearly 5 million units of light vehicles produced, so a worthy precedent has been established in the automotive sector.

Nonetheless, energy reform in Mexico clearly continues to face challenges ahead. For future rounds of oil and gas field tenders, the CNH must ensure that the terms are attractive enough to bring in additional private investment than has been the case to date. Security issues along the border regions must be addressed. Related to that concern will be the need to ensure transparency with regard to energy reform implementation in order to minimize the prospect for corruption at the state, federal, and local levels. Increasing CNH staffing in order to act as an effective counterbalance to Pemex will be critical milestone. More generally, the Mexican government must do everything possible to strengthen the rule of law in the country.

For Northern Mexico specifically, successful shale oil and gas development will have to be preceded by a wide range of infrastructure projects. Natural gas production, for example, is dependent on a pipeline network that runs all the way to the wellhead. Development of a suitable pipeline system will in turn require a skilled workforce, housing, roads, rail, water supply, and medical facilities to support construction activities. The investment at both state and federal levels will be substantial, but would go a long way toward improving the quality of life in one of the most neglected areas of the county.

No doubt, significant hurdles remain with regard to the ultimate success of energy reform in general and shale oil and gas development in particular. However, if these issues can be addressed in the coming years, Mexico is in a position to significantly improve the quality of life of many of its citizens, as well as usher in a new era of energy independence with regard to natural gas, and remain a significant oil exporter to the world market.

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