Considering Shale Gas in Europe

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1. Introduction

The natural gas landscape has seen dramatic changes within the last few years – especially in the United States (US). The production of shale gas in the US has contributed significantly to shifts in perception, prices, and investment decisions. The US shale gas market experienced what popularly has been denoted a "perfect storm" due to a combination of relatively low regulation of the shale gas industry overall, well-aimed subsidies, strong property rights of land and minerals, and abundant drill-rigs and other infrastructure (The Economist, 2012). Such a conducive framework is not currently found elsewhere. Even though estimates predict Europe to have nearly as much technically recoverable shale gas as the US (EIA, 2011a), exploration is proceeding at a much slower rate due in part to environmental concerns. As a result, even though companies such as Chevron, Exxon Mobil, and ConocoPhillips are ramping up operations (CNA, 2012), only test drillings have taken place across the continent to date[1].

The principal areas of the ongoing dialogue in the area of unconventional gas[2] in the US include: environmental and social impacts, the price of gas (economic feasibility/competitiveness), and energy security (IEA, 2011b; Wyciszkiewicz et al., 2011). Not surprisingly, these issues likewise dominate the energy debate in most European countries that are exploring, or planning to explore, unconventional gas resources. The environmental controversies are primarily attributable to the exploration process of hydraulic fracturing or "fracking", often combined with horizontal drilling techniques, in which gas is extracted from hard shale several kilometers beneath the surface by injecting a mixture of water, sand, and chemical into the rock at high pressure. Once the shale is fractured, the sand fills the open fissures and prevents them from collapsing, hereby allowing the gas to travel to the surface for collection via a drilled well (Clark, 2012; European Dialogue, 2011). One concern is that the methane and drilling chemicals used in the process will risk contaminating water supply aquifers. In several European countries,

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1 That is, as of the writing of this article – completed in Q3, 2011.

2 In line with Giles et al. (2012), *unconventional resources* are here defined as hydrocarbons not confined in conventional structural or stratigraphic traps, which are generally found in low permeability rocks. Such rocks usually require fracture stimulation to produce at economic flow rates. Unconventional resources include basin centre gas, tight gas, shale gas, and coal bed methane.

public opposition or pressure from environmental groups has forced governments to ban fracking and set moratoriums – some indefinite – for drilling activities (The Economist, 2011). In the US, where fracking has been allowed to develop under an evolving set of regulations, public concern has forced individual states, including New York, Pennsylvania, and Texas (ERCB, 2011; Freeman, 2012) to shape their regulatory frameworks to manage the environmental risks associated with shale gas production. In addition, specific localities (e.g. Longmont, Colorado) are passing local legislation (Healy, 2012). Consequently, a patchwork of state regulatory processes has emerged instead of a nation-wide one.

Unconventional gas has changed the energy security landscape of the US. In particular, shale gas has significantly contributed to US energy supply by decreasing its dependence on energy imports and displacing coal as the dominant power generation fuel. Significant influences on the shale gas development outside the US, especially in Europe, is the possibility for new LNG trading across the Atlantic and the demonstration effects on a number of European countries eager to start shale gas development, in particular in Eastern Europe. For example, the recent downward spiral of prices has allowed European customers to force through re-negotiations of traditional long-term take-off contracts with Norway and Russia in terms of both volume and price (Goldthau and Hoxtell, 2012). This has opened up possibilities for short-term arrangements and spot market transactions. Consequently, even with no shale gas production of its own, Europe has seen reductions in average gas prices. The average German import price fell from USD11.6 per million British thermal units (MMBtu) in 2008 to USD8 MMBtu in 2010, and the UK Heren NBP Index fell from USD10.8 MMBtu to USD6.6 MMBtu in the same period (BP, 2012).[3] 'Higher gas prices in the early- to mid-2000s in the US were an important driver in the development of the shale gas industry in the US, and will likely be just as important a factor in growth of future gas demand in Europe (Ernst and Young, 2012).

Faced with decreasing indigenous gas production, Europe is likely to face a substantial gap between supply and demand in the near future (Eurogas, 2010), mostly due to a significant increase in installed capacity of gas-fired power generation. New gas import arrangements are needed from 2015 as currently contracted gas supply is insufficient to meet the increased demand (Eurogas, 2010; Honoré, 2011; Timera Energy, 2011). This will pressure European regulation to solve the security of supply issues (Regulation EU 994/2010). It also provides a strong impetus to reduce reliance of foreign supplied gas, especially from Russia, and increase the diversification of the European energy mix (Natural Gas Europe, 2012c; Umbach and Kuhn, 2011a). Finally, there are closely related issues in the development of trans-national pipelines including North Stream and Nabucco. Such new gas infrastructures have already impacted decisions ranging from contract terms to politics.

It appears that the shale gas revolution witnessed in the US is not likely to occur in Europe (at least in the short-term) due to a number of geographical, market, and regulatory constraints, as well as the unresolved balance questions between energy security and climate change (CEU, GPPi and Brookings Institution, 2011). Moreover, the development of shale gas in Europe is unlikely to be uniform as the treatment of these issues differs dramatically across the continent. The future for shale gas in Europe will depend on how well these challenges are approached and to what extent industrial and political actors can apply the technical, commercial, and regulatory lessons from the US shale experience in the European context. This paper seeks to highlight aspects of the links between the US and European shale gas markets, and to distill lessons on regulation, public perception, markets, and the hype that surrounds the shale gas business.

3 In comparison, the US Henry Hub fell from USD8.9 in 2008 MMBtu to USD4.4 in 2010 MMBtu (BP, 2011). Today's price (Bloomberg, 11 September 2012) is USD2.6 MMBtu.

Section 2 provides an overview of the global trends in gas markets and the role of unconventional gas, primarily focusing on shale gas. Section 3 explores the main elements of the US shale gas experience and the drivers of the current boom. Section 4 focuses on the current stage of development in the European shale gas industry and delves into the environmental, regulatory, and security challenges in Europe. Section 5 concludes.

2. Global Trends in Gas Markets and the Role of Unconventional Energy

The future global energy system is generally believed to entail a mix of resources and technologies in which natural gas plays a greater role (IEA, 2012; MIT, 2011). We provide some context for that assertion.

2.1 Projections of Natural Gas Supply and Demand

According to the International Energy Agency's (IEA) Golden Age of Gas Scenario (GAS Scenario) (IEA, 2011b), global primary gas demand will reach 5.1 trillion cubic meters (tcm) in 2035, corresponding with a 62% increase compared to the 2008 level. Overall, the share of natural gas in the global energy mix is predicted to increase from 21% to 25% in 2035, overtaking the share of coal in 2030. Although oil is expected still to be the dominant fuel in the primary energy mix, the demand-gap between natural gas and oil is expected to decrease significantly. Growth is expected to occur in all regions of the world, albeit the largest part in non-OECD countries. In Europe, natural gas demand is expected to rise from 555 billion cubic meters (bcm) in 2008 to 670 bcm in 2035 with most of the growth stemming from power generation, which is expected grow by a moderate 2 percentage points to 22% in 2035. In 2011, European natural gas consumption declined at a record amount of 9.9% (BP, 2012a). This decline was due to cyclical and structural limits such as the ongoing Eurozone crisis, decreased competitiveness of gas versus coal due to oil indexation, continued growth in renewable power generation, and finally, somewhat mild weather throughout 2011 (Corbeau, 2012).

> The shale gas revolution witnessed in the US is not likely to occur in Europe, at least in the short term

To meet global demand, the IEA (2011b) projects that the supply of natural gas will need to increase by more than 50% by 2035. This estimate is also supported by the US Energy Information Agency's (EIA) International Energy Outlook for 2011. Even though globally conventional gas will likely continue to dominate in 2035, a large portion share of the demand will be met by production of unconventional gas[4], which will grow rapidly on a global level in the forecast period. Shale gas will total 11% of global gas production in 2035 (IEA, 2011b), with the US being the biggest producer (unconventional gas, including shale gas, represents 60% of marketed gas in the US). Between 2006 and 2011 total US natural gas production increased from 524 bcm to 651.3 bcm, corresponding to an increase of 24,3% (BP, 2012). According to EIA's (2011b) assessments shale gas could increase the world's technically recoverable gas resources by more than 40%. In Europe, a growing gap will likely emerge between production and consumption. According to the GAS Scenario, natural gas production in all of Europe will reach 213 bcm in 2035, and the average annual rate is expected to decline with 1.4% over the forecast period (IEA, 2011b). However, the production of unconventional gas may slow the rate of the overall decline. Of course, there is considerable uncertainty inherent in these projections, and their past performance in understanding the role of unconventional gas has not been inspiring.

4 Unconventional gas as measured by both the IEA (2011b) and the EIA (2011a) includes tight gas, shale gas, and coalbed methane.

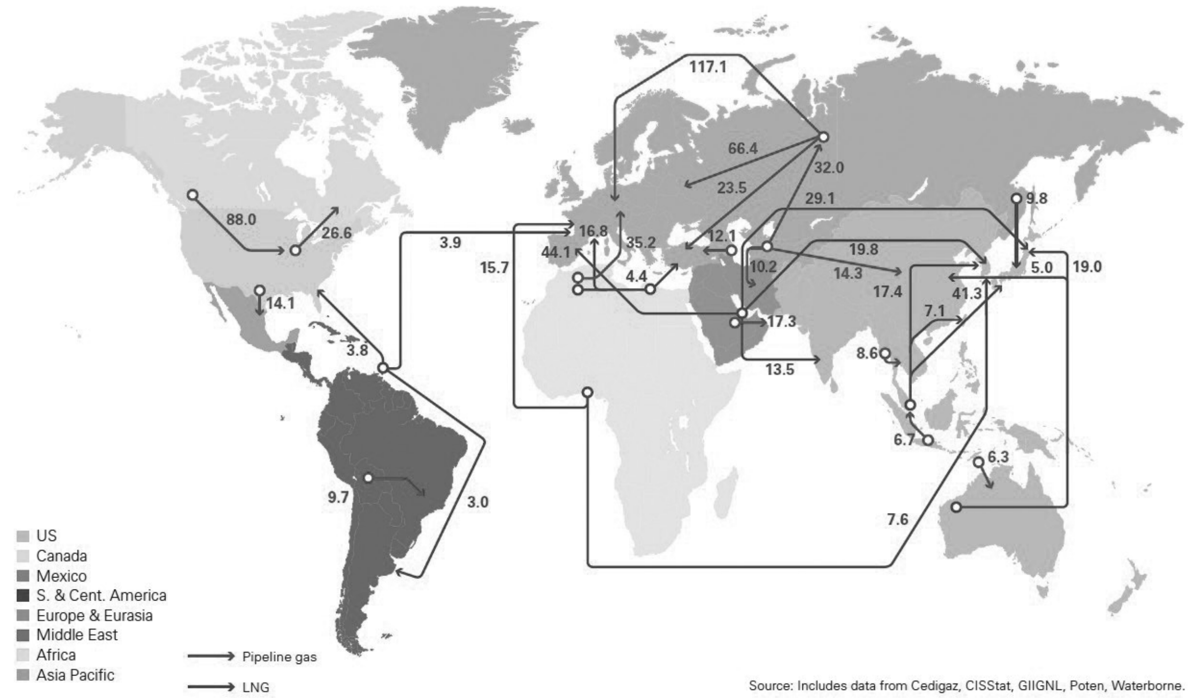

Figure 1: *Major trade flows worldwide, 2011 (billion cubic metres).*
Source: *BP, 2012a*

The EIA (2011b) estimates the current world reserves of technically recoverable shale gas to accumulate to 187.5 tcm[5] (assessment of 32 countries) - approximately the same scale as the world's economically recoverable reserves of conventional gas. Among the 12 countries with the highest estimated technically recoverable reserves, the two most promising appear to be Poland (5.3 tcm) and France (5.1 tcm). Overall, European reserve estimates are relatively modest as seen in Norway (2.3 tcm), Ukraine (1.2 tcm), Sweden (1.2 tcm), Denmark (0.7 tcm), UK (0.6 tcm), Netherlands (0.5 tcm), Turkey (0.4 tcm) and Germany (0.2 tcm) In Europe overall, technically recoverable shale gas reserves are estimated to reach 18.1 tcm. In comparison, the EIA estimates China's reserves to be as high as 36.1 tcm, the largest in the world, followed by the US with 24.4 tcm.

2.2 Changes in the Global Gas Market Geography

Today, regional markets dominate trade in natural gas (a global market does not exist) in contrast to other commodities such as oil and coal. Only close to a third of globally produced gas was traded across borders in 2010, whereas two-thirds of all produced oil was traded on the international market (European Dialogue, 2012). However, indicators point in the direction of an evolving global market as many of the major oil companies are restructuring to build up positions in gas (Quinlan, 2012). For these major companies, gas already accounts for half of the production, and it is expected that worldwide gas supplies by 2040 will be comprised of 30% unconventional gas, particularly shale gas, and 15% LNG (ExxonMobil, 2012).

Figure 1 illustrates the worldwide flow of pipeline natural gas and LNG. In 2011, global natural gas trade increased by just 4% due to an overall weak growth in gas demand (BP, 2012a). Still, in the same year, LNG shipments had a strong growth of 10% with Qatar accounting for most (87.7%) of the increase. Today, LNG accounts for 32.3% of global gas trade (BP, 2012). Notable is how US LNG imports declined by approximately 18% between 2010 and 2011, while European (2.5%) and Asian (15.2%) LNG imports increased in the same period (BP, 2012). *Figure 1*

5 The EIA's Unit Converter has been used for conversion. 1 cubic feet = 0.028316758 cubic metres.

reflects the major trade dependencies: China and Japan mostly get gas from the Middle East; Europe depends on Russia (through pipeline); and the US is more or less self-sufficient. While LNG is a major energy source in the Asia Pacific region, in Europe it adds to supply source diversification. According to the IEA's GAS Scenario, trade between the main world regions will have more than doubled by 2035, with the increase split roughly evenly between pipeline gas and LNG.

The shale gas "revolution" in the US has caused wide-reaching shifts in energy dynamics across the gas markets of the world (Apte et al., 2011; Yergin and Inieson, 2009). US import dependence dropped from 60% in 2005 to 46% in 2011 (Luft, 2011). In 2007, LNG imports were at a high with 60 mcb per day, whereas today, imports have dropped to mere 20 mcb per day

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(Policy Exchange, 2012). 'By around 2020 it is estimated that the US will have moved from being a net importer of natural gas to a net exporter; net export of LNG is expected from 2016 (EIA, 2012c). In 2011, US LNG marketers like Sabine Pass LNG signed new long-term deals for up to 16 million tons a year (t/y), thereby outrunning Qatar, who signed deals for 13.4 million t/y (Chan and Leonard, 2012). Currently, US LNG terminal owners including Cheniere Energy Inc. and Dominion Resources Inc. are preparing fuel-export permits (Klimasinska, 2012). The former has already lined up two customers in Europe: BG Group of the UK and Gas Natural Fenosa of Spain (Crooks, 2012), although full permits for LNG export are projected not to be passed before late 2013 or 2014 (Reuters, 2012b). At the receiving end, Europe, for whom LNG took up 24% of overall gas import in 2011 (CNA, 2012; GlobalData, 2012), stands ready with new terminals to receive gas tankers in the UK, Poland, Italy, and Lithuania. As of 2011, the EU LNG capacity included 20 LNG terminals (with a total re-gasification capacity of 186 bcm a year). In addition six terminals are currently under construction and 32 are in the planning or study process (CNA, 2012). Based on the widening gap between European production and consumption of gas, BP predicts an increase in import of more than 60% between 2010 and 2030 (BP, 2012b). The European market is very attractive to US gas producers especially because of the high price differentials (European natural gas prices averaged 11.41 USD/MMBtu between January and October 2012, while the US prices averaged 2.61 USD/MMBtu in the same period [World Bank, 2012]). The Asian market is even more lucrative for international gas sales as gas prices are higher. Currently, the economic disadvantage compared to the Asian market has redirected a substantial share of the supplies from the Middle East. In 2011, exports from Qatar to the EU fell 22% (CNA, 2012). However, the US still needs to address a number of issues before it can become an international gas supplier. In addition to the need for sufficient high-capital cost liquefication capacity, the historical volatility of the natural gas markets makes it difficult to find investors willing to take on the risk of financing the building of costly but much-need infrastructure (CNA, 2012). Time will show whether large-scale export given these constraints will materialize. However, a comprehensive study by NERA finds that only low levels of export will occur and this given extreme international demand in so far US gas resources turns out scarcer than what is suggested by estimates from EIA and its like (NERA, 2012).

This US supply shift has effectively released LNG otherwise intended for the US to be

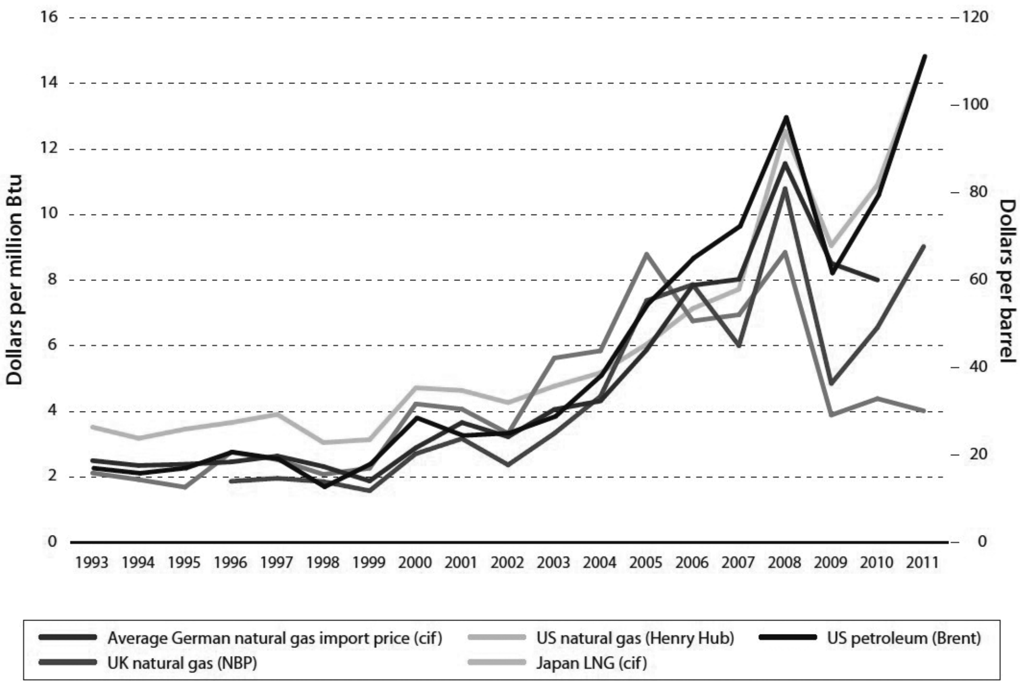

Figure 2: *Select prices of natural gas, LNG and Brent Crude, 1993-2011.*
Source*: Levi, 2012*
Note: cif is an aggregate measure of costs, insurance and freight (average)

redirected elsewhere (Chan and Leonard, 2012; Tzavela, 2012b; IEA, 2011a). Prior to the escalation of US shale gas production, major gas producing countries, especially Qatar, made large investments into LNG capacities in preparation for an anticipated increase in US gas import needs (Goldthau and Hoxtell, 2012). In total, more than 44 million t/y of LNG deals were signed by Australia and Qatar in 2011 and early 2012, compared to around 38 million t/y between 2006 and 2010 (Chan and Leonard, 2012).

2.3 Price impacts

Natural gas is a relatively high-volume, low-value commodity. Consequently, it requires sufficiently large price differentials between regional markets before it makes commercial sense to move supplies from one market to another (Stevens, 2010). Shell (2011a) reports how the selling-price of gas varies significantly from region to region. A significant impact of the revitalization of the US gas industry is the apparent decoupling of gas and oil prices (De Bock and Gijon, 2011).[6] Between December 2008 and February 2012, US gas prices dropped by 25% while oil prices rose by up to 175% at their peak (Policy Exchange, 2012). Just from 2010 to 2011 the Henry Hub average price fell by 9% (Quinlan, 2012). In early 2012, US spot gas prices bottomed out at as low as USD2.3 MMBtu (Chan and Leonard, 2012). Still, it is too early to say what the full consequences will be on the regional gas markets outside the US.

Figure 2 demonstrates how spot prices in US, European, and Asian natural gas markets, despite significant differences in these markets, more or less have followed each other for some 20 years. Also noticeable is that all three have been tracking the price of oil. The price setting on the European and Asian natural gas markets differ from the US Henry Hub spot prices. It should be noted that, in contrast to Asia, the European market since the 1990s has undergone a liberalization process leading to the emergence of several trading hubs. The

6 "US natural gas prices are determined largely by supply and demand conditions in North American markets" (EIA, 2012b).

European legislation to achieve the integrated gas market was set out in the "Third Package" (Directive of 13th July 2009) and recently, the Council of European Energy Regulators (CEER) expressed its vision of the future gas market in the Gas Target Model (CEER, 2011). Currently, there are gas hubs in Britain (National Balancing Point, NBP), The Netherlands (Title Transfer Facility, TTF), Belgium (Zeebrugge, ZEE), and Germany (NetConnect Germany, NCG). Other hubs are emerging in Europe. The European gas market is characterized by long-term take-off contracts (LTCs) that dictate volume levels independent of market conditions (The Economist, 2011). Beside the impact on contractual arrangements, the common indexation to oil is also being scrutinized and could potentially be replaced with lower spot prices (Goldthau and Hoxtell, 2012). At this point, these contracts are still mainly indexed against the price of oil regardless of the emergence of a number of Continental wholesale trading hubs. For the time being, this means that European gas prices are relatively less affected from the possible build-up of shale gas production on the continent compared to the US (Brogan, 2012). However, according to a press release from Société Générale in September 2012, spot market-based gas trading could come close to overtaking oil-indexed supplies in 2012 and overtake it by 2014 (Gloystein, 2012).

With the shale gas development in the US, this historical relationship between the close tracking of three markets appeared to end in 2009 (Levi, 2012). While some expect gas prices to continue to diverge for the indefinite future (see Levi 2012 for an examination of different convergence/divergence scenarios of the prices[7]), others argue that price convergence could occur as the US increases gas exports to Europe and Asia (CNA, 2012). At the International Energy Forum in November 2012, participants agreed that the prospects of one global price is unlikely to materialize anytime soon as the US shale gas boom has caused a "re-regionalisation" of the international LNG market. In 2011 and for the very first time, average oil prices exceeded USD100 in money-of-the-day terms (BP, 2012a). Natural gas prices in Europe and Asia (both spot market prices and those indexed to oil) followed broadly the upward trend in oil prices. This can be explained by the way natural gas contracts to European and Asian customers are drawn; such contracts are largely indexed to spot oil prices, while only a small part of the price, if any, is indexed to spot natural gas prices. The lack of highly liquid spot markets for natural gas in these regions is the main explanation for this. In the case of Europe this is largely due to the constraints in transnational pipeline networks (Levi, 2012). The recent implementation of the Gaz Target Model should increase market liquidity by inducing mergers between entry and exit zones and allowing for market coupling, the combination of which should then push price convergence on European gas markets. In the meantime, several new upstream network investments are expected; this will certainly help market liquidity by reducing cross border congestion between balancing zones.

Uncertainty in gas markets remains high, in part due to the relatively unforeseen dramatic changes in the US market. As an example, the IEA's 2009 forecast for gas prices in 2030 is 20% lower than in its previous projections, which did not take the emergence of unconventional gas into account. Also, at a national level, the UK Department of Energy & Climate Change (DECC) in 2012 projected gas prices to be approximately 24% higher by 2030 compared to 2011 - but just a year earlier, gas prices in 2030 were projected to be 11% higher than 2011 prices (DECC, 2011) and the year before that 23% higher (DECC, 2010). A recent study by the MIT (Jacoby et al., 2012) demonstrates the uncertainties associated with predictions of natural gas prices. The study approximates prices with and without shale gas recourses under various policy scenarios;

7 Levi (2012) highlights three possible (not mutually exclusive) ways for prices in the three major natural gas markets to converge back to similar levels: 1) through US LNG exports; 2) through a return of the historically tight link between oil and natural gas prices in the US market; and 3) for the three major markets to become linked to some new index rather than oil.

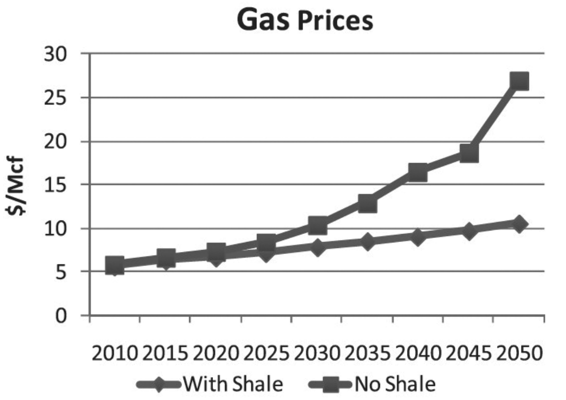

Figure 3: *The development of gas prices in the US under regulatory policy with and without shale resources.*
Source: *Jacoby et al. (2012)*

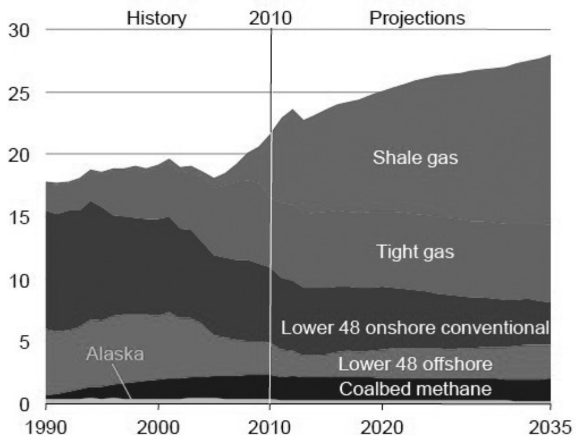

Figure 4: *Share of shale gas in US natural gas production (trillion cubic feet), 1990-2035.*
Source: *EIA (2012b)*

figure 3 below illustrates the great price-gap when applying various regulatory constraints to the production of shale gas.

3. The US Shale Gas Experience

The US is the only country to date that has managed to commercially produce shale gas in large scale.[8] The technical developments have unleashed what has been termed a "revolution"[9] of the shale gas industry in the US, successfully transforming its unconventional gas market (Policy Exchange, 2012). From being the world's largest importer of natural gas in 2007, the US today is a self-sustaining gas producer (GlobalData, 2012). According to the EIA (2012a,b, c), the continued development of shale gas in the US will be the primary driver behind increasing natural gas production from 2010 to 2040, while little change occurs in the production of tight formations, coalbed methane deposits, and offshore fields. *Figure 4* illustrates the EIA (2012b) projections of the share of shale gas in terms of total US natural gas production. In the reference year 2010, proved and unproved US shale gas resources have been estimated to 15.4 tcm out of a total US resource of 62.4 tcm. By 2035, shale gas will account for 49% compared to 23% in 2010.

Although many factors have influenced shale gas growth in the US, Deloitte (2011) has highlighted seven factors as being the most significant. 1) Increasing US import dependence between the 1970s and the 1990s was a central driver to the search for alternative exploration methods, which eventually enabled the rapid growth in shale gas development starting in the late 1990s and escalating in the 2000s; 2) Improvements in applied technology, especially horizontal drilling and fracking techniques, have made the development of shale gas economical feasible as it has enabled operators to shorten drilling and completion times, while reducing costs and raising initial production levels; 3)The US gas market has been characterized by numerous independent exploration and production companies that has benefitted from quick and resourceful service providers and a decentralized corporate structure (Deloitte, 2011). Moreover, a well-established, transparent supplier market as well as the volume of both buyers and sellers makes gas-trade relatively easy in the US (Natural Gas Europe, 2012b); 4) The availability of capital via cheap credits, joint venture partnerships, and different funding schemes has allowed the industry to advance; 5) Easy access for land-enabled drilling companies to acquire large adjoining pieces of land for the purpose of development (Deloitte, 2011); 6) A generous

8 The first serious commercial flows of shale gas began in 1981 (Stevens, 2010).

9 Still, none of the technologies needed were new; horizontal drilling had been around since the 1980s and fracking started in 1946. Hence, the US shale gas boom reflects an evolution of historical technologies but is considered to be a revolution due to the highly exponential growth in shale gas production.

tax subsidy was realized with the US Energy Act in 1980 (Natural Gas Europe, 2012b); 7) The growth of the industry has benefited from US lease regulations, which require a leaseholder to begin operations within a defined time period or otherwise lose the lease (RS and RAE, 2012).

The development of the US shale gas industry has resulted in the drilling of 20,000 wells (The Economist, 2012), and hundreds of thousands of jobs, directly and indirectly. In 2010 alone, the Marcellus natural gas development has supported nearly 140,000 jobs (Considine et al., 2011). Citigroup (2012) estimates that up to 3.6 million net new jobs could be created in effect of the transformative impacts of US shale gas production on the US and global economics. The industry also finds support from the US government; at the 2012 State of the Union, President Barack Obama stated that natural gas was one of the foundations for US energy security (the White House, 2012). He has also proposed major energy policy initiatives to develop the natural gas sector further (Koebler, 2012).

Some commentators still question the impacts of the shale gas revolution. As an example, Russia's Gazprom, the world's biggest supplier of gas, rejects shale gas as nothing more than a "well-organized PR-campaign" in line with biofuels (Orlov, 2012). It is the case that US estimates of the reserve size of shale gas is continuously adjusted – a fact stated in the latest International Energy Outlook of the EIA, which as of late as in January 2012, cut its own estimates of unproved shale gas reserves by more than 60% (Magyar, 2012). Such factors have left investors with uncertainties at all stages of the gas value chain (Stevens, 2010).

According to Wiejermars (2012), the shale gas industry is fueling a looming energy credit crunch as the increasing price volatility (coupled with the already low prices) of natural gas in the US is creating an uncertain market for US shale gas operators. Wiejermars explains that the current oversupply of natural gas on the US market and subsequent drop in natural gas prices, along with the access to easy and cheap credit has made it possible for shale-gas independents to keep drilling, even without a valid business case. These funding sources are now drying up, which is the case for Chesapeake Energy, the largest independent gas explorer in the US. Standard and Poor's downgraded the company to "junk" as of May 2012 because its ability to pay off its debt as natural prices plunged was questioned (Bloomberg Businessweek, 2012a). Wiejermars (2012) concludes that the risk associated with shale gas business, "is becoming too high for any further debt and equity financing to be feasible." In the years to come, market analysts expect consolidation to take place in the US shale gas industry due to, *inter alia*, higher capital requirements (Watson, 2012).

Large Exploration and Production companies (E&Ps) such as Exxon Mobil, Shell, and BHP Billiton have begun moving their drilling rigs out of natural (including shale) gas basins and into shale oil or LNG liquids plays (Bloomberg Businessweek, 2012b; Marcellus Drilling News, 2012; Evans, 2012). Independents such as Chesapeake and EOG moved first (Chesapeake, 2012; Brown, 2012). Another factor complicating the issue is the significant and increasing environmental attention given to shale gas in the US (EPA Ireland, 2012). The Environmental Protection Agency (EPA) has signaled that additional regulation around fracking may be introduced in 2012 (Natural Gas Europe, 2012f).[10] On the other hand, new EPA regulation on coal and meeting standards for carbon emissions tends to favour natural gas development. Public concern has, however, forced individual states (including New York, Pennsylvania, and Texas) (ERCB, 2011) to develop their regulatory frameworks to keep pace with the rapid technological advances and increases in shale gas production. At this point, the federal government has only taken small steps to coordinate a national stance on this issue (Freeman, 2012).

10 The federal laws in place are the Clean Water Act, the Clean Air Act, the Safe Drinking Water Act and the Oil Pollution Act (EPA Ireland, 2012).

Even though year-to-year production growth is still expected for 2012, the EIA projects the growth to be less than that of 2011 due to the low gas prices (EIA, 2012). The monthly price for natural gas in the US averaged 3.32 USD/MMBtu in November 2012 (World Bank, 2012). However, with the US economy showing signs of recovery, gas demand might rebound (Natural Gas Europe, 2012f). What is clear is that the largely unexpected and non-linear development of unconventional gas makes predicting the future of the industry especially difficult.

4. The European Shale Gas Experience

The shale gas debate in Europe varies widely between countries. Numerous factors influence the direction of the debate on shale gas, including the broad differences across European Member State countries in terms of energy landscapes and energy mixes. Other factors include the EU internal gas market in terms of regulation and policies and a historical preference for bilateral policies in interactions with third parties - instead of regional cooperation (Wyciszkiewicz et al., 2011). Giving the large discrepancies, different priorities for foreign policy emerge when shale gas is on the agenda. We now consider the current status of the shale gas industry in Europe and allude to several issues limiting its development.

4.1 Shale Gas Reserves in Europe

Energy dependence in the European region, particularly in gas, is high and is expected to increase, especially as production in the three major gas producers in the EU (the UK, the Netherlands, and Denmark) has been declining overall since 2004 (CNA, 2012). The IEA projects the EU dependence on gas imports will increase from 61% in 2009 to 86% in 2035 (IEA, 2011a). The gas import dependence of some EU countries is higher than 90% (CNA, 2012).[11] According to EU estimates, natural gas in the EU will meet no less than 30% of its primary energy needs in 2035 - and 80% of that is expected to be imported (Eurogas, 2011). A report published by the European Commission (EC) in September 2012 stresses that an increase in European natural gas production due to shale gas production potentially could help the EU keep its energy import dependency at a level around 60% (EU Joint Research Centre, 2012). Thus, the fact that there are large potential shale gas reserves in Europe demands further consideration as to how this resource might transform the European market.

Figure 5 illustrates, using data from the EIA's International Energy Outlook 2011, the development of unconventional gas production in OECD Europe and the development of future European (OECD) total demand for natural gas, which is a sum of the region's own production and what it imports. European production of unconventional gas, including shale gas, is projected to increase rapidly from a share of 4% of total natural gas production in 2020 (8.5 bcm) to 27.7% in 2035 (65.1 bcm). By 2035, unconventional gas will meet just below 10% of Europe's gas demand; a conclusion also drawn in the IEA's GAS scenario although the IEA expects Europe to develop a much larger share of unconventional gas by then (47%). The IEA (2012) projects how increasing production of unconventional gas in Europe and the rest of the world will help to put a lid on European gas prices and hereby drive up the demand for gas. Consequently, net import of gas will continue to increase throughout the IEA's projection period. The same picture is captured in figure 5, in which EIA data projects an increase in imports share of total demand from approximately 52 percent in 2010 to 65 percent in 2035.

Shale gas reserves are currently anticipated in at least 16 countries across Europe (Ernst & Young, 2011), and test drilling for shale gas is ongoing or underway in many countries including: Denmark, France, Germany, Hungary, Netherlands, Poland, Sweden, Ukraine, and the UK (Assenova, 2012; Ernst & Young, 2011; Skifergas.dk, 2011; Kuhn and Umbach, 2011a). Shale gas has attracted the most

11 "At times, dependency on Russian gas can reach 100 percent in countries such as Austria, Bulgaria, Slovakia, Greece, Estonia, Latvia, Lithuania, and Finland" (CNA, 2012). Meanwhile, other EU member states (such as Belgium, Ireland, Portugal, Spain, Sweden, and the UK) hardly import any Russian gas.

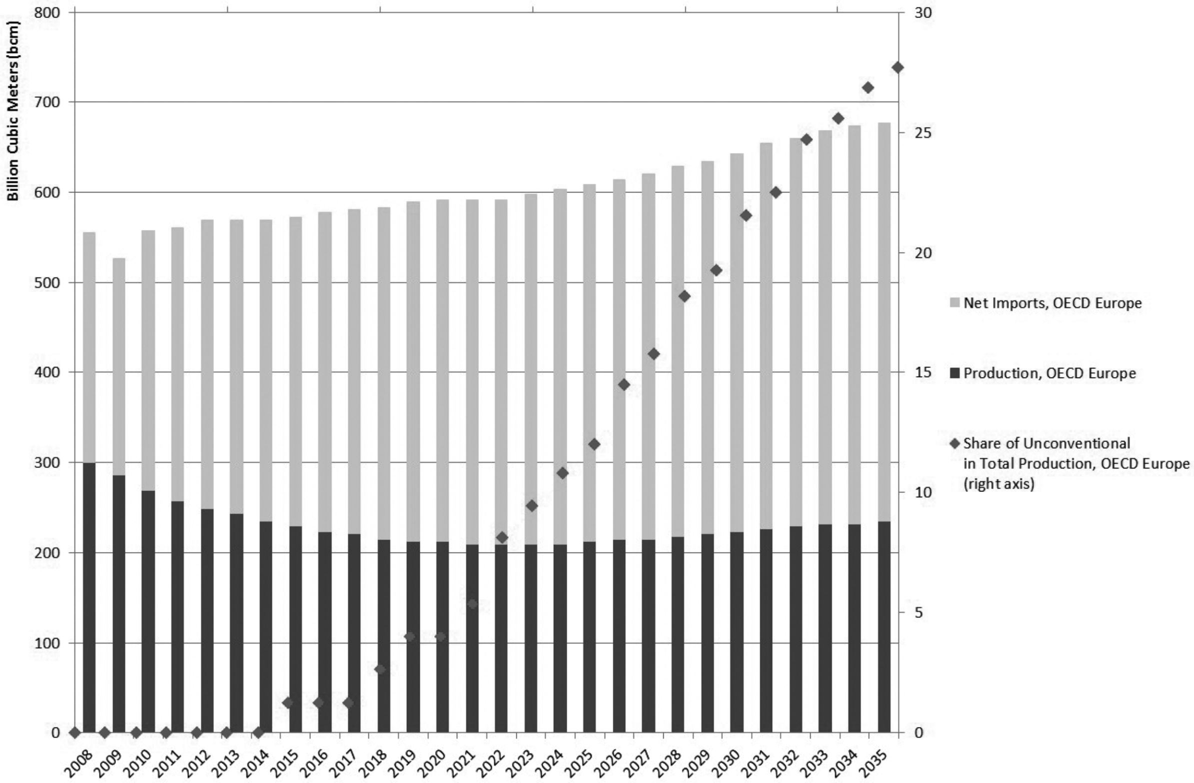

Figure 5: *Total natural gas net import and production, and share of unconventional gas in total production, OECD Europe.*
Source: *EIA (2011b)*
Note: The sum of production and net imports represents total demand.

interest in Poland (IEA, 2011b), which sits on estimated reserves large enough to make it self-sufficient for the next three decades (EIA, 2011b). Poland has granted 109 fracking concessions to 20 companies, including international energy companies such as ExxonMobil, Chevron, ConocoPhillips, Marathon Oil, Eni, and 3Legs Resources (Trudelle, 2012; Natural Gas Europe, 2012f); fracking is expected to start commercial production in 2014 (The Economist, 2011; Rzeczpospolita, 2012). With potential shale gas reserves of approximately 5.3 trillion cubic meters, Poland would have enough gas to meet its own demand of some 14 billion cubic meters per year for decades (European Dialogue, 2011). Ukraine is most likely sitting on 1,200 bcm of technically recoverable shale gas reserves (Olearchyk and Chazan, 2012), the third largest in Europe; in 2011, the country awarded exploration licenses to ExxonMobil and Shell (The Economist, 2011). It is currently accepting bids in tenders from global energy majors for two potentially large shale gas fields (Reuters, 2012a; Olearchyk and Chazan, 2012). In Germany, BNK Petroleum has been awarded several concessions across German states, although the company needs further approvals as outlined by law in order to start exploration (Erhard and Miller, 2012).

How realistic are these estimates of shale gas reserves? Gas Strategies (2010) has argued that it is too early to say, as reliable European geological shale gas maps will take time to draw. What is uncertain is not the location of the shale gas deposits, but how much gas the shale contains, and more fundamentally, how easy it is to produce that gas (depth, the types of formations involved, etc.). Compared to mapping conducted in the US, European reserve estimates will be complicated by a different geology, which is more fragmented and lacks the larger sedimentary basins. The media coverage reflects the widely diverting and frequently changing estimates of shale gas reserves. Take, for instance, the UK, where large fracking companies have claimed that national reserves could meet gas demand for nearly a century (Barkham, 2012). Cuadrilla estimates there to be 5.7 tcm of shale gas in the Bowland Basin alone (Oil & Gas Journal, 2011); a number higher than what the EIA (2011b) has estimated for the whole UK. But the British Geological Survey (BGS) believes that the recoverable reserves will barely be enough to meet current UK demand for two years; estimates suggest that just 0.1 tcm is recoverable (Robert, 2011).[12] Meanwhile, a recently as April 2012, the British shale gas company IGas doubled its estimates of shale gas in northwest England to 130 mcm (Schaps and Gloystein, 2012). These continuously changing and often greatly differing estimates of the UK shale gas potential reflect the general uncertainties associated with measuring the true size of technically recoverable resources. *Figure 6* illustrates the location of potential shale gas basins in Europe and which geographical areas were being explored for shale gas in 2010.

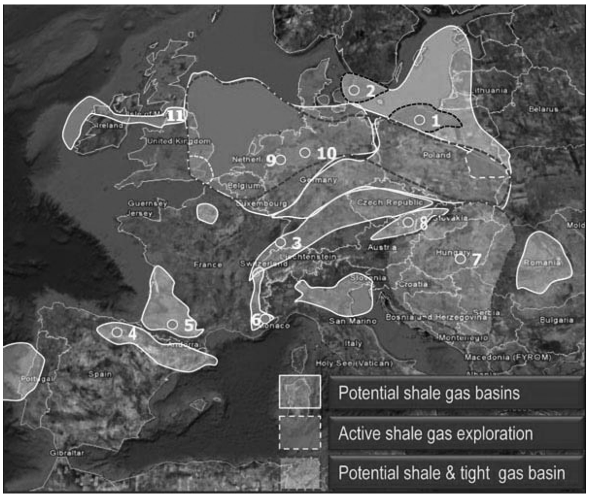

Figure 6: *Potential shale gas basins and active shale gas exploration areas in Europe***.**
Source: *Adapted from Helm (2012)*
Note: The basins are: 1 – Baltic shale, Poland; 2 – Alum shale, Sweden; 3 – Molasse basin, Germany, Switzerland, France; 4 – Cantabrian basin, Spain; 5 – Cevennes basin, France; 6 – Provence basin, France; 7 – Pannonian basin, Hungary; 8 – Vienna basin, Austria; 9 – Posidonia shale, Germany; 10 – Westphalian basin, Germany, The Netherlands; and 11 – Namurian shale, W-Lancashire Sub Basin (Blackpool area), United Kingdom.

In Poland, recent estimates of technically recoverable shale gas have been lessened by 85% by the national Geological Institute (Klimasinska, 2012). Also in Poland, ExxonMobil announced in February 2012 that drilling efforts to that point had failed, as two projects for exploratory wells had proven unsuccessful in producing sufficient gas to be profitable (LeVine, 2012a). After three years of test drilling in supposedly promising basins in the southeastern region of Sweden, Shell has concluded that the reserves are not profitable to extract (Wittrup, 2011), and hence estimates are to be re-evaluated. These changes are not unique to Europe. As an example, an independent survey of the Chinese government finds China's reserves to be nearly twice compared to the EIA (2011b) estimates.

The key to the large differences in shale gas reserve estimates is often methodological. However, as more exploratory drilling takes place, the range of resource assessments should narrow (IEA, 2011b). The term "technically recoverable" is not an agreed terminology and has a range of interpretations (Natural Gas Europe, 2012b; RS and RAE, 2012).[13] How large a share of the reserves actually turns out to be recoverable will depend on economics and politics, as well as technology and geography. The EIA (2012d) acknowledges how various market uncertainties affect projections on natural gas resources including shale gas and have caused large changes in EIA estimates over the recent years.

In an article that appeared in Bloomberg in November 2011, Schlumberger, Ltd. asserted that the cost of drilling a shale gas well in Poland was three times the cost in the US. Nevertheless, the IEA (2012) claims "high oil-indexed prices for imported gas should make shale developments profitable." While the average

12 BGS estimates were extrapolated from comparable shale gas areas in the US, whereas Cuadrilla's figures were based on real UK data from the company's own small number of drilled wells (Barkham, 2012).

13 See Giles et al. (2012) for a discussion of the methods of determining technically and economically recoverable volumes of shale gas and unconventional gas in general.

break-even cost for shale gas is USD 4-7 per MMBtu in the US, some place the break-even figure for European shale projects in the range of 8–16 USD/MMBtu–more than the current price in long-term oil linked contracts (Balmforth, 2012; Maroo, 2012). Others argue that at a price of around 8 USD/MMBtu, shale gas development should be profitable given the higher level of carbon dioxide costs and a more challenging geology (Maroo, 2012). Some postulate that once the "trigger point" of one or more large-scale developments is reached, market forces will drive down costs as companies develop the supply chain necessary to support large developments and competition, particularly as service companies not yet present in Europe. To Giles et al. (2012), the fluctuations of the US gas price over the last years serve as prove that investment in the shale gas industry requires either a long-term view of gas prices or very aggressive hedging.

4.2 Social and Environmental Opposition to Fracking

It is the social and environmental aspects of shale gas exploitation, which have made fracking the *bête noir* of environmentalists (Barkham, 2012). One concern is that the methane and drilling chemicals used in the process will risk contamination of water supply aquifers. Alleged cases of ground water contamination stemming from injected fluid and released natural gas have been documented in the US (University of Texas, 2012; Osborn et al., 2011). The injection of large volumes of fluid into the subsurface also includes the risk of earthquakes and emission of volatile components into the atmosphere. These concerns, together with the large quantities of water needed per well for fracturing operations[14], have contributed to the environmental controversies (Gas Strategies, 2010; EPA Ireland, 2012).

Adding to the local intolerance and polarized debate, the scientific understanding of the risks of fracking is certainly incomplete (Barkham, 2012). The few peer-reviewed scientific reports that do exist, suggest that the mechanical fracking jobs themselves do not pose a significant environmental risk to ground water (EPA Ireland, 2012). Instead, risks primarily depend on the design and construction of the wells, including the quality and integrity of the borehole casings and cement jobs (EPA Ireland, 2012).[15] Other risks, such as the increased seismicity and the potential impacts on the atmosphere from methane emissions call for further research and documentation.

Based on the current literature, a report from the University of Texas (2012) concludes that fracking is no more environmentally hazardous for the drinking water than conventional oil and gas operations. A study of several alleged cases of ground water contamination demonstrates no evidence for contamination from the subsurface fracking jobs themselves (University of Texas, 2012). However, more innovations may be necessary in fracking technology to reduce negative environmental impacts. Improved fracking techniques have reduced the amount of water needed in the operations[16] as well as the frequency of fracking (Natural Gas Europe, 2012b). Considerable ongoing work ranging from impacts on drinking water to LCA studies of specific shale plays will be available in the short-term and will subsequently help improve discussion and decision-making.

The emission rate of methane into the atmosphere from shale gas production is also a topic of debate (Howarth et al., 2011). A study conducted by Cornell University suggests that greenhouse gas (GHG) emissions from shale gas production might be 20%-100% higher than coal GHG emissions in a 20-year time-

14 "There are concerns that fracking could require volumes of water that would significantly deplete local water resources (Entrekin et al., 2011).

15 For a detailed review of the risks associated with shale gas extraction and the process of fracking as well as recommendations as to how to counter such risks, see RE and RAE (2012).

16 According to the EPA Ireland (2012), estimates of water volume needed in fracking operations vary widely, with between 90,000 and 13,500,000 litres per well, due to "the large variation of well 'lifetime', with operations lasting from a matter of days through to many years."

frame. This assumes that the carbon footprint is significantly larger than that from conventional gas extraction due to potential methane leakage (Howarth et al., 2011).[17] However, the general conclusion is that shale gas is likely very similar in this regard to conventional gas extraction. In addition, lessons from the American experience so far shows that not only does the burning of gas emit half as much carbon dioxide as coal, but the US GHG emission level has fallen by 450 million tons in the past five years–more than any other country is the same period (The Economist, 2012). A study published by MIT in November 2012 demonstrates, based on data from approximately 4000 wells drilled in the five main US shale sites during 2010, that the amount of methane emissions has been "largely exaggerated" (O'Sullivan and Paltsev, 2012). MIT (2011) has previously concluded, "natural gas provides a cost-effective bridge to such a low-carbon future". A EU-commissioned report published in September 2012 concludes that shale gas produced in the EU, "causes more GHG emissions than conventional natural gas produced in the EU, but - if well managed - less than imported gas from outside the EU" (AEA, 2012).

In several European countries, after public opposition governments have banned fracking and set moratoriums–some of them indefinite–for drilling activities. 'France, who was expected to be one of the first European countries to produce shale gas commercially, instead became the first country in the world to ban fracking in June 2011 after a major protest movement (Brogan, 2012). This was mainly due to concerns about water management. Recently, US Energy giant Chevron suspended its shale gas operations in Romania, Czech Republic, and Bulgaria due to ecological protests, which also have led Bulgaria to ban fracking. Furthermore, there is currently a "No-Fracking" campaign in Ireland despite the Irish government having given Enegi Oil an option to explore the Lough Allen Basin and Clare Basin for recoverable reserves (Douthwaite, 2011; BarentsNova, 2012; SEAI, 2011). Additionally, Germany, the Netherlands, and Switzerland are witnessing how the fracking debate is gaining momentum (BarentsNova, 2012; Boersma, 2012; Der Spiegel, 2012). Fracking has also already been suspended in parts of Germany for similar reasons (Olearchyk and Chazan, 2012).

However, several countries that have suspended shale gas exploration and development within the last few months and years, have reversed their opinions. This is the case in Romania, where an immediate moratorium was pledged in March 2012 by its newly appointed government (Natural Gas Europe, 2012i). Yet, in June 2012, the Romanian Senate rejected the motion to ban shale gas exploration and exploitation, as well as the cancellation of exclusive licenses granted for exploration projects that use fracking. Romania is now set to start exploring its shale gas reserves and has granted Chevron a license to drill for shale gas in three locations (Karasz, 2012; Assenova, 2012).[18] The Bulgarian parliament modified its May 2012 suspension of shale gas exploration and production just four months after banning it (Gaydazhieva, 2012). Because France is 85% energy dependent on foreign gas supplies, energy security may well be a key driver for the support of government policy in assisting operators dealing with the challenges to shale gas in Europe.[19] Further, the UK has allowed for new developments in unconventional gas resources, despite nationwide environmental campaigns (Orlowski, 2011) and temporary suspension of further test drillings due to the linkage between tremors in Northern England and

17 The study recognizes the uncertainty related to the quantification of the methane leakages and concludes that more research is needed.

18 Nevertheless, Chevron is cautious about the public objections and has announced that "the company will only conduct seismic research in the first year" (Assenova, 2012).

19 Today, building blocks have been put in place for shale gas exploration: several Government issued expert studies have been published favoring shale gas exploration, a Commission has been set up to evaluate the environmental issues involved in shale gas and the Government is now considering new applications for shale gas exploration (Shepherd, 2012).

hydraulic fracking (The Economist, 2012).[20] In a report on shale gas, the UK government appears generally supportive of fracking as a mean to extract shale gas (House of Commons Energy & Climate Change Committee, 2011). After a UK Select Committee (2011) report argued the safety of fracking, the UK allowed suspended fracking activities to continue, even after an earthquake near Blackpool attributed to well drilling by Cuadrilla (Wynn, 2012). Significantly, the quick reversals in these countries were important: it sends the message to international energy companies operating in the Central & Eastern Europe that changes in popular perceptions can change rapidly (Natural Gas Europe, 2012d).

The IEA notes the public concerns, "have prompted calls for new regulation on aspects of this practice, often based on the 'precautionary principle' that is a statutory requirement in European Union law" (IEA, 2012). The EU's lack of clear policy[21] in this area has been a been one element in the suspension of shale gas exploitation in several member state countries (Assenova, 2012; Tzavela, 2012). Today, most regulations in the EU dealing with upstream gas are determined at the national level (IEA, 2011b).

It was not before February 2011 that shale gas was officially included in a debate by the European Council (Wyciszkiewicz et al., 2011).[22] Also, the EC did not express support for shale gas development before January 2010. It concluded in November 2011, based on an independent report from Philippe & Partners (2011), that the existing regulatory framework is adequate to protect the environment in the exploration phase of shale gas, at least until it reaches commercial scale. The report further concluded that if any country wanted to introduce additional regulation (i.e., to adjust the regulations to the specific nature of extraction or to the specific nature of development), then the present European law is sufficient and flexible enough. Further studies have been undertaken, such as the EC Directorate-General desk study on environmental and health risks associated with fracking as well as a study focused on gas emissions associated with shale gas production (RS and RAE, 2012). For Austria, a recently passed legislation which requires companies to conduct detailed environmental inspection before the start of a project, has forced the Austrian oil and gas group OMV to give up its shale gas exploration plans (SeeNews, 2012).

To facilitate shale gas development in Europe, the gas industry is moving to address related social and environmental concerns. For example, Shell (2011b) has released its *Onshore Tight Sand/Shale Oil & Gas Operating Principles* to specifically address the concerns about the practice of hydraulic fracturing. These principles focus on safety of wells and facilities, continuous improvement of operation techniques, and collaboration with regulators and engagement with local residents (Shell, 2011b). Also notable is the IEA's (2012) *Golden Rules,* which suggests principles that aim to allow policymakers, regulators, operators, and others to address environmental and social impacts of the development of unconventional gas. Their application is intended to "earn the industry a social license to operate within a given jurisdiction" by ensuring a level of environmental performance and public acceptance. The Rules include advice to industry on where to drill, the design of wells, and water and chemical usage in development. European research on shale gas extraction include Gas Shales of Europe, which is sponsored by a number of industrial companies and has developed a GIS database of European black shales - including their location, the identification of sweet spots, and the prediction of shale formation. Another initiative is the European Sustainable Operating Practices (E-SOP), which, "combines Europe-specific research with

20 The UK has more than 30 years of experience of fracking for non-shale gas applications. Approximately 200 onshore wells have been drilled (10% of all drillings) using fracking to enhance recovery. (RS and RAE, 2012).

21 Currently, only four existing EU directives apply to shale gas, none of which are specifically purposed to target the sector (Wynn, 2012).

22 According to Article 15 Paragraph 1 of the Treaty on the European Union, the European Council defines the general political directions and priorities of the EU.

relevant US experience to develop best practice for shale gas extraction" (RS and RAE, 2012).

For some countries, shale gas is perceived as an obstacle in achieving climate change goals, whereas others see it as an opportunity to meet them faster. Even though the European Parliament (EP) encourages Member States to diversify their energy mixes away from an exclusive reliance on fossil fuels and encourages the pursuit of renewable energy sources,

The popularity and availability of cheap natural gas in Europe could discourage investment in renewable energy sources which are more expensive

the EP also acknowledges natural gas (including shale) as an essential element to meeting the EU's ambitious carbon-reduction targets (ITRE, 2012a; ITRE, 2012b). While nuclear power is still unpopular in the EU following the Fukushima disaster, gas is considered an ideal back-up for variable renewable energy generation (Eurogas, 2011). Hence, fossil fuels will likely remain the backbone of European energy supply to at least 2030 (Tzimas et al., 2009).

However, there is a growing concern that increasing popularity of natural gas in Europe will "crowd out" renewable and low-carbon energy forms at a time when government support is a necessary to ensure their growth (OilPrice.com, 2012). The availability of cheap natural gas could discourage investment in such energies which are more expensive (Ernst & Young, 2011). The UK House of Commons Energy and Climate Change Committee concluded in a 2011 inquiry that, "if a significant amount of shale gas enters the UK market…it will probably discourage investment in more expensive but lower carbon emission renewables". Moreover, even though the EC has communicated that renewable sources shall have a dominating presence in the European energy supply in 2050 (EC, 2012) , a new energy policy called Horizon 2020 has recently been approved which reclassifies gas a green source of power. "The European Union (EU) is likely to divert €80 billion of funds earmarked specifically for development of innovative renewable energy sources to the development of natural gas power plants" (Clean Technica, 2012). The complex interactions and potential synergies between natural gas and renewable energy are complex, and they are the subject of considerable ongoing analyses (see e.g., Lee et al., 2012).

4.3 Foreign Policy and Information for Policy Makers

US and European interests in shale gas stem part from its contribution to allaying energy security concerns (Rachman, 2010; IEA, 2012). For both regions the energy reliance on foreign suppliers had increased steadily over the last few decades. In the EU, the attention on energy security was sharpened by the Russia-Ukraine gas crisis in January 2009, which took many countries by surprise and evidenced how some States were unfit to handle the disruption (Nöel, 2009). The CNA (2012) concludes that because of, "the lack of coordination and cooperation, EU member states are dramatically more vulnerable to supply disruptions than they might be otherwise".

With shale gas, "energy security has assumed newfound geopolitical importance" (Stone, 2010). This mirrors an equation between import dependence and insecurity, which has caused a "securitization" of the energy policy discourse (Nöel, 2012). While aiming to balance the risks associated with import dependence[23], energy security is not solely about minimizing such dependence; nor is it about maximizing energy self-sufficiency (European Union, 2000 via SEAI, 2011). It is rather highly dependent on context, differing across energy markets and their stakeholders, and the merits by which they measure it (SEAI, 2011).

For Europe, the US shale gas boom has had repercussions that are sometimes difficult to interpret and apply concerning its position in energy relations with its main suppliers - Russia, Norway, and Algeria (together accounting for 50% of European gas supply), the former being the dominant supplier at 34% (CNA, 2012; Goldthau and Hoxtell, 2012; Nanay, 2011).

Russia-EU Energy Relations

The Russian gas company Gazprom has been forced to delink 15% of its supplies from the price of oil (Kuhn and Umbach, 2011), and has accepted partial indexation to spot gas prices for a period of three years (IEA, 2011b). One example of growing bargaining power is reflected by the efforts of E.ON Ruhrgas, Germany's biggest natural gas importer, to renegotiate its gas contracts with Gazprom – a relationship which is very politically charged (Powell 2011).[24] Hence, before the drilling of any wells has taken place, shale gas is changing the European gas market. With local production of shale gas in Europe, gas-to-gas competition will add further negotiating power to buyers.

Following the 2009 Russia-Ukraine gas crisis, Russia's position as a reliable gas supplier was uncertain (Mäkinen, 2010).[25] The incident encouraged the EU to look for alternative suppliers, dedicate massive investments in building a number of gas interconnectors, and construct new pipelines to diversify Europe's gas imports. With the release of the European 3rd Energy Package, the European Network of Transmission System Operators for Gas (ENTSOG), an association of Europe's transmission system operators, has been required to formulate a Ten-Year Network Development Plan, which is to frame a Union-wide non-binding plan of infrastructure development. In 2011, the EC set down new infrastructure priorities for Europe, including the sources of new pipelines, where especially the importance of the Nabucco pipeline is highlighted.[26] However, it is uncertain if the gas available will be sufficient to fill the pipeline (Mäkinen, 2010). Estimates suggest that volumes from new pipelines add up to: 50 bcm/Nordstream, 8 bcm/Medgas and 31 bcm/Nabucco. Alternatively, shale gas and additional LNG imports could close the gap in 2020. (Kenderdine, 2012)

Alternative gas suppliers with significant reserves include several Middle Eastern countries, but due to the uncertain political environment in the area (for example, Iran and Kurdistan), import reliability has been called into question (LeVine, 2012b). On the other hand, the increases in gas prices following the political upheaval in the Middle East might have created sentiments among European governments that Russia could be a more reliable supplier of gas than North African countries, such as Algeria and Libya (Blas, 2012; European Dialogue, 2012). Israel, which sits on top of the Levant Basin together with Lebanon, Cyprus, and Syria with an estimated 3.5 tcm of natural gas. Gas from this basin would thus need to traverse Syria before reaching Greece and the rest of Europe (LeV-

23 "The risks to energy security are strongly related to the availability of fuel supply and trends in energy demand. On the supply side, key variables include the size of the physical resources, robustness of infrastructure (gas pipelines), the feasibility (including political), the costs of extraction, geopolitical, and weather events" (SEAI, 2011).

24 Moreover, "Gazprom has agreed to offer discounts to some customers, such as GDF Suez (GSZ) SA and Eni SpA, while pursuing arbitration and talks with EON AG and RWE AG (RWE)'s units and Poland's PGNiG earlier this year" (Bloomberg, 2012).

25 The crisis left Europe without Ukrainian gas for two weeks; consequently, people in several Eastern European countries struggled without heating in midwinter.

26 The Regulation concerning guidelines for the implementation of European Energy infrastructure priorities is expected to come into effect on 1 January 2013.

ine, 2012b). This would be politically difficult in current (2012) conditions.

“One may observe an interesting evolution of the attitude of Gazprom to shale gas: from complete dismissal, through skepticism, to a more moderate stance” (Natural Gas Europe, 2012h). However, the impact of the shale gas boom appears to be becoming increasingly clear to the Kremlin (Blas, 2012). By 2009, the US overtook Russia as the largest producer of natural gas due to its extraction of shale gas (Bloomberg, 2010). By June 2012, Gazprom’s shipments have fallen about 14%, and its shares have fallen 57% compared to a historical high point in 2008 (Bloomberg, 2012). Putin stated (11 April 2012) that the, “US shale gas production may seriously restructure supply and demand in the global hydrocarbons market” (EurActiv, 2012).

Russia realizes that, “if shale gas takes off in Europe and other regions, it will affect competition and force Russian companies to rethink their own pricing strategies” (Tzavela, 2012). Indeed, Smith (2012) contends, “any large increase in the European gas supply would have serious implications for the Russian economy”. Gazprom has reacted to the pressure by speeding up its plans for the South Stream pipeline which is expected to supply southern Europe with gas from Russia – a project that would directly compete with the EU’s Nabucco pipeline (Herron, 2012).

Especially for the countries in Eastern Europe, unconventional gas represents a way to establish greater foreign policy independence from Russia (Medlock et al., 2011). From a European perspective, a lessening in Russian gas dependence would reduce Russia’s political leverage, and have a positive impact on the balance of power between Russia and the EU (Medlock et al., 2011). Hence, as concluded at the European Unconventional Gas Summit in Paris 2011, “shale gas and LNG together have the potential to support the development of a much more competitive and interconnected European gas market” (The Energy Exchange, 2011).

European Shale Gas Regulation

The EP has paid increasing attention to unconventional resources, especially shale gas (Wyciszkiewicz et al., 2011). In a draft report dated 4 April 2012, the Committee on Industry, Research and Energy (ITRE Committee) recommended the EU to support the assessment, exploring and development of shale gas reserves in Europe so as to pursue greater security of supply from third countries (ITRE, 2012a). The report is the first comprehensive attempt of the European legislative body to push through an EP Resolution on the issues of safety standards and inspections at safety-critical stages of well construction and fracking. Similarly, other EP Committees have stressed the need for appropriate laws to regulate shale gas exploration. In January 2012, the first meeting of an Ad Hoc Technical Working Group on Unconventional Fossil Fuels took place with representatives from approximately two-thirds of all EU member countries. No results are available from the meeting yet, which aimed for EU member states “to exchange information, identify best practices, assess the adequacy of regulation and legislation, and provide clarity to operators” (RS and RAE, 2012). The chances of the EU undertaking tough new action to regulate shale gas projects increased significantly in September 2012 as three EU-commissioned reports assessing the environmental and social risks posed by shale gas development, as well as its effect on gas markets and energy security, were published by the EU Joint Research Centre and environmental consultancy AEA. The reports highlight how shale gas exploration and production would need to comply with 19 differing pieces of existing EU legislation and how neglecting to fill current legislative gaps could leave the shale gas sector badly under-regulated (EU Joint Research Centre, 2012). The reports will add content to the intense debate within the EP on shale gas regulation.
A positive side effect of full-scale shale gas production in Europe is the generation of a substantial number of new jobs in both high and low skill sectors (KPGM, 2011). The EP acknowledges the stimulating impact shale

gas production might have on job creation in its Member States as well as the impact on competitiveness and innovation (ITRE, 2012a; ITRE, 2012b). An economic study conducted in the UK shows that a scenario, in which 50 well pads are in place over the next nine years, will have an employment impact of 5.600 full-time equivalent jobs (Cuadrilla Resources, 2011).

The economic implications of a truly global gas market, or more likely expanded regional markets, and a European market with gas-to-gas competition and a new pricing formula, are significant for both producers and consumers (CEU and GPPi, 2011). It is argued that Europe's real political problem with Russian gas can best be addressed by building a competitive, integrated market (Nöel, 2010). Currently, the environmental concerns and the climate change dimension appear to be dominating the European political focus, which in turns affects the pace of shale gas development in Europe. However, once the European economic fundamentals start to improve, focus is likely to turn back to the energy security dimension (Chan and Leonard, 2012).

5. Concluding Remarks

Since the first exploration authorizations were granted in Sweden in 2010 (Philippe & Partners, 2011), the debate on shale gas in Europe has escalated, uncovering a complex combination of economic, environmental, geological, regulatory, and social challenges. In the US, where the shale gas sector is currently booming, the sector has been supported by a relatively liberal regulatory framework, an established industrial environment, skilled manpower, and an experienced and well-equipped service industry (Gas Strategies, 2010; Tzavela, 2012; Corbeau, 2012). For Europe, the reality is different and the European shale gas sector faces a number of specific drivers and concerns.[27]

First, Europe has a much higher population density than the US (Lee, 2012, KPMG, 2011). In France, Scandinavia, and elsewhere in Western Europe, reserves tend to be close to densely populated areas. Compared to the US, the density is three times as high (Deloitte, 2012) and creates more environmental concerns on the impact of fracking on water safety. There are those who see this as an advantage though, such as Elixir Petroleum who would expect developments to take place

In Western Europe shale gas reserves tend to be close to densely populated areas and create more environmental concerns on the impact of fracking on water safety

close to a large existing gas infrastructure (Elixir Petroleum, 2010; The Energy Exchange, 2011).

Second, from a geological perspective, the plays of shale in Europe have been found to be deeper underground than in the US, more fragmented, thinner[28], and more likely to be rich in clay (Natural Gas Europe, 2012b; Balmforth, 2012). These factors together increase the cost of gas treatment and processing. Having conducted test drillings in Poland, ExxonMobil realized that the drilling techniques applied in Texas were not performing as well on the formations in Europe (Natural Gas Europe, 2012b; Natural Gas Europe,

27 Kuhn and Umbach (2011) offers an excellent comparison of differences between the US and European shale gas possibilities.

28 According to Smith (2012), what characterizes a good shale gas reservoir is a shale thickness between 90 and 180 metres. While the is the case for the major US shale sites, a large part of the European shale sites have far thinner reservoirs (for example, the reservoirs discovered so far in the UK are at most 49 metres).

2012j) and that new R&D had to take place. Deloitte (2012) highlights, “the challenge of drilling fewer and more precise wells will likely be exacerbated by the deeper and more geologically complex shale basins”. Finally, little is known about the fracture pattern attributes of the European subsurface, which means that it is necessary to thoroughly test geo-mechanical models applied elsewhere. Such models need also to be subject to ongoing future developments.

Related to this is the *third* issue of a relative lack of expertise in shale gas extraction, and the fact that much of the technology and know-how currently is concentrated solely in the US. Even if the many US drilling companies currently being granted drilling licenses in Europe bring with them technology and proficiency, additional efforts are likely to be needed to adjust knowledge to the European environment. In some cases, the US shale gas business and E&P majors trying to find their place in Europe suffer from “bad headlines” (Natural Gas Europe, 2012g; Natural Gas Europe, 2012k). There is a necessity for operators to integrate their operations into local communities including direct, accessible, and transparent education and knowledge-sharing on scientific and technical processes, as well as the benefits of shale gas at the social, economic, environmental, and national energy policy levels (Natural Gas Europe, 2012k). Moreover, the necessary service sector is currently not present to provide adequate capacity for the shale industry and allow for a reconfiguration of the European gas market (Tzavela, 2012; ITRE, 2012a).

Fourth, landowners in Europe do not own underground mineral resources, and consequently do not benefit directly from extraction, as in the US, “where developers can buy an exploration lease from private owners of land and mineral rights” (Wynn, 2012). In Europe, the state generally owns the resource and private owners, “who maintain only surface rights, have little incentive to cooperate in the face of reduced financial incentives” (Deloitte, 2012). These issues raise uncertainty about the access to exploration permits and development licenses, which causes significant regulatory risks.

For the individual European countries to create an attractive investment climate that allows companies to predict returns over the life of long-term projects, they will have to consider issues such as pricing mechanisms, royalty rates, corporate tax rates, lengths of lease terms, etc. (The Energy Exchange, 2011). In addition, the implementation of a new regulatory framework on unconventional gas, especially shale gas, could push companies to improve the fracking technology toward fewer impacts on environment. According to the Energy Security Unit at the EC’s consultancy for energy issues, “the great thing about having the American example is that European policy makers are fully aware of how much the unconventional gas revolution in the US not only caught the companies off guard by the success of unconventional gas but also in terms of the regulators” (Natural Gas Europe, 2012e).

Another difference comes from the scale of the companies involved. The drivers in the US were small gas companies.[29] The dominance of energy majors in Europe and their heavy focus on R&D may cause a lower volume of well-drillings, which could possibly have a flattening effect on the European shale learning curve (Deloitte, 2012). Unlike major oil companies, the return to investment in smaller companies does not need to be of a massive volume for them to be able to afford to support the operation. In the US, new opportunity de-risking is carried out by multiple companies, often small independents that rapidly learn, innovate, and share successful practices. Thus the cost burden of de-risking a new play is spread over multiple players, making the entry threshold low.

29 According to Honoré (2010), there has been a series of mergers and acquisitions in the European gas sector since the Liberalization Directives came into force. This has reduced the number of companies in the sector and left the remaining companies bigger. “If the European utility company landscape remains highly concentrated, it is very likely that single large companies could influence wholesale energy prices, Fabini (2012) claims. Further, “the size of these companies might prevent new entrants to access the European market…[and] the presence of big players in the wholesale market may as well prevent an effective competition and therefore reduce market liquidity” (Fabini, 2012).

Fifth, shale gas will need to compete with new LNG supplies and existing energy supplies in Europe which benefit from sunk capital costs, existing infrastructure, and a geographical favorable location to import LNG (especially from the Mediterranean and West Africa). According to Ernst & Young (2011), "the projected increase in future LNG supplies could reduce the need for significant volumes of additional gas from shale deposits in many European countries". Nevertheless, the geography of the LNG sector is also changing and the expectation that LNG will be a game changer in Europe is also dangerous as the Asian market has a clear economic advantage relative to Europe.[30]

The future of shale gas in Europe is largely a matter of its production cost, which is likely to be compared to the US given the challenges present. The changing structure of international gas markets entails new risks including, "increased price fluctuations stemming from more volatile spot markets, emerging possibilities to at least partially cartelize globalizing gas markets and incentive problems for investment in new supplies in key producer countries" (Goldthau and Hoxtell, 2012). In addition, financial constraints in the aftermath of the global recession, as well as warning signs of a new downfall in the European economy, are not serving the investment climate well (European Dialogue, 2012; Corbeau, 2012).

It is the general view that the term "game changer" should not be attached to the future of shale gas in Europe (Balmforth, 2012; CNA, 2012). Rather, an EU evolution will likely be characterized by, "a flatter geology-specific shale gas learning curve, a slower aggregate growth in proved reserves and production, and a more R&D-focused approach with longer play timelines" (Deloitte, 2012). An important difference between today's Europe and 1990s US is the current gas price environment. While the US experienced increasing prices over the period, European prices have reacted to the current global gas glut and low demand due to the recession, and have consequently dropped. With the gas glut estimated to come to an end in 2015, a reversal in the price trend could come around and hereby add more pressure to develop the shale gas sector in Europe (Deloitte, 2012).

So far only test drillings have taken place in the EU. Before shale gas exploitation is fully allowed in Europe, governments will have to weigh their concerns about environment, security of energy supply, and price and create a fiscal and regulatory framework that will have citizens confidently back shale as a supply form (The Economist, 2012). But this will take time. Finally, publicly funded research on fracking may be necessary to ensure confidence that decision-making is informed by independent, evidence-based research (RS and RAE, 2012).

30 "In 2009, about 57% of Qatar's nearly 50 bcm of LNG exports went east, while Europe accounted for a mere 33% of Qatar's exports. In 2011, Qatari LNG exports to the EU fell 22% due to higher prices in Asia. While Qatar has provided Europe with some much needed flexibility in the gas market, stemming from the short-term contracts that generally constitute import agreements, burgeoning markets in Asia may lead to a further shift of sales of gas to Europe in the future. By most accounts, this trend is expected to continue. However, the possibility for a surge in LNG exports from Australia to some of Qatar's large Asian buyers could force the Qataris to eventually shift back towards Europe" (CNA, 2012).

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