Shale gas in Europe: revolution or evolution?
Shale gas in Europe: Revolution or evolution?

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The US experience

Introduction

The transformative impact that shale gas has had on the outlook for US energy markets has been well-documented. The shale gas success story in the US has resulted in heightened speculation over the potential for shale gas to transform energy markets in other parts of the world. The spotlight is now on Europe, where early-stage exploration is under way.

However, a number of issues indicate that the experience in the US may not be replicated in Europe. Furthermore, the rapid growth in shale gas production has resulted in a corresponding increase in concerns about the impact of the development processes on public health and the environment. Opinion on the environmental impact of shale gas and its role in the future energy supply mix has become increasingly polarized.

This report looks at the potential for shale gas development across Europe and considers what the impact on gas markets across the continent might be. While there has undoubtedly been a shale gas revolution in the US, we conclude in this report that although some geological surveys indicate there is significant potential, shale gas development across Europe will follow a more evolutionary path. We identify a number of factors that will influence the pace and feasibility of shale gas development in Europe, including:

- Geology and resource potential
- Gas demand
- Energy prices
- Environmental and social factors
- Fiscal and regulatory regimes
- Infrastructure and service capabilities

Driven by advances in technology, such as hydraulic fracturing and horizontal drilling, shale gas production in the US has increased at a rapid pace. The country is now largely self-sufficient in natural gas. According to the US Energy Information Administration (EIA), the annual average growth rate in shale gas production was 51% over 2008–11. However, the pace of production growth was significantly slower in 2012, rising by just 4%. The weaker domestic gas price environment led companies to prioritize the development of liquids-rich shale deposits. Figure 1 shows the rapid increase in US shale gas production and resultant fall in natural gas prices.

Figure 1: US shale gas production and natural gas prices

According to the EIA’s Annual Energy Outlook 2013, shale gas production is predicted to almost double between 2013 and 2040. A recovery in US natural gas prices from recent lows is also predicted. Companies will need higher prices to support the investment levels required to maintain or increase production. By 2040, shale gas production in the US is forecast to total 16.7 trillion cubic feet (Tcf), representing half of total US gas production by that time.

1 There are three main types of unconventional gas: shale gas, tight gas and coalbed methane (CBM). In this report we focus on shale gas, which occurs when natural gas deposits are trapped within shale rocks.
Geology – replicating the US experience?

The US shale gas success story has heightened speculation over the potential for shale gas to transform energy markets in other regions. Energy-intensive industries in Europe and other developed economies are hoping that development of their shale gas resources will provide access to lower-cost supplies. However, exploration is at an embryonic stage in many countries. Those hoping for another shale revolution will need to be patient, and there are no guarantees that the wait will bear fruit.

European shale gas potential

In an EIA report published in April 2011, *World Shale Gas Resources: an Initial Assessment of 14 Regions outside the United States*, technically recoverable shale gas resources in Europe were estimated at 605 Tcf. This represented a little over 9% of the global shale gas resource potential. In 2013, the EIA published a revised assessment of world shale gas resources, which the new estimates suggest that the potential in Europe is greater than originally thought. Figure 2 shows that technically recoverable shale gas resources in Europe are now estimated at 885 Tcf. Estimates for some countries have been revised down, most noticeably so in the case of Norway, France, Poland and Sweden. Estimates for the UK, Germany, The Netherlands, Denmark and Ukraine were revised upwards, and estimates for four additional countries were included in the 2013 assessment. Countries in Europe with known shale gas resources collectively accounted for almost 12% of the global shale gas resource potential at the end of 2012.

*Figure 2: Changes to estimates of technically recoverable shale gas resources in Europe*

*Source: US Energy Information Administration*
Shale resources are believed to be present in at least 14 countries across Europe, including Ukraine, though no shale gas play has yet been brought into production. Three-quarters of estimated European shale gas reserves are concentrated in just four countries: Russia, Poland, Ukraine and France. The largest estimated resources in Europe are in Russia, which has 285 Tcf, or 32% of the total for the region. On a global scale, Russia’s shale resource potential is less significant, accounting for just 4% of the worldwide resource base. Limited exploration activity has been carried out in Austria, Germany, Hungary, Ireland, Poland, Sweden and the UK.

However, at present there is not enough experience in shale gas exploration in Europe on which to base estimates of current potential resources. The experience in the US may not be replicable in other countries, as the petro-physical properties of the shale vary from one rock formation to another across different regions. Even within the US, each of the shale gas basins is different, and each has its unique set of exploration criteria and operational challenges. A step-change in exploration and appraisal drilling activity will be required to gain a better understanding of the resource potential in Europe. Estimates of technically recoverable shale gas resources are certain to be revised, upward and downward, over time as new information is gathered. However, in practice, only a fraction of this resource base is likely to ever prove commercial. Figure 3 shows EIA forecasts of the volume of future shale gas production in Europe. It will be well into the next decade before we see any meaningful volumes of unconventional gas being produced in Europe.

**Figure 3: Forecast shale gas production in OECD Europe**

Source: US Energy Information Administration
Predicted gas demand growth will be an important consideration for oil and gas companies when contemplating investment in shale gas projects in Europe. In the short term, demand for gas across Europe is likely to remain weak as the region’s economies will be slow to recover from the impact of the recession and sovereign debt crises. According to the 2012 World Energy Outlook from the International Energy Agency’s (IEA), natural gas demand in the European Union is not expected to rise back above 2010 levels before 2020. The weaker demand outlook means that the issue of import dependency has slipped down the political agenda since 2010. Security of supply concerns have also eased, at least temporarily, with the availability of ample supplies from a wider group of export nations. The supply glut in the US has meant that liquefied natural gas (LNG) cargoes destined for North America have been diverted to other destinations, including countries in Europe. In addition, many European customers took minimum contractual volumes under long-term contracts, and consequently Russia’s pipeline supplies to Europe declined.

The availability of cheaper gas supplies in the US has resulted in a switch from coal to natural gas in power generation and the displaced US coal supplies have found their way to Europe, where it has undermined the economics of gas as a feedstock for power stations. This has seen utility companies increase their use of coal, despite EU environmental policies designed to curb the use of fossil fuels in the energy mix. However, longer-term carbon reduction targets mean that coal’s revival is likely to prove relatively short-lived. As Figure 4 shows, the power generation sector is likely to drive the increase in gas demand in Europe beyond 2020.

**Figure 4: Historical and forecast European gas demand**

Emissions from new gas-fired power generation would be lower than from existing coal plants, but the reduction would not be sufficient on its own to meet the region’s long-term emissions targets. Under this scenario, governments would need to offer enhanced incentives to companies prepared to invest in low-carbon energy technologies or reduce the competition for funding by placing a moratorium on the construction of new gas-fired power plants.

Nuclear power had been enjoying something of a renaissance in some European countries prior to the accident at the Fukushima power plant in Japan in March 2011. Since then, a number of countries have announced reviews of the safety of existing nuclear plants or have decided not to extend their operational life. There have also been delays or overturns of earlier decisions to approve new nuclear build. However, only one country, Germany, has actually closed any nuclear stations as a result of the Fukushima accident. The uncertainty over the future of nuclear and renewable energy could lead to a situation where gas becomes the primary energy source in Europe in the next 20 years, rather than just being a transition fuel to a low-carbon economy.
Shale gas in Europe: Revolution or evolution?
Energy prices

The issue of cost and gas prices

The price of gas was an important factor in the rapid increase in shale gas production in the US. It will be an equally important driver of future gas demand in Europe. Higher gas prices in the early to mid-2000s helped support the ramp-up in development of shale gas in the US.

Shale gas production costs across Europe are likely to be higher than in the US, at least until an understanding of the geology improves and further advances in technology can help drive down costs. The IEA estimates that production costs for US shale gas range from $3/MBtu to $7/MBtu, while estimates from a number of organizations indicate that average production costs in Europe could be between $8/MBtu and $12/MBtu. These estimates exclude the cost of the acquisition of land or leases. Production costs in North America have declined markedly over time with advances in technology and knowledge transfer gained from the experience of large-scale production. Technologies for drilling and hydraulic fracturing are not at a developmental standstill. Oil and gas and oilfield services companies will need to invest in research and development to improve the efficiency and lower the cost of shale gas exploration and production.

However, even with the higher development costs, the relatively higher gas prices that can be realized in Europe mean that shale gas projects in Europe could still be economic. As can be seen from Figure 5, gas prices in Europe have typically been higher than in the US since 2008. The differential widened after the Fukushima accident in 2011 when Japan began importing additional LNG cargoes, which helped drive up global LNG prices.

**Figure 5: Natural gas prices at selected trading hubs and Brent oil price**

<table>
<thead>
<tr>
<th>Henry Hub</th>
<th>Dutch TTF</th>
<th>Brent oil price (converted to MBtu)</th>
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Source: Thomson Reuters Datastream

The share of gas-on-gas competition in Europe has more than doubled since 2005. The most well-established and liquid spot gas market in Europe is in the UK, which moved earlier and more decisively than other European countries to introduce competition into energy markets. There are seven other spot market hubs across Europe: Zeebrugge (Belgium), TTF (the Netherlands), NCG (Germany), Gaspool (Germany), PEG (France), PSV (Italy) and CEGH (Austria). The development of some of these trading hubs has been hindered by a lack of liquidity and also by infrastructure capacity or access issues.

While the proportion of short-term, spot-traded gas in the supply mix has grown in recent years, oil-indexed pricing remains prevalent in longer-term contracts in Europe. Around 50%-60% of gas consumed in Europe still has oil price escalation in the contract price. This means that any fall in gas prices resulting from the buildup of shale gas production in Europe would not be as dramatic as in the US.
Pipeline gas

Shale gas will need to compete with existing energy sources in Europe, where investments in infrastructure have already been made. Russia stands to be particularly challenged by the shale gas boom. Along with other Atlantic Basin gas suppliers, Russia now finds that the prospects for a strong mid- to long-term market for LNG imports into North America are greatly diminished. Therefore, it is not surprising that Russia has been publicly airing doubts about the viability of shale gas. At present, Russia is the major supplier of pipeline gas to Europe and will continue to fulfill this role in the short to medium term. However, Russia’s share of gas imports into Europe fell from 45% in 2002 to around 32% by 2012, largely due to increased competition from Norway and LNG supplies from Qatar. Figure 6 illustrates this trend.

![Figure 6: Share of gas imports to Europe](source: Eurostat)

Pipeline supplies from Russia are not without their own challenges, including the distance of some reserves from market and political issues around cross-border gas transit. Further challenges include the harsh conditions in some locations (which means that work may not be possible year-round) – the scale of investment in the development of new reserves, and how quickly these reserves can be brought to market. Additionally, to underpin the development of gas fields in the more remote regions of East Russia, gas producers will be targeting customers in Asian markets that are closer to the supply source. New investment will also be required for the infrastructure necessary to develop fields in more remote regions.

Gazprom is planning to increase its share of the European gas market via the proposed South Stream pipeline, which is targeted to start supplying southern and central Europe beginning 2015. However, the EU has been exploring new gas supply routes for a number of years, in particular the opening of a southern gas corridor from the Caspian region, that could help diversify reliance away from Russia. An important milestone in this strategy was the June 2013 decision by the Shah Deniz consortium to choose the Trans-Adriatic Pipeline (TAP) as its initial preferred route to carry Azerbaijani gas to Europe. The significance of this decision is far greater than the initial volumes that will be shipped, which will be small in relation to the size of the European gas market. It paves the way for potential additional volumes of gas from the Caspian region and the Middle East to be supplied to European countries in the future.
Some of the proposed pipeline projects are competing with each other to secure supply commitments. The TAP scheme was chosen at the expense of the rival pipeline projects Nabucco, Interconnector Turkey-Greece-Italy (ITGI) and the South East Europe Pipeline (SEEP), which were all vying to carry Caspian gas to Europe. The Nabucco pipeline project, which has effectively been abandoned, was politically and financially supported by the European Commission (EC). In 2011, the EU authorized the EC to conduct negotiations with Turkmenistan and Azerbaijan over construction of a trans-Caspian gas pipeline. Not all of the proposed pipelines to supply gas to Europe will be sanctioned. The fundamentals on which these projects were brought forward have weakened. The uncertainty over the role that shale gas will play in Europe’s future energy mix has undoubtedly contributed to that weakening. In addition to the uncertainty over European shale gas, the outlook for future gas demand in Europe is much less bullish than it was pre-2008. Those import pipelines that do get built will have to compete for market share, in a reduced market, with any domestic shale gas that is produced.

### LNG imports

Between 2011 and 2012 a significant volume of LNG liquefaction capacity, which was sanctioned based on expectations that the US would become a major import market, came online. The shale gas boom in the US has rendered a number of LNG import terminal facilities redundant, and some operators are seeking approval to convert their facilities so that they can export LNG. Over the last three years, LNG volumes that were initially intended to supply the North American market have been diverted to other markets, including Europe. LNG supplies at spot prices were, at times, considerably lower than the oil-linked price of contracted natural gas supplies delivered to Europe by pipeline.

According to the International Gas Union, global trade in LNG fell by 1.6% in 2012 after 30 consecutive years of growth. In 2012, countries in Europe imported a combined 48 million tons of LNG. However, as can be seen in Figure 7, this was 27% lower than the total supplied in 2011. Strong demand from Asia, particularly from Japan and Korea, meant that around 70% of spot cargoes were supplied to these markets to take advantage of higher prices. Qatar and Nigeria accounted for almost half of all spot exports in 2012. Qatar is the largest supplier of LNG to Europe, with 46% share of the LNG import market. However, after rising steadily between 2002 and 2011, Qatar’s share of all imports to Europe, including pipeline supplies, fell from 11% in 2011 to 8.7% in 2012.

![Figure 7: LNG imports to Europe](image)

New LNG import capacity is being added in Europe at sites in Italy, Spain, Portugal, France, Lithuania and Poland. The Swinoujście terminal in northwest Poland is projected to become operational in 2014. In 2009, Poland signed a deal with Qatargas for gas deliveries for 20 years. The contract is expected to fulfill one-third of Poland’s total gas needs. The projected increase in LNG supplies post-2015, coupled with the installation of additional LNG import capacity in Europe, could reduce the need for significant volumes of additional gas from shale deposits in many countries. Customers in Europe, the Middle East and Asia will be competing to secure the additional LNG supplies.
Environmental and social factors

Mounting concern as production rises

With the increase in shale gas production in the US, there has been a corresponding increase in concerns about the potential impact of the process on public health, drinking water and the environment due to hydraulic fracturing. The key issue in the US debate is the potential impact of hydraulic fracturing on drinking-water supplies. In response to public concern, the US Congress directed the United States Environmental Protection Agency (EPA) to conduct research to examine the relationship between hydraulic fracturing and drinking-water resources. Preliminary findings are expected to be published in 2014, and the EPA will then consider whether action needs to be taken and what form that may take.

The controversy surrounding shale gas development in the US is likely to have some impact on government and public attitudes to shale gas exploitation on the other side of the Atlantic. Fewer than 10 hydraulic fracturing processes had been carried out in Europe by mid-2013, but public opposition has been mounting, attracting heightened media attention along the way. Public protests against exploratory drilling for shale gas have been held in Romania, Lithuania, Poland, the Netherlands and the UK. A small number of protesters have taken direct action, such as occupying sites to prevent drilling activity. Governments will expect a certain amount of public opposition to shale gas development. However, the public clamor for government action could result in moves to regulate or limit the exploration and production of shale gas. Significant investment will therefore be required by governments and industry to build trust with local communities.

Environmental concerns

Subsurface impacts

The primary environmental concern seems to be the risk of contamination of drinking-water supplies by the chemicals used in the hydraulic fracturing process. Hydraulic fracturing fluid is typically 97%-98% water and sand, with fracturing chemicals comprising only 2%-3% of the fluid. The fluid formulas vary slightly among production sites in accordance with the unique requirements of each site’s geology. Some commentators have called for increased transparency and disclosure on the chemicals used in the hydraulic fracturing process. Shale producers contend that the composition of fracturing fluids is proprietary information and that fracturing fluids are physically separated from the water table by cement and steel casings. There is, however, the risk of groundwater pollution from improperly constructed wells. The EPA has stated that proper well construction is essential to isolate the production zone from underground sources of drinking water.

Many European countries have a one time opportunity to undertake studies or data gathering before shale gas drilling begins. These results could then be compared with post-drilling results to better understand the impacts. Disposal of the water that flows back to the wellhead after fracturing is another concern the industry needs to address. Wastewater has to be stored, treated for chemicals and disposed of appropriately. Operators are currently exploring ways to use and recycle the water produced from hydraulic fracturing. The use of recycled water could significantly reduce the demand for surface water withdrawal and wastewater treatment or disposal. The EPA recognizes that there are important potential research areas related to hydraulic fracturing other than those involving drinking-water resources. These include potential effects on air quality, ecosystem impacts, seismic risks, public safety concerns, occupational risks and economic impacts.

Drilling activity by Cuadrilla Resources at a site near Blackpool in the UK was voluntarily suspended in May 2011 while investigations took place into whether hydraulic fracturing operations caused two small tremors. An independent study commissioned by Cuadrilla Resources concluded that the seismic events were due to an unusual combination of geology factors at the well site coupled with the pressure exerted by water injection as part of operations. The authors of the report noted that the combination of geological factors was extremely rare and unlikely to occur together again at future well sites. Land subsidence has been shown to occur in areas where mineral extraction activities take place, as the removal of material causes overlying surface rock to sink or collapse. However, this could happen with conventional oil and gas production or mining activities and is not unique to shale gas exploitation. Subsidence can also result from fluid withdrawal in areas where soft subsurface materials like sand and clays are present.
Surface impacts

The physical footprint associated with shale gas exploration and production is significantly larger than that for the exploitation of conventional hydrocarbons. Access to land and land usage are likely to be important issues in densely populated Europe. The typical well pad needs to be large enough to accommodate the drilling rig equipment, wastewater ponds, storage and pipeline infrastructure, and facilities for staff and contractors.

In the US, companies have sought to reduce land use through the development of “superpads.” The multi-well pad system allows wellheads to be clustered together and enables the drilling of multiple horizontal wells from a single pad. This is a more expensive option, but it helps reduce the geographical footprint of shale operations. For example, it reduces the need for new transport infrastructure and minimizes the site traffic on roads. Moreover, the additional cost may be the price that has to be paid to allay concerns over the economic and social costs associated with land use and to win public acceptance.

There are also concerns that the large volumes of water required for hydraulic fracturing may place undue stress on the local water supply. The drilling and hydraulic fracturing of a horizontal shale gas well typically requires more water than conventional oil and gas developments. Precipitation levels vary significantly across Europe, and periodic pressure on water supplies already exists in regions where levels are relatively low. The water needs of shale gas development should be balanced with existing regional requirements for water. Competing or alternative energy sources can also have large water needs. Hydroelectricity is an obvious example, but crop-based biofuels also require water for irrigation, and nuclear plants rely on water for cooling systems.

Social acceptance

In addition to the environmental issues, there is the issue of social acceptance of the shale gas industry in Europe. Compared with the US, Europe has a higher population density and more stringent environmental regulations. Issues like noise pollution, which has so far been less of a concern in the US than some of the other issues, might be more of a problem in densely populated regions of Europe. There has been widespread media coverage of the growing public backlash against shale gas development based on concerns over its impact on the environment.

In late 2012, the EC began a public consultation on the future development of unconventional fossil fuels such as shale gas. There were almost 23,000 respondents to the consultation, with most from Poland, France, Romania, Spain and Germany. The respondents fell into three categories: those in favor of the development of shale gas, identifying many potential benefits; those that think strict environmental and health safeguards should be put in place; and those against development, including some wanting a ban of unconventional fossil fuels in the EU. The majority of respondents agreed that there is a need for more public information and that there is a lack of public acceptance of unconventional fossil fuels. The results also show that around 60% of the EU public are opposed to shale gas production when statistics are weighted by population in each member state. However, the results showed that the attitudes of individual countries vary significantly. Less than 5% of individual respondents from Poland believe that unconventional resources should not be developed in Europe, but almost 90% of French respondents hold that belief.

The European public will be waiting for the results of studies on the environmental impact of shale gas exploration to emerge before fully accepting its development in their own countries. Environmental concerns are likely to bolster public support for a strengthening of the regulatory regime governing shale gas development. Governments need to promote public confidence in the regulation of shale gas activity, and operators need to demonstrate that their operations are sustainable and properly managed.
Prospects for Pan-European regulation

In 2012, the IEA released a special report, *Golden Rules for a Golden Age of Gas*, which proposed key principles to address the environmental and social impacts of unconventional gas development. In the report, the IEA stated that it is not always possible or desirable to regulate every aspect of unconventional gas extraction as the technology is evolving rapidly. Furthermore, the IEA estimates that compliance with the Golden Rules could add 7% to the overall cost of development of a single shale gas well.

In the US, fracturing is largely regulated by individual states, although some would like to see the Federal Government impose overarching regulations. At present, the EC does not have jurisdiction over sovereign states’ subsoil laws or resource development programs. Member states are responsible for deciding their energy mix, but they have to ensure that this is done in line with the environmental rules that apply. Existing hydrocarbon regulation in Europe was drafted by individual countries for conventional exploration and production activities and may not apply to the development of shale gas deposits or cover the new processes and technologies involved. A legal assessment conducted by the EC in 2011 concluded that existing EU environmental legislation applies to practices required for unconventional gas exploration and production from planning to cessation.

However, more information was deemed necessary to determine whether the existing EU regulatory framework is adequate to manage the identified risks. As part of the assessment process, the EC has published three new studies on unconventional resources. The studies look at the potential effects of these fuels on energy markets, the potential climate impact of shale gas production, and the potential risks shale gas developments and associated hydraulic fracturing may present to human health and the environment. The EC has indicated that it may propose EU-wide legislation covering environmental standards in shale gas extraction by the end of 2013. The European Parliament is due to vote in late 2013 on whether to include shale gas exploration in an update of the EU Environmental Impact Assessment Directive. Industry participants are asking for any requirements to apply only once production begins and a better understanding of the size of the opportunity has been gained.

Some oil companies may desire common pan-European regulation to make it easier for them to operate across borders. At present, different national standards and safety requirements may hinder the transfer of equipment between countries, for example. However, gaining unanimity among member states of the EU on shale gas regulation is likely to be an almost insurmountable feat. Poland and the UK are likely to veto any attempt to limit shale gas development through new EU-wide regulation. To get agreement on common standards, they may have to be watered down to such an extent that makes them less stringent than those already in place in some individual member states.
European government attitudes to shale gas development

National energy policy considerations, which include security of supply concerns, emissions targets and state support for competing energy sources, will all shape individual countries’ attitudes to shale gas development. This, coupled with a lack of consistent evidence on the impact of hydraulic fracturing on the environment and public health, has resulted in a situation where opinion on shale gas development in Europe has become polarized. Figure 8 shows the wide spectrum of government opinion on shale gas development.

Figure 8: Shale gas resources and government attitudes to shale gas development

Shale gas resources - Tcf

<table>
<thead>
<tr>
<th>Country</th>
<th>Resources (Tcf)</th>
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<tbody>
<tr>
<td>Poland</td>
<td>300</td>
</tr>
<tr>
<td>Ukraine</td>
<td>250</td>
</tr>
<tr>
<td>Romania</td>
<td>200</td>
</tr>
<tr>
<td>Bulgaria</td>
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<td>Sweden</td>
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<tr>
<td>Denmark</td>
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<td>Spain</td>
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<tr>
<td>UK</td>
<td>50</td>
</tr>
<tr>
<td>Russia</td>
<td>300</td>
</tr>
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</table>

The divergence of opinion is perhaps best illustrated by the differing policy positions of the UK and France. On 30 June 2011, France became the first country in Europe to enact a ban on hydraulic fracturing. The permanent ban replaced a temporary suspension of shale drilling activity that had been put in place earlier in the year. Operators with shale gas acreage in France opposed the ban, claiming that, while alternatives to hydraulic fracturing exist, they may not be economically viable. However, French President François Hollande has ruled out exploration for shale gas during his presidency.

In contrast, the UK Government is a strong advocate of shale gas development and has established an Office of Unconventional Gas and Oil to focus regulatory effort. The UK Government has also proposed fiscal incentives for shale gas explorers. The Polish Government has also been supportive of shale gas development. However, initial excitement about Poland’s shale potential has been tempered by significant downgrades to resource estimates, mixed drilling results, exits of some large companies and uncertainty over the regulatory regime. As a result, progress to date has been fairly slow, with only around 50 test wells drilled in Poland by mid-2013. The country’s Chief Geologist has said that 300 will need to be drilled to better estimate the size of shale deposits in Poland.

Germany’s relatively modest estimated shale gas resources are unlikely to have a significant impact on the country’s heavy dependence on imports from Russia and Norway. Despite this, public opposition to the development of shale gas in Germany has been gathering momentum. The German state of North Rhine-Westphalia (NRW) has announced that it will no longer permit exploratory drilling projects using hydraulic fracturing until it receives the findings of a study it has commissioned into the environmental risks associated with shale gas.

Most European countries have taken a less firm stance and appear to be adopting a “wait and see” approach to shale gas development. The Irish Government will grant no new fracturing licenses until more is known about the impact of the process. Research by the country’s Environmental Protection Agency into the potential impact on rural land use and water quality has been completed, but no definitive conclusions have been reached. The Czech Government has imposed a ban on shale gas exploration licenses until June 2014. Bulgaria has banned hydraulic fracturing and withdrew a drilling permit issued to Chevron. And Spain has enacted its first regional ban (in Cantabria) on producing natural gas using hydraulic fracturing.
Infrastructure and service capabilities

The lack of oilfield service sector capacity, suitable equipment and a skilled labor force have been highlighted as potential bottlenecks preventing the faster development of shale gas in Europe. This is one of the challenges that countries in Europe will need to address to develop their unconventional resource potential. The service level intensity for shale gas development is typically higher than for more conventional oil and gas developments. In the US, the oilfield services sector has grown and developed to support the shale gas industry. Many of these oilfield services companies are now looking to export the techniques they have used successfully in North America to international markets.

Typically, Europe has fewer than 50 onshore rigs actively exploring for or developing oil and gas at any one time, compared with up to 2,000 in the US. Figure 9 shows the number of active rigs operating onshore and offshore across Europe since 2005. Although the number of active land rigs in Europe increased to more than 80 in early 2013, a higher number than operating offshore, there is still a shortage of suitable rigs for shale gas exploration and development in Europe. The US land rig fleet would not be relocated to Europe unless there was a firm work commitment. However, equipment from other regions may not be suitable for use in Europe, where the geology is different. Moreover, the equipment may not meet mandated local standards, which could delay the import process. The transport of equipment across European borders might be hindered by differing regulatory requirements and health and safety standards among EU member states. If new, high-specification equipment needed to be built for shale gas operations in Europe, significant capital expenditure and firm commitments from operators would be required.

**Figure 9: European rig counts**

Number of rigs

![European rig counts graph](image)

Source: Baker Hughes

Most industry observers do not expect to see shale gas production across Europe reach commercial levels for at least another 10 years. Given the lead time to first production and the likelihood that developments will evolve more slowly, this will give the service industry the breathing room needed to gear up to meet the requirements of the shale gas industry in Europe. It will also give operators the opportunity to assemble a skilled workforce through targeted recruitment and training programs.

If Europe's shale gas potential is proven, this will provide tremendous opportunities which in recent years has focused on more substantive opportunities in other markets, such as the Middle East. However, a headlong rush to invest in new capacity is unlikely until the results of initial exploration and development efforts provide more evidence about the potential for commercial shale gas extraction in Europe. Some government support may be provided to help the service sector adapt to the needs of the shale gas sector. The state-owned Polish bank, BGK, has agreed to lend €15 million to Nafta Pila, a subsidiary of PGNiG, for the purchase of a new drilling rig and supporting equipment. The limited supply of drilling rigs that meet regulatory requirements is one of the factors slowing the exploration for shale gas in Poland.
Infrastructure issues present another potential barrier to the efficient development of shale gas in Europe. Significant investment may be required in the gas transmission infrastructure in some countries to upgrade the network so that it is able to cope with increased gas flows. Access to natural gas transmission pipeline capacity in Europe is typically controlled by the large national utility companies and governed by national-level regulations. Furthermore, suppliers may have existing capacity tied up under long-term capacity reservation contracts.

Cross-border pipeline connections would need to be improved if shale gas production reaches a level that makes it possible for some countries to export gas for the first time. However, all of the shale gas produced in Europe is likely to be consumed within the region. The forecast increase in LNG supplies, including potential exports from the US, is likely to be more than sufficient to meet demand needs in Asia and the Middle East. In September 2011, the Prime Ministers of Poland and the Czech Republic opened a Polish-Czech gas interconnector in Cieszyn, southern Poland. The new interconnector could form part of an enhanced north-south gas corridor that may be required if Poland’s shale gas production could support exports. The infrastructure requirements associated with shale gas development are not limited to pipeline transportation capacity. Requirements would potentially include new access roads for site traffic, access to water supplies, wastewater treatment and processing facilities, gas storage capacity and amenities for on-site personnel.

The competitive environment

Companies own shale gas acreage across more than a dozen countries in Europe, but most activity is currently focused on Poland. While not all companies are active, 108 licenses for exploratory shale gas drilling in Poland had been issued by June 2013. The acreage holders include a number of North American and Europe-based small- to mid-cap independent players, with the oil majors primarily represented by Chevron and ConocoPhillips. There are likely to be a number of other entrants, as some of the companies with experience from the shale gas boom in the US are actively evaluating opportunities in Europe. Shell in particular has significant shale gas interests in other regions, such as China and South Africa, and is in the early stages of assessing potential shale gas resources in Sweden.

Large reserves in place, drilling successes, early development and sustainable economic levels of production are among the factors that will shape the fortunes of the small to mid-cap companies that are focused on shale gas exploitation. Early successes could prove to be transformational for the companies that are focusing their development efforts on the nascent shale gas industry in Europe. It is likely that the successful companies will attract the attention of larger potential acquirers. Asian national oil companies have already bought into shale gas companies in the US and may also turn their sights to Europe. In the US, a number of the independent players that were active in the early development of shale gas have either been acquired or have farmed out stakes in projects to better-capitalized players.

There have also been a number of partnerships announced between some of the oil majors and the independent players to jointly explore for shale gas in Poland and other European countries. 3Legs Resources plc, which is listed on the UK’s Alternative Investment Market, and its subsidiary, Lane Energy, are working with ConocoPhillips in the Baltic Basin. In the UK, European energy utility company Centrica has acquired a 25% interest in the Cuadrilla Resources-operated Lancashire Bowland shale gas exploration license area. The burgeoning cooperation between companies is being mirrored at the state level. There is greater inter-country cooperation on evaluating and exploiting global shale gas resources. The US Government has agreed to finance the survey of Ukraine’s shale gas deposits amid speculation that the country may have some sizable deposits. In Spain, a regional government is partnering with two US-based companies in a joint venture to explore unconventional natural gas deposits in Basque Country in northern Spain. Two wells are planned to be drilled initially to see whether extraction is technically feasible and economically viable. The increased collaboration is likely to help drive down costs and improve the ability of projects to attract funding.
## Evolution rather than revolution

While there has undoubtedly been a shale gas revolution in the US, shale gas development in Europe will follow a more evolutionary path. As discussed earlier, a number of factors will influence the pace and feasibility of shale gas development in Europe; these factors are summarized in Figure 10.

**Figure 10: Shale gas in Europe — revolution or evolution**

<table>
<thead>
<tr>
<th>Category</th>
<th>Evolution</th>
<th>Revolution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geology and resource potential</strong></td>
<td>• Disappointing well results</td>
<td>• Early exploration success</td>
</tr>
<tr>
<td></td>
<td>• Reserves found to be uneconomic</td>
<td>• Reserves potential proven to be greater than expected</td>
</tr>
<tr>
<td></td>
<td>• Unsustainable production rates</td>
<td>• Rapid ramp-up in production</td>
</tr>
<tr>
<td><strong>Environmental and social factors</strong></td>
<td>• Results of studies into environmental impacts leads to restrictions/bans on use of hydraulic fracturing</td>
<td>• Studies show that hydraulic fracturing is safe to public health and the environment</td>
</tr>
<tr>
<td></td>
<td>• Increased public pressure on governments to halt development activity until impact is known</td>
<td>• Public desire for lower energy prices</td>
</tr>
<tr>
<td><strong>Fiscal and regulatory regimes</strong></td>
<td>• Potential EU-wide regulation of shale gas development</td>
<td>• Incentives provided by individual countries to shale gas developers</td>
</tr>
<tr>
<td></td>
<td>• Inclusion of shale gas in EU environmental impact assessment legislation</td>
<td>• Expedited approvals process for developments</td>
</tr>
<tr>
<td></td>
<td>• Incentives provided by individual countries to shale gas developers</td>
<td>• Government support for shale gas R&amp;D</td>
</tr>
<tr>
<td><strong>Energy prices</strong></td>
<td>• Competition from LNG and pipeline gas from Russia and the Caspian region</td>
<td>• Deregulation of gas markets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Limited spot market liquidity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Long-term, oil-indexed contracts not renewed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improved interconnectivity between gas markets</td>
</tr>
<tr>
<td><strong>Gas demand</strong></td>
<td>• Slower growth due to measures to support development of a low-carbon economy</td>
<td>• Increased demand for gas as a fuel for power generation</td>
</tr>
<tr>
<td></td>
<td>• Slow Eurozone economic growth</td>
<td>• Gas positioned as a transition fuel to a low-carbon economy</td>
</tr>
<tr>
<td><strong>Infrastructure and service capabilities</strong></td>
<td>• Limited supply of suitable equipment or skilled personnel</td>
<td>• Oilfield service industry is fast to adapt to industry needs</td>
</tr>
<tr>
<td></td>
<td>• Lack of funds available to invest in new gas supply infrastructure</td>
<td>• Technology developments that result in lower per-well costs</td>
</tr>
</tbody>
</table>

Source: EY analysis
The impact of shale gas is unlikely to be transformational for the European energy market as a whole, but it could prove to be significant for individual countries by helping reduce their dependence on imports. Advocates of shale gas development in Europe put forward improved energy security as one of the key benefits, helping countries become more self-sufficient. Security of supply could also be achieved through diversity of supply sources. A shale gas boom in Europe could, in practice, weaken energy security in Europe through over-reliance on a single energy source.

There is no consensus across Europe on shale gas development, and government attitudes vary, in some cases markedly, as exemplified by the positions of France and the UK. Public opinion on the issue is similarly divided, adding to pressure on governments to take action to either support or restrict shale gas development. At present, most countries in Europe appear to be adopting a “wait and see” approach on the issue. European countries with sizable shale gas resources are closely monitoring the situation in Poland and will hope to replicate any success achieved in their own countries. There will, however, be setbacks along the way – gas flow rates achieved from wells drilled so far in Poland have not been commercial.

The impact that shale gas will have on energy markets will differ from one country to the next, depending on the country’s national energy strategy, degree of import dependence, projected growth in gas demand, and the cost and social acceptance of alternative and competing supply sources. The impact could, however, prove to be transformational for the small- to mid-cap independent companies that are focused on the nascent shale gas industry in Europe. There will also be opportunities for service companies to carve out new revenue streams and gain an early foothold in shale gas development activity in Europe. Research is not at a standstill, and new technologies will be developed that will help lower the cost of shale gas extraction and improve the efficiency of development and production activities.

The shale gas debate has become increasingly contentious, but there is no denying the economic benefit that the evolution of a shale gas industry could bring to individual countries in Europe. The increase in government revenues from taxes on shale activity, and private sector job creation, would be especially welcome in these times of fiscal austerity. Most of the issues used by opponents to call for restrictions on shale gas development are not exclusive to shale gas activity. But environmental concerns are likely to bolster public support for a strengthening of the regulatory regime governing shale gas development. Any risks that are shown to be linked to shale gas development need to be balanced with its potential contribution to energy security and economic development. Many hope that the experience in the US can be replicated in other countries. This experience also needs to include learning the lessons from studies under way on the environmental and public health impacts of shale gas development in the US and using them to shape appropriate regulation where necessary in Europe.
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