Schroders

A ‘Golden Age’ of Shale ... or Just a Pipe Dream?

Research Paper

A review of the challenges facing the shale energy industry

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Executive Summary

Whilst shale energy exploitation is not new, the game changer has been the improved cost economics resulting from advances made in shale energy extraction techniques. These have come against a favourable backdrop of rising oil prices and governments facing challenges in encouraging the development of energy solutions which bring about sustainable, affordable, secure and reliable energy supply.

The US shale energy experience has provided a tangible example of the transformational effect of shale energy. The growing recognition that many other countries may also hold significant shale resources means attention is increasingly turning to the potential elsewhere. However, the US shale story is unlikely to be replicated, since the context generally differs markedly from the US. So, while there will most likely be a ‘golden age’ for shale energy in certain countries, it will not be universal.

We have developed a framework incorporating the main policy, regulatory, legal and ‘natural’ factors which we view as important to shale energy exploitation on a country basis (focusing on the US, China, Russia and the UK). Of these, the US is positioned most favourably, while China and Russia also have significant shale resources. Whereas China is a net importer of energy with strong political will but technical, infrastructural and environmental challenges, Russia has fewer natural hurdles but less political will given the abundance of conventional natural gas and a less favourable fiscal regime. The UK, in contrast, has much lower reserves and a relatively favourable set of natural attributes for developing shale energy. However, the industry faces significant public opposition in light of the potentially adverse social and environmental impact of extraction.

Certain non-governmental organisations and parts of the general public have environmental and social concerns about the widespread commercial production of shale energy as extraction techniques present an array of risks. It would be wrong for governments and the industry to ignore such concerns as they could be a ‘wildcard’, adding costs to shale energy projects, or even leading to them being prohibited altogether. We agree with the International Energy Agency’s assessment that there is a critical link between the way governments and industry respond to these environmental and social challenges and the prospects for shale energy. Just as some natural challenges can be addressed by technological developments and changes in operational practices, so can environmental ones to a certain extent.

However, many of the social issues and outstanding environmental challenges require approaches which are as much geared towards changing attitudes as operational practices. Efforts can – and should – be made to ensure safe, responsible and environmentally sustainable shale energy practices, thereby establishing a social ‘licence to operate’. Encouragingly, recommendations on good and best practice for the shale energy industry do exist. However, despite calls for greater and more proactive transparency by operators about their operations, the evidence to date reveals that it remains inadequate. The industry should expect to see continued scrutiny and some level of opposition to its shale efforts until the deficit between actual performance and expectations is closed. Otherwise, there is a risk that a ‘golden age’ of shale energy will never be realised.
The global shale industry has the potential to reshape the global energy landscape

A snapshot of shale energy

Unconventional energy sources such as shale oil (‘tight oil’) and shale gas are oil or natural gas trapped within shale rock formations (‘plays’). Whereas conventional oil/gas reservoirs (‘basins’) typically rely on large volumes of oil/gas trapped between non-porous rocks, shale oil/gas is trapped within the shale formation itself. As a result, rather than forming concentrated deposits as is common with conventional reserves, shale oil/gas is more usually distributed over wide areas following shale seams and requires artificial stimulation to stimulate flow to the surface. Moreover, the heterogeneity of shale resources means that no two plays are identical, and even within plays, there are regional or localised productive ‘sweet spots’ in terms of how favourable the geology is to extraction techniques. Appendix A provides further background on shale energy and the extraction techniques used.

Whilst shale energy exploitation is not new, with shale gas first extracted in the US in the 1820s, and use of horizontal drilling (‘completion’) started in the 1930s and hydraulic fracking (‘fracking’) in the 1940s, the critical game changer has been the more recent advances made in these extraction techniques and their combined use in plays. For the first time, the US has shown that shale energy can be economically available.

This improvement in shale energy economics has occurred against a backdrop of rising oil prices and governments being increasingly challenged to develop energy solutions which bring about affordable, secure, reliable and more environmentally sustainable energy supply. For them, the interest in developing an indigenous shale energy industry has economic and political drivers: an increasing energy import dependency and related risks to security of supply, low diversification of energy resources, rising energy prices and its impact on competitiveness, as well as the need to decarbonise the energy system (in order to tackle climate change), air and water pollution.

The US experience has demonstrated the transformational potential of unconventional hydrocarbons

The US shale energy experience provides a tangible example of the potential transformational effect of shale energy, with positive impacts on the domestic industry, energy production, power costs and by extension industrial competitiveness and economic growth:

- Calculations vary, but typical estimates put the benefit of shale development to the US economy at 0.5-1.0% pa.¹
- The success of shale gas in the US has reduced its reliance on energy imports. It overtook Russia as the world’s biggest producer of natural gas in 2011. The US Department of Energy estimates US shale gas production could reach 50% of total energy production by 2040 – this would make the US a net exporter of gas by 2020 (US energy imports will fall to 10% of energy consumption over 15 years from 24% in 2009).²
- With escalating output, US domestic gas prices have remained low since pre-crisis years, contrasting with escalating costs elsewhere in the world (see Figure 1). Power costs have become amongst the most competitive in the world, bringing about knock-on benefits to the country’s high energy intensive industrial sectors.
- Should the US become a net exporter of natural gas, the domestic price of natural gas in the US is unlikely to rise significantly, and will remain well below the level in most other countries around the world.
Figure 1: Examples of the impact shale gas has had on US gas prices

Source: Didas Research, March 2014 (the countries referenced are for illustrative purposes only and as such does not constitute investment advice)

The scale of international reserves surpasses those in the US

The growing recognition that many other countries also hold significant shale energy resources (see Figure 2 and Appendix A) – less than 10% of the world’s potential (technically recoverable) resources are in the US and China’s reserves are twice those of the US – means attention is increasingly turning to the potential for similar effects of shale energy development on other countries.

Figure 2: World shale oil (left map) and gas resources

Source: JPM, January 2014

There is strong political will in many countries to develop those assets, as illustrated by China’s plans. The Chinese government has cited the opportunity shale gas presents to the country in its latest five-year plan (2011-2015). From a current contribution of <1% of domestic gas production, the country has set an ambitious target of producing 8% by 2015 (with 3% coming from shale) and aiming for 60-100 billion cubic metres (bcm) of shale gas by 2020.3

Mixed outlook on the potential impacts on individual countries and the global energy landscape, but clear it will not replicate the US path

It is hard to say definitively how widespread commercial shale energy production will impact on global energy markets, given we are nowhere near this situation, with only North America realising commercial material production volumes, and other countries at exploratory and appraisal stages.
However with potentially more domestic energy production in countries like the US and China, a weaker OPEC (Organisation for the Petroleum Exporting Countries) could easily lead to a drop in oil prices and have implications for political unrest in these countries. Any attempt by the US to withdraw from the region risks creating a power vacuum that draws in other international powers. However the IEA believes that - whilst shale gas will be more material than shale oil on the global energy market, and that between now and 2035 a third of global increase in gas output will come from unconventional sources (which includes shale gas) - in relative terms shale energy is unlikely to upset the current global energy market power balance (i.e. the dominance of the Middle East) in the foreseeable future.

Shale energy represents challenges for decarbonising the world which need to be addressed

One of shale energy’s most significant global environmental issues is greenhouse gas (GHGs) emissions and the implications for climate change. Here the concerns are that efforts on advancing shale energy are a distraction from what should be a focus on truly clean and renewable energy alternatives, and further that it becomes a permanent energy source rather than being the ‘transitional fuel’ supporters put it forward as. Whilst use of natural gas emits less carbon dioxide ($\text{CO}_2$) than coal, it does emit more methane ($\text{CH}_4$) which is 20 times more potent than $\text{CO}_2$ as a GHG on a 100 year timescale. Greater reliance on shale gas alone cannot realise the international goal of limiting the long-term increase in global temperatures.1 As such, developments in shale energy need to be considered as part of a broader energy policy framework that promotes energy efficiency improvements, increases efforts to roll out low-carbon energy sources and broadens the application of new low-carbon technologies (including Carbon Capture and Storage2 to capture emissions).

A framework for assessing shale energy prospects at country level

A range of factors/conditions determine shale energy prospects

The reason the US shale energy story is unlikely to be replicated elsewhere is that the backdrop to developing shale energy resources generally differs markedly from the US. So while there will most likely be a ‘golden age’ for shale energy in terms of commercial production in some countries, this will not be a global one.

As already alluded to in the previous section, a number of different factors – which can broadly be categorised into two groupings – policy, regulatory and legal on the one hand and natural ones on the other (Figure 3) – will determine the pace and scale of commercial development of shale energy (i.e. if it will happen, when and how) and these will play out in different ways across – and even within – countries.

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1 Although the IEA’s Chief Economist does believes that greater use of gas over coal would lead to substantial reduction in carbon emissions relative to the status quo, and would make meeting global climate goals significantly easier. Source – IEA’s chief economist, Dr Faith Birol at a roundtable lunch attended by Morgan Stanley Research as reported in: “Oil & gas: Investor feedback on our sector upgrade, plus on the road with Eni”, 21st March 2014.

2 Carbon capture and storage or carbon capture and sequestration (CCS) is the process of capturing waste $\text{CO}_2$ from large point sources (e.g. power plants), transporting it to a storage site, and depositing it where it will not enter the atmosphere, normally an underground geological formation. The aim is to prevent the release of large quantities of $\text{CO}_2$ in the atmosphere, so presenting a potential means of mitigating the contribution of fossil fuel emissions to global climate change.
Of the set of factors relating to natural conditions:

- Having favourable geology is a critical issue as the rock has to be ‘frackable’.  
- Having well developed and open access infrastructure – both in energy terms, as well as road networks, coupled with the availability of equipment and a skilled workforce are also important.

In terms of the policy, regulatory and legal conditions:

- Clear and favourable legal land and mineral access rights are critical in terms of enabling those most directly impacted by shale energy developments to be compensated financially and so providing the incentive to develop the resource.
- Supportive fiscal policy regimes as well as gas price and pipeline liberalisation are needed to incentivise operators and ensure a practical route to market.
- The regulation of shale operations is an evolving landscape – the industry has developed so rapidly that it has often outpaced the availability of information for regulators to develop specific guidance.
- Much of the regulatory approach to date has focused on:
  - Adapting existing legislation (which cover conventional and unconventional energy projects, use of specific technologies, environment and public health etc.) to shale energy activities such as has occurred in the UK.

### Figure 3: Success factors impacting a country’s ability to exploit shale energy resources

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
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<tbody>
<tr>
<td>Natural (e.g. physical environmental characteristics, infrastructure related)</td>
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<tr>
<td>Climate</td>
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<tr>
<td>Energy supply chain (availability of equipment and services)</td>
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<tr>
<td>Geology (e.g. how well understood, how deep down in the rock formation)</td>
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<tr>
<td>Industry competitiveness (e.g. how well motivated to push for cost efficiencies/risk appetite/access to funding)</td>
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<tr>
<td>Infrastructure – pipelines (availability of)</td>
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<tr>
<td>Infrastructure – roads (availability of)</td>
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<tr>
<td>Labour market (supply/skill set for hydraulic fracking and completion)</td>
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<tr>
<td>Population (proximity to/density/familiarity with energy industry)</td>
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<tr>
<td>Resource availability (absolute quantity/available/distribution)</td>
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<tr>
<td>Technology development (e.g. R&amp;D for improving knowledge and techniques for shale energy exploitation)</td>
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<tr>
<td>Topography</td>
<td></td>
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<tr>
<td>Water availability</td>
<td></td>
</tr>
<tr>
<td>Policy, Regulatory and Legal</td>
<td></td>
</tr>
<tr>
<td>Environmental, health and safety (EHS) and social/community (regulation for environmental protection/legal mechanisms for community consultation/public sentiment)</td>
<td></td>
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<tr>
<td>Energy policy (energy security/self-sufficiency/environmental priorities)</td>
<td></td>
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<tr>
<td>Fiscal regime (e.g. tax incentives, subsidies)</td>
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<tr>
<td>Geological data availability</td>
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<tr>
<td>Land and mineral (sub-soil) rights regime</td>
<td></td>
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<tr>
<td>Market liberalisation – gas/oil price</td>
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<tr>
<td>Market liberalisation – pipeline</td>
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</table>

Source: Schroders, April 2014

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3 There are six key geological parameters for shale plays: formation depth, total organic content, net thickness of the shale interval, thermal maturity, formation overpressure and silica/clay content.
- Development of new legislation (e.g. Poland) or
- Moratoriums or bans (e.g. New York State, France) on shale energy or fracking activities specifically.

- Whilst there are global, regional, national as well as state, county or local level environmental legislation in place, given the localised nature of many of the impacts from shale energy projects, local level regimes are more material in determining shale projects’ economic attractiveness.
- There is significant fragmentation and non-harmonisation of regulatory approaches due to lack of joined-up strategic thinking and co-ordination both between and within countries, leading to uncertainty, gaps in environmental protection and ineffective management of impacts, as well as redundancies and potential delays for operators.4
- Compliance monitoring and enforcement actions – or rather the lack of these – are major challenges and is evidenced in the USA in Societe Generale Cross Asset Research’s5 analysis of state water regulation, and highlighted as a priority area to be addressed by the IEA and the EU.
- The overlap between development stages which occurs for unconventional developments such as shale energy presents a practical challenge by increasing the complexity of the interaction between the operator and the regulators (and the operator and local communities) throughout the lifecycle of the development.6
- Given the infancy of the industry, it is most likely that operators will face increased environmental and social regulatory risk as governments and regulators seek to close the gap in existing legislation to govern shale practices and respond to societal concerns.
- Shale policy, regulation and legal frameworks are most likely to follow a similar route to that of another unconventional energy – coal bed methane (CBM), which is more developed as an industry than shale energy.

Our framework evaluates shale energy prospects on a country level

To facilitate a more systematic analysis for identifying the most prospective regions for shale energy, and so the investment opportunities potentially available to investors, we have developed a framework incorporating the main policy, regulatory and legal, as well as natural factors which we view to be most important. We have applied this to four countries in contrasting situations in this report; US, China, Russia and the UK.7 Figure 4 summarises our analysis of the favourability of key shale energy development considerations across each country, compared to the favourability of those factors in the US. Appendix B provides the details underlying the favourability statuses assigned to the countries associated with each factor.

From the framework in Figure 4 it can be seen that the US is positioned most favourably of the four countries under review in terms of conditions for shale energy exploitation. Whilst China and Russia both have significant shale energy resource, whereas the former is a net importer of energy with strong political will but technical, infrastructure and environmental challenges, Russia has fewer natural hurdles to developing its resources but lower political will given the abundance of conventional natural gas. The UK in contrast, has much lower reserves than China and Russia, but has relatively many favourable natural attributes to draw upon and yet it faces significant public opposition arising from social environmental concerns associated with shale energy.

4 There are concerns about legal loopholes in US environmental regulations concerning shale energy activities e.g. exemptions from the Safe Drinking Water Act, Clean Water Act, Emergency Planning & Community Right to Know Act, Resources Conservation and recovery Act, Comprehensive Environmental Response Compensation, and Liability Act, and National Environmental Policy Act. From: Societe Generale Cross Asset Research, January 2012, “SRI fracking facts.”
5 Societe Generale Cross Asset Research also point out that industry accountability is further constrained as public disclosure by regulators of company compliance, violations, and enforcement actions is poor. They found limited state disclosure in their analysis of water regulation in 24 US states, and even where this exists (Colorado, Ohio, Texas), it is insufficient to extract quantifiable data (e.g. type of violation, penalty details, in order to review company performance).
6 For instance, the regulatory system in most jurisdictions requires the submission and approval of a detailed Field Development Plan (FDP) at the end of the exploration phase. But because of the relatively immaturity of the industry, there is a knowledge gap as to what a comprehensive FDP for shale is, and as such, the risk increases that relatively small subsequent plan alterations could trigger the need to resubmit and reapprove the entire plan, a lengthy and burdensome process for both sides.
7 We have selected China, Russia and the UK to compare and contrast with the US experience as these were the countries of particular interest to our in-house equity oil and gas sector analysts, as they sought to better understand the policy and regulatory landscape for shale energy prospects. The largest known reserves in the world of shale energy are in China, the US, Argentina and Mexico.
Figure 4: A framework for assessing factors determining shale energy prospects in different countries

<table>
<thead>
<tr>
<th>Factor</th>
<th>Country</th>
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<tr>
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<td>US</td>
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<tr>
<td>Natural</td>
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<tr>
<td>Climate</td>
<td>Highly favourably</td>
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<tr>
<td>Energy supply chain</td>
<td>positioned (for shale energy exploitation)</td>
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<tr>
<td>Geoology</td>
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<td>Industry competitiveness</td>
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<td>Infrastructure – pipelines</td>
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<td>Infrastructure – roads</td>
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<td>Labour market</td>
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<td>Population</td>
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<td>Resource availability</td>
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<td>Technology development</td>
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<td>Topography</td>
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<td>Water availability</td>
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<td>Policy and Regulatory/Legal</td>
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<tr>
<td>EHS and social/community</td>
<td>Highly favourably</td>
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<tr>
<td>Energy policy</td>
<td>positioned (for shale energy exploitation)</td>
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<td>Fiscal regime</td>
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<td>Land and mineral rights regime</td>
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<td>Market liberalisation – gas/oil price</td>
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<td>Market liberalisation – pipeline</td>
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<tr>
<td>Geology data availability</td>
<td></td>
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<tr>
<td>(Industry competitiveness)</td>
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</table>

LEGEND

- Highly favourably positioned (for shale energy exploitation)
- More of a mixed picture (in terms of positioning on shale energy exploitation)
- Highly challenged (against shale energy exploitation)

Source: Schroders, April 2014 (the rationale for selecting the countries referenced are given in footnote #7, and as such does not constitute investment advice)

Taking all of the above, together with what we have seen in the US and could possibly see elsewhere, we can surmise the following:

- **US**: shale gas should continue to dominate growth in overall US gas production in coming years and decades. Whist it looks set to become a net gas exporter, energy independence is not the same as oil independence.

- **China**: shale should be the main resource, where a strong political agenda is pushing the government to promote its development, with some commentators predicting meaningful production by 2020. Whilst some challenges can be mitigated by technology and more responsible practice, only time will tell how limiting natural factors of geology and topography, water and infrastructure will ultimately be. Should Chinese shale development take off in a large scale way, China would also see reduced reliance on imports which may result in more of a relative impact on global energy markets (vs. US) given it is the world’s biggest energy consumer.
**Companies and investors need to be selective in their shale energy investments**

**Corporate cost discipline is key given shale energy projects are more costly compared to conventional ones**

The track record of oil and gas producers on cost management is poor, a fact which becomes even more of a critical issue with costs of shale development higher versus conventional projects. Figure 5 illustrates how the costs are broken down in terms of key activities for a shale gas well drilling in China.

**Figure 5: Cost structure of a typical shale gas well drilled by CNPC**

Generally speaking, for energy projects, exploration and production costs account for the majority of the upstream costs.

For conventional projects, this amounts to two-thirds of the total upstream costs, but for unconventional projects such as shale energy, the proportionate cost is relatively higher, at 75% (due to more drilling and fracking activities to compensate for less favourable geology, rapid well decline rates, higher cost of equipment etc.). HSBC Global Research (September 2013) states shale oil incurs relatively higher costs than shale gas.

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8 On the whole, the oil and gas industry does not have a good record on cost management. We have seen a steady growth in capital employed, particularly since the early 2000s in the upstream activities, Kepler Cheuvreux (January 2014) states that according to Independent Project Analysis (IPA), the typical major upstream project was 25% more expensive than planned. One reason given for explaining this is the sector’s historical focus on schedule driven, volumes based production (e.g. barrels of oil produced) irrespective of cost.

9 Costs will vary depending on the starting point and on how each jurisdiction formulates its rules. Construction costs are primarily influenced by the geographical location, the well depth and some extent, the reservoir pressure, and by the market and infrastructure conditions in the country or region under consideration. Operating costs will so vary with local conditions.
other industry data - costs can be brought down by 40%. Standard Chartered Research concurs, putting estimates of current average gas well drilling costs in China to be US$15m but projecting this to decrease by as much as 50% to US$7m by 2018 or lower as a result of higher use of local manpower, equipment and technology.10

Figure 6: Shale well drilling costs across different plays

Source: Standard Chartered Research, March 2014, referencing Wood Mackenzie data

Figure 7: Shale cost efficiencies in Marcellus shale in the US over time

Source: BofA Merrill Lynch Global Research, September 2011

Investor selectivity is key to identifying potential shale energy investment opportunities

Our framework clearly highlights the need for investors to be selective. Investment opportunities associated with growth in the shale industry are shown in Figure 8. Potential losers are likely to be coal producers (need to export more of their production), major LNG (liquid natural gas) suppliers11, nuclear power plants and transportation companies. On a more macro view, net investment returns from the US shale industry have been rather limited. Despite periods of significant outperformance, the industry in aggregate has performed poorly relative to the Standard & Poor benchmark in recent years. A number of individual companies have

10 Standard Chartered Research gives as an example of how using local labour can lower costs: China’s privately owned oilfield service companies pay their site service engineers a day rate of US$220, while foreign counterparts from global companies like Schlumberger normally costs US$1,400 per day. Although they do assume abandonment costs will rise due to stricter environmental regulations.

11 Especially those in South East Asia, Australia and the Middle East, whose delivery contracts with Chinese buyers mostly lapse around 2030-36. From: Standard Chartered Research, September 2013.
performed significantly better than that average, but selectivity has been vital to benefiting from the industry’s rising investment and output.

**Figure 8: Potential ways to play the shale energy theme across the investment value chain**

<table>
<thead>
<tr>
<th>Industry Sub-sectors</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resource owners</strong></td>
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<td>e.g. upstream</td>
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<td>Exploration &amp;</td>
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<tr>
<td>Production (E&amp;P)</td>
<td></td>
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<tr>
<td>independents,</td>
<td></td>
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<tr>
<td>operators,</td>
<td></td>
</tr>
<tr>
<td>national operators</td>
<td></td>
</tr>
<tr>
<td></td>
<td>US: the upstream independent E&amp;P operators (e.g. Chesapeake, EQT, Range Resources) are the true shale energy discoverers. Nearly every independent E&amp;P operator has at least a few shale gas programmes. Been slow to venture outside the US</td>
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<tr>
<td></td>
<td>China and Russia: e.g. Petrochina, Sinopec, Rosneft, Gazprom own the licenses to many of the already defined, easy to access blocks but have to date not prioritised these as focused on conventional sources with more favourable economics</td>
</tr>
<tr>
<td></td>
<td>Only recently getting involved through either leasing and/or acquisitions, generally have small relative exposure in terms of asset portfolio. Likely to lead on shale energy ex-US. Companies: e.g. BG Group, BP, Chevron, ConocoPhilips, ExxonMobil, Marathon, OMV, Royal Dutch Shell, Statoil, TOTAL</td>
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<tr>
<td><strong>Oilfield service</strong></td>
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<td>contractors</td>
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<td>e.g. land drilling</td>
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<td>rigs, pressure</td>
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<td>pumping, proppant,</td>
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<td>oil country</td>
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<td>tubular goods (OCTG)</td>
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<td></td>
<td>Benefit from increased demand for their equipment and services from producers, innovative new products and services to address water management, chemicals use etc.</td>
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<td></td>
<td>International companies best placed as most knowledge and experience</td>
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<td></td>
<td>e.g. Schlumberger, Halliburton</td>
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<td></td>
<td>Domestic players will also benefit (lower service charge and operational flexibility, general overall increase in service demand, need for SOCs to outsource service work, scope to cross-selling services)</td>
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<td></td>
<td>e.g. in China – Hilong, Arton Oilfield Services, SPT Energy, Russia e.g. Eurasia Drilling</td>
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<td><strong>Mainland transporters</strong></td>
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<td>logistics operators</td>
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<td>Access to and control of the midstream is important, owners of key transportation infrastructures e.g. rail cars for shale oil and pipelines (and transporting equipment to the well site) for shale oil and gas</td>
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<tr>
<td><strong>Others</strong></td>
<td></td>
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<tr>
<td>Refiners</td>
<td>Inland refiners could find themselves having cheap feedstock</td>
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<tr>
<td>Petrochemical and</td>
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<td>industrial</td>
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<tr>
<td>manufacturers</td>
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<td></td>
<td>Downstream petrochemical plants and industrials could benefit from switching to cheaper natural gas feedstock (high energy input costs, can use natural gas so benefit from lower gas prices via lower production costs) – chemicals, plastics, metals, wood and paper product industries</td>
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<tr>
<td>LPG (liquefied</td>
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<td>petroleum gas)</td>
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<td>shippers</td>
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<td></td>
<td>Companies could benefit from the need to transport more LPG from some regions such as the US to others e.g. Europe and Asia</td>
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<td></td>
<td>Water and wastewater companies</td>
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<td></td>
<td>Treatment of recovered fracking fluid e.g. Abtech Industries, Aqua-Pure Ventures, Cameron, Ecosphere Technologies</td>
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</tbody>
</table>

*Source: Schroders, April 2014 (adapted from JPMorgan Cazenove, January 2014; HSBC Global Research, September 2013. Companies referenced are for illustrative purposes and as such does not represent investment advice)*

**Environmental and social concerns associated with shale energy projects presents potential material investment risks**

Whilst key stakeholders such as non-governmental organisations (NGOs) and the public have environmental, health, safety and social concerns about energy projects *per se*, widespread, commercial shale energy production presents different or in some cases, increased concerns mainly related to perceived risks from the extraction techniques used. \(^{12}\) \(^{12}\) Figure 9 summarises the main areas of environmental and social concern, with the most significant being GHG emissions, water availability and quality, chemicals usage, as well as community concerns. \(^{12}\) \(^{13}\) On the whole, concerns (the exception being those related to GHGs and climate change) tend to be quite localised in nature – with water being one of the most critical in this regard.

\(^{12}\) The use of hydraulic fracking is not limited to unconventional energy developments. The term high-volume hydraulic fracturing (HVHF) refers to fracking associated with unconventional energy projects whilst low-volume hydraulic fracturing (LVHF) refers to that associated with conventional projects.

\(^{13}\) Whilst this report only summarises and does not seek to evaluate the different environmental and social risks, back in January 2012, we did publish a report which did just this, entitled “Fracking and shale gas: what we know and what we don’t.”
### Figure 9: Summary of environmental, safety and social concerns associated with shale energy projects

<table>
<thead>
<tr>
<th>Issue</th>
<th>Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emissions – climate change and air pollution</strong></td>
<td>Climate change – GHGs emissions: shale gas has higher production related GHGs emissions (CO₂, CH₄) than conventional gas (due to more wells/fracking needed per unit of gas produced, more venting or flaring during well completion particularly if lack of investment in gas separation and processing facilities results). Also concerns relate to transportation and use of natural gas itself. Methane from gas is more of a concern than CO₂ given it is a more potent GHG (20x) although it has a shorter lifetime in the atmosphere. Four main sources of methane: intentional venting for safety or economic reasons, fugitive emissions (accidental leaks or build into the equipment), incidents involving rupture of confining equipment, incomplete burning. Air pollution: concerns about volatile organic compounds (VOCs).</td>
</tr>
<tr>
<td><strong>Water availability &amp; quality</strong></td>
<td>Majority of concerns relate to use of fracking and horizontal drilling (latter uses more water than conventional vertical drilling) in development and production phases. Average single shale gas well uses between 1-6m gallons of water depending on the basin and rock formation characteristics. Scale of shale projects (multiple wells) increases water stress and potential risks of accidents occurring. Water availability and water stress (latter in terms of competition for water such as agriculture): concerns relate to both use of surface freshwater (rivers, lakes etc.) and groundwater (aquifers). Water quality (pollution or contamination). Four main sources: accidental surface spills of fluids or solids, leakage of fracturing fluids or saline water or hydrocarbons into shallow aquifer through imperfect casing efforts, leakage of hydrocarbons/chemicals from producing zone to shallow aquifers through the rock between the two, and discharge of insufficiently treated wastewater into groundwater or deeper underground. Waste water generated in production stage needs to be treated and disposed of safely. After being injected into the well, part of the fracking fluid is returned as 'flow back' water in the days or weeks after (20-50% of original input, the rest remains in the ground), this contains some chemicals used in fracking as well as those leached from the rock (high salinity levels, weakly radioactive). Concerns over well integrity over the long-term, at the abandonment stage in terms of potential long-term leaks to aquifers or the surface.</td>
</tr>
<tr>
<td><strong>Chemicals use</strong></td>
<td>Use and unsafe disposal of: concerns about the nature of chemicals used in the fracking fluid in terms of impact on public health and wildlife should there be spills, leakages, or if disposed of untreated (benzene, lead, methanol, 2-butoxyethanol (2BE), BTEX compounds, diesel).</td>
</tr>
<tr>
<td><strong>Waste materials</strong></td>
<td>Drilling fluid (‘mud’ – base fluid of water or oil, mixed with salts and solid particles and variety of chemical additives): as drill bit bores into the rock, ‘mud’ is circulated through the wellbore in order to control pressure and remove cuttings. Concerns about safe storage and disposal of the mud to prevent leaks and spills in pits.</td>
</tr>
<tr>
<td><strong>Health &amp; safety</strong></td>
<td>Well blowouts: potential risks of above ground pollution and danger, plumes of underground pollution. There have been a few instances where a well blowout in the US shot natural gas and drilling water into the air for several hours while staff struggled to gain control. Seismic ground disturbance: there has been instances of earthquakes in the UK and US associated with shale energy activities – although these were small, meaning they were discernible by humans but did not create any surface damage.</td>
</tr>
<tr>
<td><strong>Earthquake risk</strong></td>
<td>Concerns about physical disruptions to soil or sub-soil flora and fauna, as well as potential for chemicals contamination.</td>
</tr>
<tr>
<td><strong>Soil</strong></td>
<td>Potential impacts on nearby (threatened, endangered or endemic wildlife e.g. habitat loss and fragmentation, wildlife disturbance, water stress and any water pollution issues. A coalition of conservation charities including the RSPB conducted research to better understand shale fracking risks in the UK and found it could threaten wildlife (e.g. threatened species of birds, fish and mammals) and the water environment (water contamination of chalk streams).</td>
</tr>
<tr>
<td><strong>Ecosystem &amp; biodiversity</strong></td>
<td>Drilling phase is the most visible and disruptive (24/7 operation, noise and fumes from diesel generators, lights at night, regular stream of truck traffic during mobilisation and demobilisation periods). Transportation can potentially increase congestion on local roads, increase wear and tear to roads and bridges and road accidents. Industrialisation of rural landscapes.</td>
</tr>
<tr>
<td><strong>Noise, dust, visual, traffic</strong></td>
<td>Economic exploitation of shale gas requires continuous drilling of wells, so over time taking up an ever larger land acreage, increase land use intensity concerns etc.</td>
</tr>
</tbody>
</table>

**Source:** Schroders, April 2014

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14 While these volumes are large, they are small in comparison with some other use of water such as agriculture, electric power generation and municipalities, and generally represent a small percentage of the total water resource use in each shale gas area. However as the development of this resource requires many wells to be drilled, the required volume can have an impact. From: Societe Generale Cross Asset Research, January 2012, "SRI fracking facts".
It is important to recognise that some of these concerns are valid and so need to be mitigated, whilst others need more research to quantify the actual versus perceived risks. It would be wrong for governments and the industry to ignore such concerns as they represent a ‘wildcard’ in terms of potential added costs to shale energy projects.

Legislative uncertainty and, or increase regulation, along with unsafe and irresponsible conduct can increase investment risks and cost for operators (and so investors). Costs can vary and potentially be in the form of:

- Increased operational costs from financial investment in order to comply with regulations (including unnecessary or redundant regulations) e.g. improved well design, surface disturbance mitigation, fracking related costs.
- Increase operational costs from restrictive conditions (e.g. water rationing), delays or stoppages resulting from unclear or revisions to regulation e.g. changes to contract agreements or well construction requirements, added regulatory paperwork, long lead times for permits, additional site reviews and tests, discovery of potential non-compliance issues and corrective action, public campaigns etc.
- Ability to get approval for licensing, environmental permits, access to water supplies
- Financial costs as a result of fines, penalties and associated legal proceedings.
- Brand and reputational impacts.
- Restrictive and potentially prohibition of shale energy exploitation activities.\(^{15}\)

In terms of trying to quantify what proportion of total costs of shale energy projects ensuring responsible and high standards of environmental and social practice could comprise, the International Energy Agency (IEA) estimates an additional 7% cost of applying its Golden Rules to the overall financial cost of developing a typical 2011 shale gas well.\(^6\) Putting this into perspective, it asserts this is small when considered across a complete licensing area and where the additional investment in measures to mitigate such impacts is offset in many cases by lower operating costs brought about by economies of scale. It also points out that not adopting the highest reasonable environmental and social standards now risks incurring additional costs later on of still higher regulatory hurdles (which could ultimately include the abandonment of shale energy exploitation).

As an example of the potential costs at a country level, the Independent Petroleum Association of America (IPAA)\(^{16}\) claims that if fracking were to be regulated under the Underground Injection Control provisions of the Safe Drinking Water Act in the US, there would be an incremental cost of c. US$100K per unconventional well.\(^7\) The US Bureau of Land Management is currently finalising a rule for fracking on federal lands in order to prevent water pollution through well-casing leaks and to ensure chemicals are removed from wastewater before disposal. The Western Energy Alliance trade group says such measures will add US$96,913 of costs per well.\(^8\) The Colorado Oil & Gas Association have stated that complying with new oil and gas emissions regulations (rules requiring active detection and repair of tank and pipe leaks to cut volatile organic compounds (VOCs and methane emissions) could cost companies US$100m, while Noble Energy estimates a US$3m pa cost to ensure compliance.\(^9\)

All this reinforces the need for governments and the industry to engage with the public and communities to build trust and support for shale development by being transparent and committed to safe, responsible and environmentally responsible best practice.

\(^{15}\) Even in the US, which is generally considered to be supportive of the shale industry (e.g. Pennsylvania allows shale drilling across the entire state), there are differences in views with states such as Maryland putting applications for shale drilling on hold for three years pending an environmental impact study, New York imposing a moratorium due to public health concerns, and Vermont banning fracking practices outright. Outside of the US in Europe, France and Bulgaria for instance, have banned fracking.

\(^{16}\) The IPAA represents independent oil and natural gas producers and promotes the development and use of domestic petroleum and natural gas.
Improvements needed on company management of environmental and social risks

In our view, companies that have identified, and are managing, key environment and social risks will gain a competitive advantage over the long term over those that are lagging in their efforts. We agree with the IEA’s assessment that there is a critical link between the way governments and industry responds to these challenges and the prospects for shale energy production.

Just as some of the natural challenges can be addressed by technological developments and changes in operational processes, so can some environmental ones to some extent. However many of the social issues and outstanding environmental challenges requires approaches which are more geared towards changes in operational mind-sets and practices (Figure 10). Efforts can, and should, be made to ensure safe, responsible and environmentally sustainable shale energy practices, thereby helping to establish a social license to operate.

Figure 10: Examples of technological, engineering and operational best practice solutions to some key environmental and social concerns

<table>
<thead>
<tr>
<th>Issue</th>
<th>Mitigation measures</th>
</tr>
</thead>
</table>
| Air pollution/climate change | - Design of equipment to minimise fugitive methane emissions  
- Use carbon capture and sequestration (CSS) technology  
- Carry out green completions  
- Baseline studies of air quality; regular monitoring (of emission and leaks)  
- Disclosure of performance, including results of inspections, non-compliance, sanctions imposed etc. |
| Water usage                  | - Non-potable water policy; develop waterless fracking technologies; water recycling and treatment processes which enables reuse of fracking fluid flowback  
- Disclosure of water consumption, reuse and recycling as well as results of inspections, non-compliance, sanctions imposed etc. |
| Water availability and quality | - Baseline water studies and testing of groundwater and drinking water; regular monitoring; robust well integrity design; spills management  
- E.g. Baker Hughes H2prO water recycling service – decreases fracturing costs and freshwater consumption by tailoring water treatment methods according to the unique properties of the flowback water  
- Disclosure of performance, including results of inspections, non-compliance, sanctions imposed etc. |
| Chemicals                    | - Reduce types and quantities of chemicals especially, toxins in fracking fluids and develop green products – service companies have responded with innovative products e.g. Schlumberger’s OpenFrac fluid additive; Halliburton’s CleanStim, Baker Hughes ‘SmartCare’, Gasfrac’s LPG in gel form  
- Disclosure of chemicals used in fracking fluid (mandatory in UK, voluntary in US); spills management; robust well integrity design |
| Seismicity                   | - Baseline studies; regular monitoring |
| Wildlife and biodiversity    | - Baseline studies; biodiversity action plans (BAPs), regular monitoring  
- Disclosure of performance |
| Noise                        | - Better design of drilling equipment to reduce noise generation; regular monitoring |
| Community impacts            | - Community consultation early on and throughout the exploration and production process  
- Local content  
- Best practice well abandonment protocol |

Source: Schroders, April 2014 (adapted from JPMorgan Cazenove, January 2014; HSBC Global Research, September 2013)

Encouragingly, recommendations on good and best practice which can be applied to the shale energy industry do exist. For example, the International Energy Agency (IEA)\(^{17}\), industry bodies such as the International

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\(^{17}\) The IEA is an autonomous organisation which works to ensure reliable, affordable and clean energy for its 28 member countries and beyond.
Association Oil & Gas Producers (OPG) and the global oil & gas industry association for environmental and social issues (IPIECA) and multi-stakeholder collaborative initiatives such as the Centre for Sustainable Shale Development (CSSD), have all been active in developing guidance – see Figure 11.

**Figure 11: Some examples of good and best practice operational approaches to addressing environmental and social concerns**

**IEA – ‘Golden Rules’**

The Rules are a set of principles for industry (along with policy-makers, regulators, others) and underline that full transparency, measuring and monitoring of environmental impacts and engagement with local communities are critical to addressing public concern – Appendix B expands on these in more detail).

- Measure, disclose and engage
- Watch where you drill
- Isolate wells and prevent leaks
- Treat water responsibly
- Eliminate venting, minimise flaring and other emissions
- Be ready to think big
- Ensure a consistently high level of environmental performance

**CSSD – 15 performance standards for operators that are protective of air quality, water resources and climate**

- **Air and climate** – performance standards focus on the following key areas: limitations on flaring; use of green completions; reduced engine emissions; emissions controls on storage tanks
- **Surface and ground water performance standards** – focus on the following key areas: maximising water recycling; development of groundwater protection plan; closed loop drilling; well casing design; groundwater monitoring; wastewater monitoring; impoundment integrity; reduced toxicity fracturing fluid
- These performance standards are intended to exceed regulatory minimums set by states and the federal government in the US. The Standards Committee will regularly review and add new standards over time, updating existing standards to ensure they continue to drive leading practices. The CSSD is operating an independent, third party certification and verification programme against these performance standards – Royal Dutch Shell anticipates applying for this during 2014.

**OPG and IPIECA – December 2013 good practice guidelines for the development of shale oil and gas**

- Worker safety, health and emergency response
- Stakeholder engagement and community impacts
- Water sourcing and efficient use
- Groundwater and surface water protection
- Cementing and well integrity
- Operational water management
- Air emissions
- Biodiversity and ecosystems
- Induced seismicity

**Source:** Various: IEA’s Golden Rules, November 2012; CSSD performance standards, August 2013; OPG and IPIECA good practice guidelines, December 2013

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18 The OPG, formed in 1974, is a global forum for upstream oil & gas companies to identify and share best practices to achieve improvements in EHS, security, social responsibility, engineering and operations.

19 IPIECA was formed in 1974 and is the only global association involving both the upstream and downstream oil & gas industry on environmental and social issues. It develops, shares, and promotes good practices and knowledge to help the industry improve its environmental and social performance. It is the industry’s principal channel of communication with the United Nations.

20 The CSSD is a collaboration built on construction engagement among environmental organisations, philanthropic foundations and energy companies and other stakeholders committed to safe, environmentally responsible shale resource development. Strategic energy partners include Chevron, EQT Corp and Shell, and environmental organisations such as the Environmental Defense Fund. The performance standards can be found at: [https://www.sustainablesbrane.org/wp-content/uploads/2014/01/Performance-Standards-v-1.1.pdf](https://www.sustainablesbrane.org/wp-content/uploads/2014/01/Performance-Standards-v-1.1.pdf)
The investment community itself has also sought to develop its own thinking in this area given the potential investment risks and rewards. It is vital for investors to have assurances that the companies they invest are reducing business risks by addressing operational exposure and are capturing business rewards flowing from environmental management practices that have the potential to lower costs, increase profits and enhance community acceptance. As part of this, investors require relevant, reliable, and comparable information about companies’ shale energy operations to make investment judgments based on a robust assessment of companies’ environmental, social, and governance policies, practices and performance.

Organisations such as the Institutional Investor Group on Climate Change (IIGCC)\textsuperscript{21}, the Interfaith Centre for Corporate Responsibility (ICCR)\textsuperscript{22} and the Investor Environmental Health Network (IEHN)\textsuperscript{23} have been active in developing investor statements and guidance for shale energy operators. In their framework covering management goals, best management practices and key performance indicators, the ICCR and IEHN in December 2011\textsuperscript{10} (more details in Appendix C) calls on companies to:

\begin{itemize}
  \item Drive operational efficiencies – reduce cost yields increased margins and profitability.
  \item Provide insurance in case of accident or natural disaster.
  \item Reduce air emissions and freshwater withdrawals that trigger violations of environmental standards – mitigate risk of regulatory ban or restrictions on operations).
  \item Protect and enhance companies’ social license to operate.
\end{itemize}

**Current company responses to environmental and social concerns are inadequate**

Despite calls for greater and proactive transparency by operators on their shale operations, the evidence to date reveals this to be inadequate. However this should be considered in the wider context of companies generally not adequately disclosing on ESG challenges, of which shale or fracking is but one. Following on from their best practice framework, the IEHN along with some asset managers evaluated 24 companies on their performance in November 2013.\textsuperscript{11} Their research (Figure 12) revealed that the industry is failing to effectively disclose impacts on communities and the environment. However they do acknowledge some energy companies such as Apache, Chesapeake, ExxonMobil, Halliburton and Royal Dutch Shell are already adopting some of the core management goals and best management practices and reporting outcomes.

Another analysis commissioned by investors (also in late 2013) arrived at similar conclusions in terms of limited fracking-specific disclosure, even within markets where there is a high degree of production and servicing activity.\textsuperscript{12} The review of 46 oil and gas companies and 10 oilfield services companies generated an average score of only 21\% (Figure 13).

\begin{flushleft}
\textsuperscript{21} The IIGCC is a forum for collaboration on climate change for investors.
\textsuperscript{22} The ICCR is a coalition of faith and values-driven organisations who view the management of their investments as a powerful catalyst for social change.
\textsuperscript{23} The IEHN is a collaborative partnership of investment managers, advised by NGOs, seeking to encourage companies to adopt policies to reduce and eliminate toxic chemicals in their products.
\end{flushleft}
An investor scorecard analysis of the industry’s transparency, management and performance on hydraulic fracking in November 2013, concluded companies are failing to effectively manage the risks.

While scores varied, no company succeeded in disclosing information on even half of the selected 32 indicators developed by the ICCR and IEHN in December 2011. Even Encana, the highest scoring company provided sufficient disclosure on just 14 of the 32 indicators. Lowest scoring companies included BP, ExxonMobil, and Southwestern Energy.

**Figure 12: Disclosing the facts – company analysis**

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>SCORE (OUT OF POSSIBLE 32 POINTS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encana Corp. (ECA)</td>
<td>14</td>
</tr>
<tr>
<td>Apache Corp. (APA)</td>
<td>10</td>
</tr>
<tr>
<td>Ultra Petroleum Corp. (UPL)*</td>
<td>10</td>
</tr>
<tr>
<td>Hess Corp. (HES)</td>
<td>8</td>
</tr>
<tr>
<td>Noble Energy, Inc. (NBL)</td>
<td>7</td>
</tr>
<tr>
<td>Royal Dutch Shell plc (RDS)</td>
<td>7</td>
</tr>
<tr>
<td>EOG Resources, Inc. (EOG)</td>
<td>6</td>
</tr>
<tr>
<td>Cabot Oil &amp; Gas Corp. (COG)</td>
<td>5</td>
</tr>
<tr>
<td>Chesapeake Energy Corp. (CHK)</td>
<td>5</td>
</tr>
<tr>
<td>ConocoPhillips Corp. (COP)</td>
<td>5</td>
</tr>
<tr>
<td>CONSOL Energy, Inc. (CMK)</td>
<td>5</td>
</tr>
<tr>
<td>EQT Corp. (EQT)</td>
<td>5</td>
</tr>
<tr>
<td>Anadarko Petroleum Corp. (APC)</td>
<td>4</td>
</tr>
<tr>
<td>Devon Energy Corp. (DVN)</td>
<td>4</td>
</tr>
<tr>
<td>Chevron Corp. (CVX)</td>
<td>3</td>
</tr>
<tr>
<td>Range Resources Corp. (RRC)</td>
<td>3</td>
</tr>
<tr>
<td>Talisman Energy, Inc. (TLM)</td>
<td>3</td>
</tr>
<tr>
<td>WPX Energy, Inc. (WPX)</td>
<td>3</td>
</tr>
<tr>
<td>BHP Billiton Ltd. (BHP)</td>
<td>2</td>
</tr>
<tr>
<td>BP plc (BP)</td>
<td>2</td>
</tr>
<tr>
<td>Exxon Mobil Corp. (XOM)</td>
<td>2</td>
</tr>
<tr>
<td>Occidental Petroleum Corp. (OXY)</td>
<td>2</td>
</tr>
<tr>
<td>Southwestern Energy Co. (SWNN)</td>
<td>2</td>
</tr>
<tr>
<td>QEP Resources, Inc. (QEP)</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: As You Sow, Boston Common Asset Management, Green Century, IEHN, November 2013 (the companies referenced are those evaluated in the study and as such do not constitute investment advice)

**Figure 13: Analysis of company ESG management of fracking operations**

**Key stats**

- Average company score of 21%
- E&P companies fared slightly better overall, average 23%; servicing companies performed much worse, average 11%
- Only two companies received more than half of the available points
- Significant diversity in quality of disclosure across company size, geography and four focus areas
- The focus area of Governance was the best scoring, with overall average of 27% – true for both Exploration & Production (E&P) and servicing companies
- Water quality and use was 2nd strongest focus area with average score 22%, with E&P companies performing better on disclosure than servicing ones
- Air emissions disclosure was the worst performing focus area, with average score of just 12%, again with E&P companies performing better on disclosure than servicing ones
- Community impact reporting was 2nd lowest scoring focus area, average score of 20%, large and medium firms in E&P sub-sector scored highest, especially European and Canadian firms

**Recommendations for investors:**

- Advocate for fracking-specific disclosure
- Promote greater depth of fracking disclosure for specific focus areas
- Establish and promote a global benchmark for leading fracking disclosure practices
- Promote and leverage public/private partnerships to enhance disclosure.
- Promote creation of global violation records database
- Promote disclosure regulation among governments and securities exchanges in emerging fracking regions
- Promote standardisation of quantitative reporting

Source: Accountability, September 2013
Taking a subset of shale energy environmental management issues – water – in March 2014 Societe Generale Cross Asset Research published their analysis looking at 26 companies with shale operations and their water risk exposure and management practices. Demonstrating the transparency gap, they were only able to rate 15 companies due to insufficient public disclosure. Their framework identified Encana and Range Resources as having more progressive water management practices, whilst Marathon Oil and Talisman Energy as the least.

Given the evidence of a gap between current practice and stakeholder expectations and to some degree, a policy-practice gap in current rhetoric and performance on the ground, investors (see Figure 14) and other stakeholders are actively seeking to promote responsible practice in the shale energy industry through direct dialogue as well as filing shareholder resolutions in the case of the US.

Figure 14: United Nations Principles for Responsible Investment (PRI) fracking engagement initiative

Nearly 40 UN Principles for Responsible Investment (UN PRI) signatories with combined assets under management of US$6 trn have joined an engagement initiative targeting better disclosure of fracking policies, management systems and reporting. Schroders is a supporting investor to the initiative.

The three year collaborative engagement programme, formally launched in early 2014 (although initial planning started in late 2012), aims to:

- Better understand companies’ ability to identify, manage and reduce fracking related risks and capacity to improve practices and disclosure
- Achieve enhanced disclosure of policies, management systems and reporting related to fracking operations, by companies
- Enable investors to better assess and manage their exposure to the financial, operational and reputational impacts of the risks related to fracking operations in their portfolios

Source: UN PRI, March 2014

Conclusion

Unconventional fossil fuel energy sources such as shale oil and gas are likely to remain an area of interest for governments and the industry for the foreseeable future. However, the ability of individual countries to successfully develop indigenous energy sources and realise self-sufficiency - and of individual companies to operate economically viable upstream projects and realise profits - depends on a complex set of natural, as well as policy, regulatory and legal factors in the particular project setting. Whilst some unfavourable conditions can be addressed through technological or engineering solutions, or through changes in policy, regulation or legislation, it is not clear all can be overcome to the extent that shale energy develops a social license to operate and proves to be economical.

We believe environmental, health, safety and social concerns can potentially be a material factor in determining the ultimate scale of shale energy developments. At present some of these concerns stem from potential risks which are not yet fully understood, these range from a lack of confidence in the regulatory regime (which is lagging behind industry developments), to a distrust of the industry due to poor disclosure and lack of commitment to best practice. Whilst it may be possible to apply existing regulation and legislation governing conventional energy to shale energy projects, it will be necessary to develop new ‘smart’ rules

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24 An organisation called Critical Resource which is based in the UK, and has clients in the energy sector, has started work to develop The Responsible Shale Gas Model. Taking a multi-stakeholder approach, it seeks to develop industry best practice to address five key areas of concern: community consultation, local environmental impact, GHG emissions, social and economic benefits, and getting the basics right in terms of environmental regulation and best practice.

25 In 2009, 21 shareholder resolutions were tabled at company management in the US urging them to recognise and ensure responsible practices. During 2011’s proxy season, five companies had shale proposed tabled which received an average of 40.7% support, a 10% rise fro 2010. From: Societe Generale Cross Asset Research, January 2012, “SRI fracking facts”, quoting ISS.

26 The United Nations Principles for Responsible (UN PRI) Initiative is an international network of investors working together to put the six Principles for Responsible Investment into practice. It’s goal is to understand the implications of sustainability for investors and support signatories to incorporate these issues into their investment decision making and ownership practices.
which better address and reflect key shale energy concerns. Greater clarity and certainty, as well as more harmonisation of standards within and between countries, will help the industry and investors, better evaluate shale energy opportunities on a cost-reward basis. More specifically on the policy side, how global and country level politics evolves with regards to decarbonisation will be a critical determinant of how ‘golden’ the future of shale energy can be. The development of shale energy needs to be considered as part of a broader energy policy framework that promotes energy efficiency improvements, increases efforts to roll out low-carbon energy sources and broadens the application of new low-carbon technologies.

Along with the public, some sections of the investment community have expressed concerns about the shale energy industry's ability to effectively address key environmental and social risks which potentially have financial implications for the companies they invest in. In recent years, as well as efforts to develop guidance on good or best practice frameworks, investors have been actively engaging with companies and evaluating their performance. Currently, there is a perceived gap between the industry’s disclosure, management and performance across a range of environmental, health, safety and social concerns versus investors’ expectations. The industry should expect to see continued scrutiny and some level of opposition to their efforts until the deficit between actual practices and expectations is met. This can be addressed at both the industry and individual company level by better demonstrating a willingness and openness to respond to stakeholder concerns, by being more transparent and adopting best practice.

For Schroders, in evaluating investment opportunities in the shale energy space, we will seek to:

- Determine whether companies have a solid understanding of, and have adequately assessed, the economic viability of developing shale energy projects in terms of the natural, policy, regulatory and legal conditions present in a particular project setting.
- Obtain reassurances that companies recognise and are effectively addressing key environmental, health, safety and social concerns about actual or perceived risks through a long-term strategy, given the potential for these to negatively impact on reputation as well as costs.
- Engage with companies (either working alone or in collaboration with others such as the UN PRI initiative) to get commitments from companies to consider and incorporate good or best practice guidance on more environmentally sustainable and socially responsible operational practices, including those highlighted in this report, and demonstrate a willingness to engage with key stakeholders to establish and maintain a social license to operate.
Appendices

Appendix A: Shale energy primer

What is shale energy?

Shale energy is an unconventional energy source, as distinct from conventional energy sources, the latter of which has been the primary focus of the industry to date. The ‘unconventional’ term refers to the difference in their reservoir (‘basin’) basin storage characteristics and the production techniques required to extract them from the rock formations (or ‘plays’). Shale energy is oil (‘tight oil’) and gas contained within rocks classified as shale. Conventional oil and gas basins typically have high porosity (so high volume potential) and permeability (so high flow rates), are contained within a small area and generally do not require artificial stimulation to elicit flow in a well. By contrast unconventionals have traditionally been considered difficult or uneconomical to produce as they typically reside in ‘tight’ or low permeable rock formations which do not readily allow the flow of hydrocarbons (so requiring artificial stimulation) and which have low porosity (so low volume potential). To add to the challenge, in the case of shale in particular, its heterogeneity means that no two plays are identical, and even within plays there are regional or localised ‘productive sweet spots’ in terms of how favourable the geology is to extraction techniques.

What technologies are involved in shale energy production?

The process of extracting and producing the shale energy occurs at the upstream stage of the oil and gas lifecycle. Upstream operations follow the lifecycle of a petroleum reservoir which typically covers the following major phases:

- Acquisition of license/block
- Exploration & appraisal
- Development
- Production
- Abandonment

For the industry and investors the game changer in making shale energy a commercial proposition in the USA was technological innovation in the extraction techniques used:

- Improvements in the combined use of fracking and horizontal drilling means wells can be guided more accurately and swiftly into the reservoir, accessing a much greater surface area of producible gas or oil.
- Improved seismic technology has also enabled better sub-surface imaging, meaning drillers can ‘see’ the potential reservoirs more clearly.
- Advances have also been made in the fracking fluid itself to enhance recovery rates.

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27 Generally speaking, the categories of unconventional fossil fuel energy spans tight oil and gas (including shale oil and gas), coal seam gas, oil sands (heavy/viscous oil), oil shale and gas hydrates. Excluding gas hydrates, all these are located exclusively onshore.

28 Although the oil and gas obtained in each instance is essentially the same in terms of chemical composition and utilisation.

29 Shales are geological rock formations rich in clays, typically derived from fine sediments, deposited in fairly quiet environments at the bottom of seas or lakes having been buried over the course of millions of years. When a significant amount of organic matter has been deposited with the sediments, the shale rock can contain organic solid material called kerogen. If the rock has been heated up to sufficient temperatures during the burial history, part of the kerogen will have been transformed into oil or gas (or mixture of the two), depending on the temperature conditions in the rock.

30 The upstream phase is only one part of the oil and gas industry value chain. The others are: storage, transportation and distribution; specialty operations; refining; and refining and marketing (the later often referred to as downstream processes).
Techniques used to extract shale energy - hydraulic fracking & horizontal drilling

Hydraulic fracking (fracking), initially developed in the late 1940s, is a post-drilling/production technique that enhances the flow of oil/gas from the vertical wellbore which uses fracking fluid (mainly water (99%), chemical additives, sand or ceramic proppant particles) pumped under high pressure into the reservoir to create fractures ('fracks') in the reservoir.

The relatively new aspect of its use is the combining of the technique with horizontal drilling (or completion), which started in the early 1980s Fracturing and horizontal drilling occurs in the upstream life-cycle, it is in the development and production stage.

- **Step 1**: site drilling rig construction (up to 3 days) - drills vertical/horizontal portions of well, is temporary structure, usually remains on site for 1 – 8 weeks
- **Step 2**: vertical drilling phase (up to 14 days) layers or 'strings' of steep pipe called conductor casing lowered down-hole and cemented to prevent oil/gas from escaping. Separate string of steel pipe (surface casing) used to protect underground sources of drinking water
- **Step 3**: drilling continues until well reaches kick-off point (the 'heel') to go horizontal, usually 500 ft above the shale formation, 6,000 ft below the surface
- **Step 4**: horizontal drilling starts, section perforated - distance of the horizontal section of the well extents 1,000 – 10,000 ft towards the 'toe'. Perforating and fracturing operations starts at the toe and move towards the heel. A perforating gun creates a series of small holes to penetrate the steel pipe, cement and adjacent rock creating the flow path for oil/gas to move into the wellbore, and for fracturing fluid into the reservoir as well as flow channel for energy to flow from the reservoir to wellbore
- **Step 5**: arrival of the completion rig (completion phase 3-10 days) - drilling equipment removed, fracturing equipment brought on site. A temporary wellhead is constructed which connects the wellbore to the fracturing equipment. Water is required
- **Step 6**: frack job starts - a horizontal wellbore may have 10-100 stages in order to accurately control and optimise the fracturing process, with stages separated by mechanical plugs that are removed when the operation is complete. When process completed, part of the fluid flows back to the surface where it is reused/recycled/disposed off
- **Step 7**: reservoir flowing to the wellbore - once the fracturing process is completed, the equipment is removed, the well is cleared of water, the temporary plugs are removed and the oil/gas flows freely through the wellbore and to the surface
- **Step 8**: remediated well-site on production well head and other collection equipment is installed on the surface. A reclaimed well site may be fenced in, consisting of 1-3 tanks, a well head and monitoring equipment
Although the exploration and development cycle for shale energy and the technologies used in its production have much in common with those used in conventional upstream activities, they do have some distinctive features resulting from their differing reservoir characteristics, all of which impact on shale economics in terms of different project risk, well return and ultimate cost profiles:

- **Shale energy resources are less concentrated and do not give themselves up easily** – yields a smaller recoverable hydrocarbon content per unit of land. Developments thus tend to extend across a much larger geographical area (to produce the amount) with a higher intensity of industrial activity and disruption above ground.

- **Heterogeneity of resource resulting in wide range of production outcomes** – unlike conventional reservoirs, each shale play has different geological characteristics that affect the way gas/oil can be produced, the technologies needed and the economics of production. Even within the same reservoir, the geological quality varies, with high quality areas (‘sweet spots’) that gradually deteriorate towards the outer reaches of the field. As core sweet-spot areas get developed, secondary and tertiary quality acreage will not produce the same results even with higher oil service inputs.

- **Need for more complex and intensive preparation for production** – although hydraulic fracturing is already used on occasions to stimulate conventional reservoirs (termed ‘low volume hydraulic fracking, LVHF), it (along with horizontal drilling) is almost always required for low permeability reservoirs such as those associate with unconventional shale (termed ‘high volume hydraulic fracturing’, HVHF)

- **Shorter well production and decline duration profiles** – shale oil/gas wells will peak and decline at a much faster rate than conventional wells. Without continued investment to maintain/grow production, which requires an ever increasing number of wells to be drilled (potentially closer and closer together), volumes decline to minimal levels.

- **Potential for range of different phase activities at a single site** – conventional energy projects generally follow a fairly well defined sequence whilst the distinctions between the phases of shale energy can be much less clear-cut – development generally proceeds in a more incremental fashion. The overlap between stages of development means that at any given time an operator may be exploring or appraising part of the license area, developing another part and producing from a third.

### Where can shale energy be found?

While the energy industry has known about the existence of unconventional energy resources for many years, given the abundant availability and favourable economics of extracting conventional ones, there has been little need to exploit this area until now. As such whilst some data exists as to the extent of shale energy resources around the world, its quality (particular for outside North America) should be treated with caution in terms of what is risk weighted technically recoverable given such limited drilling. The most widely used current estimation from the US Energy Information Administration (EIA).

Some key points to make about the global picture and state of development are:

- There are more shale gas resources (7,299 trillion cubic feet (Tcf)) than there are shale oil (345 billion barrels (bbl)).
- By country, China, Argentina and Algeria are among the top three in terms of shale gas (US is ranked 4th and Russia comes 9th), and Russia, the US and China for shale oil.

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31 More intensive activity also due to the shorter leasing period afforded to operators vs conventionalals.

32 The EIA has reported that production rates from different wells in the same formation can vary by as much as a factor of ten. Recoverable hydrocarbons per square km is typically 8-30% for shale gas, compared with 60-80% for conventional gas drilling (Barclays, August 2012).

33 This can be partly mitigated if the fields has multiple horizons – the physical footprint does not need to be increased as further production can be added relatively cheaply over time (e.g. through down-spacing).

34 For conventional wells, the IEA (based on 2009 analysis) states production last 30 years or more. With unconventional shale gas wells though, typically they exhibit a burst of initial production and then a steep decline, followed by a long period of relatively low production. Output typically declines between 50-75% in the first year of production, and most recoverable gas is usually extracted after just a few years.

35 ‘Technically recoverable shale resources’ refers to the share of the risked shale resources in place which can be extracted on the basis of their shale mineralogy, reservoir properties and geological complexities with currently available technologies. JP Morgan (January 2014) states recovery factor can range from 15-40%, with 20-30% a more common range. Note technically recoverable is not the same as – and is less than – economic recoverable resources.
Whilst there will be commercial shale energy production outside the US, this is likely to happen at a slower pace than in the US. Like many we believe it is unlikely there will be material commercial shale gas production outside the US before 2020.14

Shale resources in the US, China, Russia and China (EIA, June 2013; HSBC Global Research, September 2013; Standard Chartered Research, September 2013)

**United States**
- The US has more gas than oil resources – the EIA ranks it 4th in the world for shale gas resources (665 trillion cubic feet, Tcf) and second for shale oil (58 billion of barrels of oil, or B bbl)
- Shale gas activities started earlier than for shale oil, 2005 vs the tail end of the last decade
- Commercial shale gas production reached critical mass in less than five years. In 2000, shale gas accounted for virtually none of the US gas production, in 2012 it accounted for around a third. US shale oil production is now 2.2 mb/d from virtually nothing a decade ago
- Price of natural gas has fallen and it has become much cheaper compared to alternative energy sources, and is displacing coal in electricity generation

**China**
- Abundant shale oil and gas resources. Shale gas is the material resource for China. EIA puts shale gas resources at 1,115 Tcf (ranked 1st globally) and shale oil at 32 B bbl (ranked 3rd).
- No commercial shale production yet – currently at exploration & appraisal stage
- Standard Chartered predicts that China’s shale gas output will increase significantly by 2018, rising to 61 billion cubic metres (B cm) by 2020E

**Russia**
- EIA believes Russia to have most shale oil resources globally (at 75 B bbl), and less of shale gas (ranked 9th with 285 Tcf)
- No commercial shale production – challenge for shale is plentiful supply of conventional oil & gas resources which are more economically attractive to produce

**UK shale**
- EIA analysis puts UK shale gas resources to be 26 Tcf and 0.7 B bbl for shale oil
- Only exploration shale gas energy activities in the UK currently
- It is likely to take time before any tangible benefits materialise: could take 1-2 years for exploration and evaluation, another 10 yrs to drill the wells and build the infrastructure for commercial production, and another 1-2 yrs to secure development and environmental approvals, and 10-15 yrs before UK shale starts to flow
## Appendix B: Shale energy country framework

### Key natural factors/conditions vs. countries relative positioning against them

<table>
<thead>
<tr>
<th>Natural Factors</th>
<th>US</th>
<th>China</th>
<th>Russia</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>Manageable (but increasingly an issue e.g. floods)</td>
<td>Variable – cold/mountain conditions in North, more manageable conditions elsewhere</td>
<td>Cold subarctic/humid continental conditions</td>
<td>Manageable</td>
</tr>
<tr>
<td>Energy supply chain</td>
<td>World’s largest (60%), most advanced (90%), HVHF land drilling fleet</td>
<td>Limited no. of land drilling fleets (esp. suited HVHF)</td>
<td>Some availability of land drilling fleets (esp. suited HVHF)</td>
<td>Limited no. of land drilling fleets (esp. suited HVHF)</td>
</tr>
<tr>
<td>Geology</td>
<td>Straight forward (at economic depths) but heterogeneity across plays</td>
<td>More complex (extensive faulting/folding), deeper so harder to extract (seeking to overcome with technology development), heterogeneity across plays</td>
<td>More complex (faulting/folding), deeper so harder to extract, heterogeneity across plays</td>
<td>Deeper so harder to extract, heterogeneity across plays</td>
</tr>
<tr>
<td>Industry competitiveness</td>
<td>Large no. aggressive/entrepreneurial indep. companies, high access to market funding</td>
<td>Limited no. of independents, dominated by SOCs (who have funding access) but now seeking to open up market to IOCs/independents</td>
<td>Limited no. of independents, dominated by SOCs (who have funding access)</td>
<td>Meaningful no. of independents but limited funding access</td>
</tr>
<tr>
<td>Infrastructure – pipelines</td>
<td>Well developed</td>
<td>Undeveloped</td>
<td>Adequate network (as conventionals also at same location)</td>
<td>Grid exists but some connection issues</td>
</tr>
<tr>
<td>Infrastructure – roads</td>
<td>Well developed network</td>
<td>Undeveloped</td>
<td>Adequate network (as conventionals also at same location)</td>
<td>Adequate network</td>
</tr>
<tr>
<td>Labour market</td>
<td>Large no. and highly experienced shale drilling workforce</td>
<td>Shortage of supply and skillset but seeking to acquire via JVs with IOCs and/or US acquisitions and university training</td>
<td>Good supply of labour but lacking shale drilling skillset</td>
<td>Some experience of fracking (although with conventionals)</td>
</tr>
<tr>
<td>Population</td>
<td>Near low density popns with substantial experience of energy industry</td>
<td>Near high density populations in some regions lacking energy industry exposure, high competition for land</td>
<td>Remote, away from high density populations</td>
<td>Near high density populations in some regions lacking energy industry exposure</td>
</tr>
<tr>
<td>Resource (shale) availability</td>
<td>#2 for shale oil, #4 for shale gas globally</td>
<td>#1 deep shale gas, #3 for shale oil globally</td>
<td>#1 shale oil, #9 shale gas</td>
<td>Outside top 10 global – sufficient but not significant</td>
</tr>
<tr>
<td>Technology development</td>
<td>Government/industry R&amp;D investments since 1980s</td>
<td>Lack shale drilling technology and knowledge but started to fund now (industry/govm)</td>
<td>Lack shale drilling technology and knowledge</td>
<td>Lack shale drilling technology and knowledge</td>
</tr>
<tr>
<td>Topography</td>
<td>Broadly manageable</td>
<td>Most resources located in mountainous terrain (seeking to overcome with technology development)</td>
<td>Broadly manageable</td>
<td>Broadly manageable</td>
</tr>
<tr>
<td>Water availability</td>
<td>Not an issue to date although some basins located in high/extremely high water stressed areas (According to WRI) so be become more challenged</td>
<td>Water scarcity issue in some regions with largest shale gas reserves, high competition for water (e.g. agriculture)</td>
<td>Abundant surface water supplies, little competition for usage</td>
<td>Water stress due to high competition for usage</td>
</tr>
</tbody>
</table>

**LEGEND**
- **Highly favourably positioned (for shale energy exploitation)**
- **More of a mixed picture (in terms of positioning on shale energy exploitation)**
- **Highly challenged (against shale energy exploitation)**
### Research Paper:
**A ‘Golden Age’ of Shale … or Just a Pipe Dream?**

April 2014

<table>
<thead>
<tr>
<th>Policy and regulatory/legal and other factors</th>
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<th>China</th>
<th>Russia</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EHS and social/community</strong></td>
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</tr>
<tr>
<td>• Although envir regs exist @ federal, state/county level, those not considered to be as strict as in Europe - lack of widespread effective monitoring and enforcement is challenge</td>
<td></td>
<td>Political priority to tackle air pollution (climate change to less extent) by diverting efforts to switch from coal to gas. Concerns re water stress</td>
<td>States one of reasons for not actively exploiting</td>
<td></td>
</tr>
<tr>
<td>• BUT situation is changing (in wake of BP Macondo oil-slick)</td>
<td></td>
<td>Ambitious 12th 5 year development plan (2011-2015) targets 8% from natural gas in 2015 with shale gas playing a key part (aiming for 6.5 bcm within 10% of total 60 bcm production). Also stated aiming for 60-100 bcm of shale gas by 2020</td>
<td>Climate change: GHGs emissions 16-25% below 1990 levels</td>
<td>Strong envir regs, good level monitoring and enforcement (more to come @ UK/EU level)</td>
</tr>
<tr>
<td>• Some mechanisms in place for communities to input into planning process; been lack of meaningful public opposition to date but outlook changing re climate/water/community impacts</td>
<td></td>
<td>Envir regs generally not considered to be as strict as in Europe of US. Monitoring and enforcement challenge</td>
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<td>Regulatory process allows for relatively high level of envir/community consultation/input into drilling planning process (EIA/SEAs)</td>
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<tr>
<td><strong>Energy policy</strong></td>
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<td></td>
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<td>• Energy security/self-sufficiency high up political agenda</td>
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<td>Russia is energy rich so concerns low on political agenda</td>
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</tr>
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<td>• Taxation regime for shale relatively benign, incentives include higher prices, tax credits (up to 30% realised price)</td>
<td></td>
<td>• Not been particularly encouraging of shale activities but govt is starting to address</td>
<td>Has abundant conventional resources that economics not attractive for shale investment</td>
<td>Current conservative govt on record as saying ‘going all out for shale’</td>
</tr>
<tr>
<td>• Taxations: • Production tax rates lower (e.g. Russia: 6% 4% vs. US: 12% 6.5%) • Gas royalties lower for unconventional shale (Russia: 12-15% vs. US: 20% - 25%)</td>
<td></td>
<td>• Nice to have: enhanced production subsidy for shale gas (PMB 0.4c/m 2012-15) doubles that for CCM. However, renewal of similar incentives will be review given the short window – market expects subsidy will likely be extended for additional 2-3 yrs.</td>
<td>To date tax regime does not make shale attractive vs other sources (which have reduced taxes). Regime onerous – heavy tax rates and wrong tax base: two tier – royalties (MET) and duties on exports, often on top-tier, volume-based (Vs bottom line) as tax base, not accounted for higher costs with shale energy (effective tax rate of 100% in absence of tax holidays)</td>
<td>Economically infeasible as Russia being much more abundant and closer to market</td>
</tr>
<tr>
<td>• Market expects additional govt incentives e.g. full rebate on the VAT (15%), exemption from capital gains tax on royalty payments upon commercial production</td>
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<td>Guidance on the depreciation method allowed for shale gas is pending</td>
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<td>Growth seeking to reform – no. of policy announcements during 2012-13. 1) Perm to tax to 30% vs. 62% offshore energy projects - Russian favorable approach equal to 75% of capital spending on onshore process. 2) Jan 2013 govt announced local authorities that allow shale drilling will receive 100% of the business rates collected from the scheme - double the current 50% (would be worth £1.7m extra a year for each site a council agrees):</td>
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<td>Less favourable tax regime than US but not as onerous as Russia</td>
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</tr>
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<td></td>
<td>• Must basic geological and well data is not publicly available as treated as trade secrets, no liaison to whether there are any plans to return this</td>
<td>Data available for companies and regulators but not for competitors</td>
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<tr>
<td><strong>Land and mineral (sub-salt) rights regime</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>• Landowners own land and mineral rights</td>
<td></td>
<td>Landowners do not own land or mineral rights – govt does</td>
<td>Landowners own the land but mineral rights belong to the State. They are not owned by a holder of a mineral licence until they are extracted</td>
<td>Landowners own the land but not necessarily the mineral rights, which owned by state</td>
</tr>
<tr>
<td>• Companies will tend to operate on a royalties and tax concessions basis</td>
<td></td>
<td>Gains issues E&amp;P licenses via auctions for companies to bid on – 2 rounds held so far (1st closed, 2nd public auction)</td>
<td>Gains considering amendments to the existing</td>
<td>Gains issues E&amp;P licenses via auctions for companies to bid on (13 rounds so far)</td>
</tr>
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<tr>
<td>Companies will tend to operate PSAs – production sharing agreements with govts (govn still owns the mineral resources, the PSAs determine the amount of oil/gas allocated to the company to recover their costs (‘cost oil’) and how the rest (‘profit oil’) is split between them. Allocated to companies in form of bids/auctions at regular intervals. Suggested foreign partners seeking access to China should have advanced shale gas technologies</td>
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<td>Liberalised market starting in 1070s (Phased removal of price control), complete deregulation applied from 1st Jan '13</td>
<td>Deregulated prices for shale in 2011, but currently no production</td>
<td>July ’13 announced reform aimed at eventual free market pricing</td>
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<td>Policy of open access to pipelines from 1980s – unbundles transportation and sale/marketing of gas</td>
<td>Pipeline infrastructure has not been open access but gvn is seeking to address.</td>
<td>July ’13 – gvn allowing diversified investment in gas pipeline construction (move control of prices from the well-head point to city-gate levels)</td>
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<td>Limited no. of independents, dominated by SOCs (who have funding access)</td>
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</tbody>
</table>

### Market liberalisation – gas/oil price
- Liberalised market starting in 1070s (Phased removal of price control), complete deregulation applied from 1st Jan '13
- Active and liquid spot market
- Deregulated prices for shale in 2011, but currently no production
- July ’13 announced reform aimed at eventual free market pricing
- Liberalised market for oil prices
- Regulated gas price for Gazprom, other companies technically free to set any price but in practice follow Gazprom with small discount
- Gas market liberalisation in 1980s removing any caps on prices
- Open energy market

### Market liberalisation – pipeline
- Policy of open access to pipelines from 1980s – unbundles transportation and sale/marketing of gas
- Pipeline infrastructure has not been open access but gvn is seeking to address.
- July ’13 – gvn allowing diversified investment in gas pipeline construction (move control of prices from the well-head point to city-gate levels)
- Transneft and gazprom monopolise as they operate pipelines, transportation tariffs are regulated
- Policy of open access (although to date been n/a as lacking any onshore energy projects)

### Geology data availability
- Data widely publicly accessible/available
- Most basic geological and well data is not publicly available as treated as trade secrets, no sense as to whether there are any plans to reform this
- Data available for companies and regulators but not for competitors
- Data widely publicly accessible/available

### (Industry competitiveness)
- Large no. aggressive/entrepreneurial indep. companies, high access to market funding
- Gvn trying to encourage diversified investment by allowing foreign participation: none-choose all companies have been able to enter the Chinese shale market through block auctions in the 2nd round (currently not allowed to directly be involved in upstream activities must form alliance with SOCs in the form of joint PSAs
- Gvn only allowed SOCs to participate in the 1st round of auctioning of blocks (June ’12), 2nd round (Sept ’12) was open to all Chinese companies and Chinese-controlled foreign JVs (with a registered capital > RMB 300mn if had shale exploration qualification or partnership with companies with such qualification). A third auction is expected to occur during 2014 of 10 blocks
- Limited no. of independents, dominated by SOCs (who have funding access)
- Meaningful no. of independents but limited funding access

### LEGEND
- Highly favourably positioned (for shale energy exploitation)
- More of a mixed picture (in terms of positioning on shale energy exploitation)
- Highly challenged (against shale energy exploitation)
Appendix C: Golden rules for a golden age of gas (IEA, May 2012)

Measure, disclose and engage

- Integrate engagement with local communities, residents and other stakeholders into each phase of a development starting prior to exploration; provide sufficient opportunity for comment on plans, operations and performance; listen to concerns and respond appropriately and promptly
- Establish baselines for key environmental indicators, such as groundwater quality, prior to commencing activity, with continued monitoring during operations
- Measure and disclose operational data on water use, on the volumes and characteristics of waste water and on methane and other air emissions, alongside full, mandatory disclosure of fracturing fluid additives and volumes
- Minimise disruption during operations, taking a broad view of social and environmental responsibilities, and ensure that economic benefits are also felt by local communities

Watch where you drill

- Choose well sites so as to minimise impacts on the local community, heritage, existing land use, individual livelihoods and ecology
- Properly survey the geology of the area to make smart decisions about where to drill and where to hydraulically fracture: assess the risk that deep faults or other geological features could generate earthquakes or permit fluids to pass between geological strata
- Monitor to ensure that hydraulic fractures do not extend beyond the gas producing formations

Isolate wells and prevent leaks

- Put in place robust rules on well design, construction, cementing and integrity testing as part of a general performance standard that gas bearing formations must be completely isolated from other strata penetrated by the well, in particular freshwater aquifers
- Consider appropriate minimum-depth limitations on hydraulic fracturing to underpin public confidence that this operation takes place only well away from the water table
- Take action to prevent and contain surface spills and leaks from wells, and to ensure that any waste fluids and solids are disposed of properly

Treat water responsibly

- Reduce freshwater use by improving operational efficiency; reuse or recycle, wherever practicable, to reduce the burden on local water resources
- Store and dispose of produced and waste water safely
- Minimise use of chemical additives and promote the development and use of more environmentally benign alternatives

Eliminate venting, minimise flaring and other emissions

- Target zero venting and minimal flaring of natural gas during well completion and seek to reduce fugitive and vented greenhouse-gas emissions during the entire productive life of a well
- Minimise air pollution from vehicles, drilling rig engines, pump engines and compressors

Be ready to think big

- Seek opportunities for realising the economies of scale and co-ordinated development of local infrastructure that can reduce environmental impacts
- Take into account the cumulative and regional effects of multiple drilling, production and delivery activities on the environment, notably on water use and disposal, land use, air quality, traffic and noise

Ensure a consistently high level of environmental performance

- Ensure that anticipated levels of unconventional gas output are matched by commensurate resources and political backing for robust regulatory regimes at the appropriate levels, sufficient permitting and compliance staff, and reliable public information
- Find an appropriate balance in policy-making between prescriptive regulation and performance-based regulation in order to guarantee high operational standards while also promoting innovation and technological improvement
- Ensure that emergency response plans are robust and match the scale of risk
- Pursue continuous improvement of regulations and operating practices
- Recognise the case for independent evaluation and verification of environmental performance
Appendix D: ICCR/IEHN – 12 core management goals for
natural gas operational (December 2011)

Investors supporting this document produced by the Interfaith Centre on Corporate Responsibility (ICCR) and Investor Environmental Health Network (IEHN) recommend that companies adopt the following 12 core management goals (CMGs) for natural gas operations, implement best management practices (BMPs) to achieve them, and report on key performance indicators (KPIs) to communicate outcomes. Some BMPs also function as KPIs.

1. Manage risks transparently and at Board level: Ensure environmental, health, safety, and social risks are core elements of corporate risk management strategy
2. Reduce surface footprint: Minimize surface disruption from natural gas exploration and production activities
3. Assure well integrity: Achieve zero incidence for accidental leaks of hazardous gases and fluids from well sites
4. Reduce and disclose all toxic chemicals: Comprehensively disclose and virtually eliminate toxic chemicals used in fracturing operations
5. Protect water quality by rigorous monitoring: Identify baseline conditions in neighbouring water bodies and drinking water sources and routinely monitor quality during natural gas operations
6. Minimize fresh water use: Draw the minimum potable water necessary to conduct fracturing operations, substituting non-potable sources to the fullest extent practicable
7. Prevent contamination from waste water: Store waste waters in secure, closed containers, not in pits open to the atmosphere, and recycle and reuse waste water to the maximum extent practicable
8. Minimize and disclose air emissions: Prevent/minimize emissions of greenhouse gases and toxic chemicals by systematically identifying emission sources of all sizes, implementing operational practices to reduce emissions, and installing emission control equipment; monitor ambient air quality prior to and during operations
9. Prevent contamination from solid waste and sludge residuals: Minimize risks and impacts by deploying closed loop systems for solid waste and sludge residuals from drilling and fracturing operations and fully characterizing and tracking toxic substances
10. Assure best in class contractor performance: Systematically assess contractor performance against the company’s own BMPs and KPIs across the entire range of environmental, health, safety, and social concerns, with the objective of engaging and retaining best-in-class, continually improving contractors.
11. Secure community consent: During the site selection process, identify all communities impacted and address major concerns central to community acceptance of company operations; establish community engagement process and third party conflict resolution mechanisms.
12. Disclose fines, penalties and litigation: Acknowledge performance issues by disclosing infractions, legal controversies, and lessons learned
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