

Guidance note for financiers

This Guidance Note has been produced to assist financial institutions in their internal conversations and decision-making with regard to risks and responsible business practices associated with shale gas production. This Guidance Note was convened and developed under the auspices of the Climate Principles, an initiative of financial institutions building leadership on climate change. Participating organisations included Climate Principles signatories, non-signatories and other experts from around the world.

Guidance note for financiers

Contents

1.0	Exe	cutive Summary	4
2.0	Issu	ies overview	8
	2.1	The gas-coal equation and implications for climate change	9
	2.2	Fugitive methane	9
	2.3	Concerns about water use, chemicals & contamination	10
	2.4	Seismicity	11
	2.5	Truck traffic	12
	2.6	Community fabric	12
	2.7	Workforce silica exposure	13
	2.8	Cumulative impacts to do with scale, multiple operators/contractors	
		& risk management	14
	2.9	The challenge of regulation	14
3.0	Res	ponsible business practices	15
	3.1	Corporate protocols, governance & disclosure	15
	3.2	Community engagement & support	16
	3.3	Supply chain and contractor management	17
	3.4	Fines, penalties & litigations	18
	3.5	Environmental & social impact assessments across the operational lifecycle	19
	3.6	Well integrity	19
	3.7	Toxic chemicals	21
	3.8	Water quality	22
	3.9	Freshwater Use	22
	3.10	Waste water management	23
	3.11	Solid waste and sludge residuals	24
	3.12	Air emissions, including fugitive methane	24
		Local infrastructural impacts	
	3.14	Seismicity	26
	3.15	Worker exposure to silica	26
	3.16	Biodiversity	27
4.0	Sun	1mary	28
Ack	now	ledgements	29
App	oend	ices	30
	1.	Regulatory approaches to shale gas development	30
	2.	Methane Leakage & Venting Avoidance	
	3.	Truck Traffic Volumes	32
	4	Case study – The Karoo	33

Figures

Figure 1	Shale gas production process	.7
Figure 2	EIA Study of shale gas resources	8
Figure 3	Shale gas well design	0

Guidance note for financiers

1.0 Executive Summary

This briefing has been developed to provide guidance to financiers seeking to understand the key issues associated with shale gas exploration and production, and to assist in identifying the types of responsible business practices that might be reasonably expected from companies operating in this arena. While many examples and practices are drawn from experience in the US, this note is intended to be relevant to a global audience.

The International Energy Agency (IEA) has described natural gas as poised to enter a golden age¹, if a significant proportion of the world's vast resources of unconventional gas can be developed profitably and in an environmentally and socially acceptable manner. In certain conditions, the IEA expects the greater availability of gas to drive down prices and lead to growth in demand of over 50% by 2035, which would give gas a 25% share of the global energy mix and make it the second largest primary energy source after oil and ahead of coal. Such a scenario would see annual production of unconventional gas – primarily shale gas – more than triple to 1.6 trillion cubic metres (60 trillion cubic feet)² by 2035.

While the rise of unconventional shale gas production will increase a sense of energy security in certain markets, it also brings a complex set of challenges at global and local levels (see section 2), regarding:

- Climate change impacts associated with shifting power generation to natural gas from other sources, as well as fugitive methane emissions during production
- Concerns about the high volumes of water and toxic chemicals used in the extraction of shale gas and risks of contamination, particularly to local sources of drinking water
- Impacts on the environment, biodiversity and ecosystems as a result of operations, the intensive use of chemicals, associated emissions (intentional or otherwise), waste and truck traffic
- Social, cultural and economic consequences for local communities arising from factors such as landscape impacts, high volumes of truck traffic and the consequences of an influx of new workers into an area
- Challenges to operating companies pertaining to scale and the cumulative impacts of multiple operators and contractors working in a single area, posing issues for coordination and the anticipation and management of risks, including accidents and occupational health hazards
- Regulatory variation and weakness in providing effective oversight of an activity with such complex potential impacts, especially in countries with weak governance, and where there may be a history of corruption and poor contractor management.

² 1 cubic foot = 28.316846 litres

This complex set of strategic and operational challenges will require successful operators to be equipped with a combination of robust management frameworks and accountabilities, as well as strong operating practices on the ground and throughout their supply chains. Companies' quantitative disclosure of their performance against KPIs will be fundamental to their credibility and to track progress. The document sets out 16 high-level business practices (Section 3) that financiers might look for in companies committed to operating responsibly in this field, as follows:

We recognise that research, debates, risks and mitigation associated with shale gas are rapidly evolving, and we welcome feedback that will improve insight and understanding.

In Brief: Shale gas and hydraulic fracturing³

Shale⁴ is a common type of sedimentary rock formed over centuries from deposits of mud, silt, clay and organic matter. As mud turns into shale near the earth's surface, bacteria feed on the organic material – also called kerogene – to release biogenic methane as a byproduct. Several kilometres deeper underground, greater heat and pressure crack the kerogene (including any oil already produced by that heat and pressure) into smaller hydrocarbons, creating thermogenic methane. Some oil and gas escapes from the shale into more porous conventional reservoirs, but some does not. Shale gas consists mainly of thermogenic methane and other gases which have been trapped in shale with such low permeability that the gas cannot readily flow into a well. Hydraulic fracturing, or 'fracking', is used to increase the permeability of the rock so the shale gas can be released. (See figure 1)

Hydraulic fracturing involves drilling a well that reaches into the strata from which the shale gas is to be produced. Controlled charges then perforate holes in appropriate sections of the well, and fracturing fluids are pumped in at high pressure. Fracturing fluids usually consist of water, sand 'proppant' and a range of chemicals, such as those contained in slickwater to help increase fluid flow, bactericide, gelling agents and surfactants, which reduce the interfacial tension between liquids and solids.

The injection of fracturing fluids generates stresses in the shale that exceed its strength and force open existing fractures as well as creating new ones, which are propped open by the sand. Additional fluids are then pumped in to maintain the pressure so fracture development can continue and the \checkmark

³ Information mainly from 'Shale gas extraction in the UK: review of hydraulic fracturing' – Royal Society & Royal Academy of Engineering, 2012

Johnson, Mike, Jim Davidson and Paul Mortensen, 'A perspective on Canadian shale gas', National Energy Board 2009.

^{&#}x27;Hydraulic Fracturing Operations — Well Construction and Integrity Guidelines', API Guidance Document HF1 First Edition, 2009

sand proppant can be carried deeper into the formation⁵. After fracturing, the well is depressurised to create a gradient so that gas flows out of the shale into the well. Fracturing fluid will flows back to the surface at the same time ('flowback water') and will now also contain saline water from dissolved minerals in the shale formation ('formation water'). Fracturing fluid and formation water return to the surface over the lifetime of the well (produced water). Waste waters⁶ are usually comprised of flowback and produced waters.

Shale gas extraction typically comprises three stages:

- *Exploration and pilot production*, when 2 or 3 wells may be drilled and fractured to determine if shale gas is present and can be extracted, followed by more wells to characterise the shale and its economic viability. It can take 12-15 days for each exploration well to be drilled, but this may vary.
- **Production** involves the commercial development of shale gas. Commercial reserves are often found in shales over a hundred metres thick, covering hundreds of square kilometres. As vertical wells tend to access only a small volume of shale; horizontal wells are also likely to be drilled and fractured. The initial fracturing of a well may take around 30 days – although this will vary with geography - after which the gas will be produced for many years or decades, although the well may be fractured again at a later stage to improve throughput.
- *Abandonment* takes place when the well reaches the end of its life and extraction is no longer economic. Sections of the well are then filled with cement to prevent gas flowing into water bearing zones or up to the surface, and a cap is put in place and then buried. ▼

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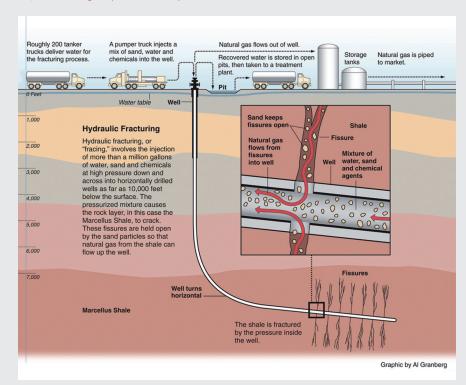


Fig.1 Shale gas production process

Illustration by Al Granberg, courtesy ProPublica, under Creative Commons. Original at http://www.propublica.org/special/hydraulic-fracturing

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2.0 Issues overview

(Please note the following discussion of issues is not set out in any particular order of priority or weighting. Each market and operator will face its own particular challenges that need to be given specific attention.)

Shale gas is described as a game-changer in world energy markets, with the potential to bring new 'unconventional' gas supplies to an otherwise contracting market. The US Energy Information Administration (EIA) estimates the total volume of technically recoverable shale gas in 14 regions outside the US to be 6,622 trillion cubic feet /188 trillion cubic metres, which could effectively increase global natural gas resources (estimated at approx 16,000 trillion cubic feet /453 trillion cubic metres) by 40%⁷.

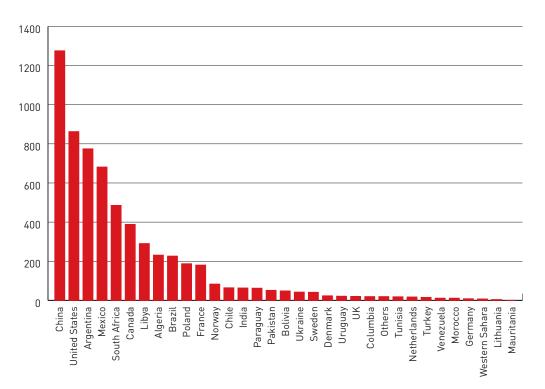


Fig 2: EIA Study of shale gas resources⁸

In the US, the discovery and exploitation of vast shale gas reserves has resulted in US gas prices falling by nearly 75% in from July 2008 to January 2013⁹. The contribution of shale gas to domestic gas production has grown from less than 1% in 2000 to over 20% by 2010, and is projected by the EIA to account for 46% by 2035¹⁰. As gas grows to become the fuel of choice in the US, the share of coal-powered generation has fallen 19% in the year to May 2012¹¹.

⁷ 'World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States', US Energy Information Administration, 2011

http://nextbigfuture.com/2011/04/global-shale-gas-boosts-total.html

NYMEX Natural Gas Futures - June 30, 2008: \$13.58 and January 15, 2013: \$3.44

¹⁰ Stevens, Paul, 'The "shale gas revolution": Developments and changes', Chatham House, 2012

¹¹ Mackenzie, Craig, 'Shale gas: the fugitive methane problem', SWIP/Sustainability Research Series, 2012

2.1 The gas-coal equation and implications for climate change

- On the one hand, shale gas's displacement of coal powered generation has been welcomed by some as positive from a climate change perspective as – at the point of combustion – burning natural gas emits 40-50% less carbon dioxide per megawatt of power than burning coal¹². For this reason, gas is often described as a 'transition fuel', bridging the way to a lower carbon economy.
- With the US and China as the world's largest greenhouse gas emitters and with a substantial share of their emissions coming from coal it's argued that the prospect of both economies developing their vast shale gas reserves is a step in the right direction away from carbon-intensive coal.
- However, a recent study by the IEA shows that coal consumption in Europe rose by 6% in 2011 as a result of cheap excess coal on the market because of reduced US demand, and an EU carbon price that was too low to act as a deterrent¹³.
- The IEA¹⁴ makes the point that renewable energy is needed to address climate change and that care is needed to ensure policy commitments and investments in renewables do not become the victim of a dash for gas. In its World Energy Outlook 2012, published in November 2012, the IEA warned that in order to limit global warming to 2°C¹⁵, no more than one-third of proven hydrocarbon reserves should be used by 2050.

2.2 Fugitive methane

- There is limited data regarding methane leakage rates from shale gas developments.
- While methane is short-lived and decays more rapidly in the atmosphere than CO₂, it has a stronger warming impact over its lifetime. It is argued that unless methane leakage rates can be kept below 2%, then substituting gas for coal would not be an effective means of reducing the magnitude of future climate change¹⁶.
- The numbers used by the Intergovernmental Panel on Climate Change's 4th Assessment Report in 2007 suggest that over its first twenty years, methane has 72 times the global warming potential of CO₂, which falls to 24 times over a century. Analysis by SWIP Research finds that, from a global warming perspective, gas compares favourably to coal over 100 years based on mid-range US EPA methane leakage rates but over a shorter time-scale of 20 years, the climate impact of gas is about the same as coal¹⁷.

 $^{^{\}rm 12}$ $\,$ 'The role of natural gas in a sustainable energy market', International Gas Union / Eurogas, 2010 $\,$

 $^{^{13} \}qquad http://www.guardian.co.uk/environment/2012/may/29/gas-boom-renewables-agency-warns$

¹⁴ IEA - Golden Rules for a Golden Age of Gas: World Energy Outlook – Special Report on Unconventional Gas (2012)

¹⁵ IEA – World Energy Outlook 2012

Wigley, Tom M. L., 'Coal to gas: the influence of methane leakage', Climatic Change, Springer Science+Business Media, 2011

Mackenzie, Craig, 'Shale gas: the fugitive methane problem', SWIP/Sustainability Research Series, 2012

- More positively, low cost commercially available technologies do exist to capture methane at various points along the gas production and distribution system (*see Appendix 2*) and further studies into methane emissions from shale gas production are working to address the data deficit around leakage rates.
- The Global Methane Initiative¹⁸ and UNEP's Climate & Clean Air Coalition on Short-Lived Climate Pollutants¹⁹ are new forums established to raise awareness, build understanding, develop best practices and improve capacity to cut methane emissions.

2.3 Concerns about water use, chemicals & contamination

- Hydraulic fracturing requires large amounts of water and chemicals to be injected deep underground, where their migration is not entirely predictable. While hydraulically fracturing a conventional (non-shale) well with a single fracture generally requires 50,000 to 100,000 gallons (190-380 m³)²⁰ of fluid, fracking a horizontal shale well requires from one to eight million gallons (3,800-30,000 m³) of water and thousands more gallons of chemicals²¹.
- Although companies may try to contextualise the significance of these figures for instance, ExxonMobil says the amount of freshwater required for drilling and fracking a typical horizontal well is usually equivalent to about 3 to 6 Olympic size swimming pools²² the absolute numbers are less important than the water stress that results. This varies by location and the impact of withdrawing an Olympic-sized swimming pool's worth of water is different from country to country, and community to community.²³
- Given the volumes of water and chemicals involved and geological stresses intrinsic to hydraulic fracturing, there have been concerns about earthquakes and also the risk of contamination to drinking water. For instance, well failures, due to insufficient well casing, may cause the release of fracturing fluids at shallow depths, close to drinking water supplies, and while some fracturing fluids are removed from the well at the end of the fracturing process, a substantial amount remains underground.
- In some areas, wastewater is removed from shale gas wells to be disposed of by injection into deep underground wells, a process which has been linked to seismic concerns²⁴. Storage of wastewater in open pits has also been a cause for concern.

²¹ Williams, Susan, 'Discovering shale gas: an investor guide to hydraulic fracturing', IRRC Institute, 2012

¹⁸ http://www.globalmethane.org/index.aspx

¹⁹ http://www.unep.org/ccac/

²⁰ 1 US gallon = 3.78541 litres/0.0037854118 m³

²² Olympic swimming pool volume = 2,500 cubic metres or 660,000 US gallons

²³ Williams, Susan, 'Discovering shale gas: an investor guide to hydraulic fracturing', IRRC Institute, 2012

²⁴ http://www.globalenergyprofs.com/2012/06/study-finds-higher-earthquake-risk-from-wastewater-injecting-thanfracking/

- In the US, unless oil and gas companies use diesel in the hydraulic fracturing process, the underground injection of chemicals for hydraulic fracturing is not regulated by the Environmental Protection Agency (EPA) due to a 2005 exemption under the Safe Drinking Water Act. This has led to heightened anxiety and controversy. However, Royal Dutch Shell estimates that at state level, 17 states representative of 96% of unconventional production do have hydraulic fracturing regulation that addresses the issue of chemical disclosure²⁵.
- The US House of Representatives' Committee on Energy & Commerce recently reported into the chemicals involved and stated that: 'Between 2005 and 2009, oil and gas companies used hydraulic fracturing products containing 29 chemicals that are (1) known or possible human carcinogens; (2) regulated under the Safe Drinking Water Act for their risks to human health, or (3) listed as hazardous air pollutants under the Clean Air Act. These 29 chemicals were components of more than 650 different products used in hydraulic fracturing²⁶.' There are also concerns regarding the fate of chemicals that are recovered and disposed of as wastewater, which is often stored in tanks or pits at the well site, where spills are possible. The US EPA is currently studying hydraulic fracturing's impacts on drinking water, with a report due in 2014.
- There has also been controversy in the US regarding levels of methane in local drinking water as a result of shale gas operations²⁷. Recent research²⁸ has found that average and maximum methane concentrations in drinking water wells increase with proximity to the nearest gas well. At certain levels, methane concentrations in some water wells have been found at level that present an explosion hazard. (Methane needs to be vented at concentrations above 28 milligrams per litre²⁹ to avoid possible explosions.)

2.4 Seismicity

• Concerns have been raised in some countries about seismicity induced by hydraulic fracturing itself, or by the injection of wastewaters into deep disposal wells. In the US, the Ohio Department of Natural Resources – in the wake of a series of tremors recorded within one mile/1.6 km of a well – has recommended that the state pass a new law prohibiting drilling at the so-called Precambrian basement rock level (a depth that begins at 9184 ft) and requiring companies to review existing geological data before drilling³⁰.

²⁸ Osborn, Stephen G. et als, 'Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing', Proceedings of the National Academy of Sciences of the United States, 2011

²⁵ Royal Dutch Shell estimate based on regulatory comparison work done by Resources for the Future (available on their website) and information available on the Interstate Oil and Gas Conservation Commission website

⁶ 'Chemicals used in hydraulic fracturing', United States House of Representatives Committee on Energy and Commerce Minority Staff, 2011

²⁷ http://www.bloomberg.com/news/2012-03-29/high-methane-in-pennsylvania-water-deemed-safe-by-epa.html

²⁹ http://www.usgs.gov/newsroom/article_pf.asp?ID=3391

 $^{^{30}} http://www.reuters.com/article/2012/03/09/us-energy-fracking-ohio-idUSBRE8281DX20120309$

- A recent UK study³¹ reports an emerging consensus that the magnitude of seismicity induced by hydraulic fracturing would likely be no greater than magnitude 3 or 3M i.e. felt by few people and resulting in negligible, if any, surface impacts. Recent seismicity in the UK as a result of hydraulic fracturing was of magnitude 2.3 and 1.5. Traffic-light monitoring systems that use real-time monitoring are recommended to enable operators to anticipate problems and respond accordingly.
- Seismicity and geological risks similar to the challenges of water scarcity vary by location and associated risks need to evaluated on a case-by-case basis.

2.5 Truck traffic

- The high volumes of water and chemicals required for hydraulic fracturing also have implications for transport, storage and truck traffic around a site.
- It takes some 200 trucks to transport one million gallons (3,800 m³) of water, and hydraulic fracturing can take up to 8 million gallons (30,000 m³) per well. The wastewater must also then be removed. In addition, some 30-45 semi-trucks are needed to move and assemble a rig that can drill down 1000 feet/300m, alongside further trucks to carry sand, waste, other equipment and heavy machinery. [*See Appendix 3 for detailed breakdown of truck volumes.*]
- These traffic impacts and associated congestion, noise, dust and increased risk of accidents can quickly inflame local communities and degrade local infrastructure, leading to the need for more community spending on road maintenance. Although some companies may drill multiple wells from a single pad to reduce their footprint and costs, this activity still concentrates other impacts specifically air emissions and truck traffic to and from a certain site.³²

2.6 Community fabric

- Every community is different and sensitivities and concerns will vary from place to place. Some communities may be accustomed to a degree of industry in their local environment and be more familiar with the impacts, benefits and trade-offs. Other communities may be much less experienced. Whatever previous history, sensitivities may arise for all sorts of reasons.
- Lease constructs may be a particular source of tension and potential litigation particularly where land owners are entitled to surface rights, but not royalties associated with mineral rights. Ensuring adequate and timely compensation for surface rights owners can help ameliorate and mitigate this tension.

- Shale gas jobs require specific skills and the movement of new workers into an area to support the hydraulic fracturing industry can have multiple impacts on the fabric of a local community. On the one hand, it can bring economic benefits and new money into an area, but with trade-offs. While increased demand may drive up some local housing prices, this may make access to certain properties difficult for long-term local residents, and not all property values will rise. Homes and agricultural land in close proximity to shale gas operations may lose value due to environmental degradation and risks to groundwater³³. The US National Bureau of Economic Research found that those living within two miles/3 km of shale gas wells could expect house prices to fall by some 24%.³⁴
- An influx of temporary workers can also bring a raft of issues, for instance, making demands on the health service, and so increasing pressure and costs for local police, fire, schools, health and social welfare.³⁵
- In certain remote or rural communities, the influx of hydraulic fracturing activity can disrupt a long-established way of life, with lasting cultural ramifications. For instance, shale gas development can significantly alter landscapes and the character of an area, which may impact other local economies, such as tourism and investments related to conservation and the natural environment. [*See Appendix 4 for Karoo case-study, South Africa.*]
- In parts of the US, oil and gas facilities are prohibited within 1000 feet/300m of a home, school, freshwater well, public park, religious institution, public building or hospital building³⁶. The Natural Resources Defense Council (NRDC) in the US has initiated the Community Fracking Defense Project to provide legal and policy assistance to communities seeking additional controls and protections from hydraulic fracturing activity in their communities³⁷.

2.7 Workforce silica exposure

- Large quantities of silica sand are used during hydraulic fracturing and its transport and movement can lead to the release of dust containing silica into the air. Workers can be exposed too if they breathe the dust, which can lead to a lung disease called silicosis.
- In the US, the Occupational Safety & Health Administration (OSHA) has released a hazard alert³⁸, identifying the issues, associated standards and directives, and appropriate protection and mitigation.

³³ Klaiber, H. Allen and Sathya Gopalakrishnan, 'The Impact of Shale Exploration on Housing Values in Pennsylvania', Ohio State University, 2012

³⁴ http://www.thisismoney.co.uk/money/news/article-2227344/Shale-gas-redraw-economic-map-Britain-price-houses-nearby-wells-fall-24.html

³⁵ Williams, Susan, 'Discovering shale gas: an investor guide to hydraulic fracturing', IRRC Institute, 2012

 $^{^{36}} http://switchboard.nrdc.org/blogs/amall/communities_have_the_right_to.html$

³⁷ http://www.nrdc.org/media/2012/120919.asp

³ http://www.osha.gov/dts/hazardalerts/hydraulic_frac_hazard_alert.html

2.8 Cumulative impacts to do with scale, multiple operators/contractors & risk management

- In considering all the above impacts, the intensity and scale of hydraulic fracturing in any given area is a significant amplifier of risks to a particular community. In some instances, in a given area, a number of different operators and contractors may be drilling from numerous pads as part of their exploration and production. Given the density of hydraulic fracturing activity in such an area, there only has to be a small percentage of incidents or leakages, for the impact to be significant.
- The scale of development and activity that tends to accompany the hydraulic fracturing business means the probability of any risk occurring escalates and, where there are multiple operators, risk management and regulation becomes even more challenging.

2.9 The challenge of regulation

- The need for effective regulation of the complex dimensions of shale gas development is repeatedly cited as a critical component in ensuring safe and responsible operations and practices at all phases.
- A country that has weak, corrupt or ineffective regulatory processes puts local people at risk and also presents a potential minefield of contention and conflict for oil and gas companies seeking to do business in such an area, and whose brands may well become lightning conductors for a range of related contentious issues to do with environmental impacts, economic transparency, respect for human rights and more. (*See Appendix 1 for summary of different country approaches to regulation.*)

Guidance note for financiers

3.0 Responsible business practices

Shale gas development presents a combination of specific operational and technical challenges for companies, as well as overarching strategic management challenges. The Investor Responsibility Research Centre³⁹ (IRRC) has questioned whether the industry has the will, short-term economic incentives or oversight to manage the complexity and avoid the issues that are likely to provoke controversy and more stringent regulation over time or outright bans. As such, when evaluating a company's risk profile on shale gas, attention needs to be given to both the robustness of its management protocols and accountability, as well as the effectiveness of its technical and operating procedures. This brief itemises some of the critical factors for investor consideration:

NB: The following factors are not in any order of priority or weighting. In circumstances where certain considerations may be commercially sensitive, financiers and operators should seek to work together to communicate transparently and agree what is appropriate to disclose in a particular circumstance.

Shale Gas Management and Accountability

Shale gas operations present a complex set of issues and risks to any business, and strong management functions need to be in place to ensure an organisation is fit to: anticipate key risks; disclose them appropriately; develop, deliver and report upon responsible policies and practices, both within their own operations and through their supply chain; and engage critical stakeholders and communities to ensure free, prior and informed consent.

Financiers seeking to establish if a company has strong management in place regarding its shale gas operations, may choose to investigate the following areas:

3.1 Corporate protocols, governance & disclosure

Responsible companies will be able to demonstrate that they can manage the complexity of risks associated with shale gas development transparently and at Board level. **Finan-**ciers could consider whether:

• The board of directors and senior management have oversight of risk management and strategic considerations associated with the company's shale gas operations, including the significance of shale gas for its overall portfolio, the company's preparedness to transition to a low carbon economy and its exposure and ability to mitigate environmental, health, safety and social impacts

- The board and senior management are able to appraise risks posed by shale gas operations in different countries and communities, with varying regulatory regimes that may pose a variety of potential contentious and reputational issues for their business.
- Clear standards, policies and procedures are in place and consistently applied throughout the company's shale gas operations. (See Shell's Shale Gas Operating Procedures⁴⁰) and ultimate responsibility for oversight and management of these standards, policies, procedures and risks lie with a clearly nominated Board member.
- The board and senior management encourage corporate and public policies that foster best practice and continuous improvement for shale gas operations.
- The board requires third-party independent monitoring and auditing of environmental, health and safety functions for the company's operations, including its shale gas activities.
- The company's standards, policies, procedures and risk management are applied in the company's work with joint venture partners and contractors, and subject to monitoring and audit.
- Compensation and incentive packages for senior management should include links to environmental, health, safety and social impact performance results, including activities relating to shale gas.
- Whistleblower policies and procedures ensure that complaints involving the company and its contractors are addressed, whistleblowers protected from retaliation, and reports of concerns regularly and systematically shared at Board level.
- The company implements high workforce training standards.
- The company has a policy of public reporting, at least annually, with regard to its status on hydraulic fracturing indicators, and progress on hydraulic fracturing risk management targets; with the information also disclosed to regulators as required. The company updates publicly available reserve and production estimates on a timely basis as new data become available.

3.2 Community engagement & support

During its site selection process, a responsible company will identify all potentially impacted communities and seek to understand and address their concerns. This is important for wherever a company may be operating, but particularly in countries with weak governance, where there may be no formal requirement for local engagement. Responsible companies will establish community engagement procedures around their

operations and put measures in place for third party conflict resolution that go beyond formal local requirements. Companies will also take care to ensure operations do not take place close to sensitive locations – such as schools, hospitals or churches, or outdoor environments and parks that are locally valued. **Financiers could consider whether:**

- The company has policies and practices relevant to seeking broad community support and, in the case of any indigenous peoples, 'Free, Prior and Informed Consent' for any new developments and activities. Community support might comprise reaching advance agreements with local community officials or organisations that outline the company's practices related to specific concerns, such as noise, road use, damage repair and the monitoring of environmental, social and health impacts. Such agreements may include practices that go above and beyond the requirements of the prevailing regulatory environment.
- The company has an 'open door' and proactive approach to informing and engaging the local community on its operations including proactive distribution of its policies and principles regarding shale gas development; tours of the site and regular 'town hall' meetings to hear and address issues and concerns.
- The company has a dedicated hotline to receive individual complaints arising from company operations and a mechanism in place to record complaints and company responses.
- The company has independent third-party conflict resolution mechanisms to address concerns and complaints arising from company operations in the community.
- The company formally discloses the results of its community engagement, including the number and character of complaints arising from its operations, trends over time and lessons learned.

3.3 Supply chain and contractor management

Responsible companies will systematically assess contractor performance against their own corporate standards, performance indicators, policies and practices across the entire range of environmental, health, safety and social concerns, with the objective of retaining best-in-class and continually improving contractors.

Financiers could consider whether:

- The company has evaluated and developed an appropriate balance between the activities which it resources in-house and those which it outsources.
- For outsourced activities, the company can demonstrate robust procurement and

management systems, including third party audit, that evaluate the environmental, health, safety and social policies, procedures and performance of contractors and partners, with a focus on driving continuous improvement.

- There is provision to ensure contractor compensation and incentives include EHS performance and disclosure
- There is disclosure of corporate approaches to contractor management and quantitative results.
- The company holds contractors to the same high standards that it requires of its own performance.

3.4 Fines, penalties & litigations

Responsible companies are transparent and proactive in acknowledging any performance issues by disclosing specific problems, legal controversies, regulatory penalties and identifying the lessons learned.

Financiers could consider whether:

- Corporate disclosures cover individual government penalties and an annual aggregate of fines; notices of violation regarding health threats or environmental damage; pending litigation (including amount of claim or company's own worst estimate); facility shutdowns, licence suspensions or moratoria on licencing; and the nature of cases settled (even where settlement contents are sealed) in response to private party allegations.
- Evidence of institutional learning and whether fines, penalties and litigations represent unique events or are symptomatic of systemic underlying problems that are being addressed.

Responsible Operating Procedures & Risk Management

Beyond high-level corporate management strategies and policies regarding shale gas development, responsible companies will also undertake specific activities regarding the siting, operation and risk management of their activities to ensure they are safe and have minimal impacts on environment, health and safety and the well-being of surrounding communities. NB: The following areas are not in any order of priority or weighting.

3.5 Environmental & social impact assessments across the operational lifecycle

Complete assessments of the environmental and social impacts of a planned operation are essential.

Financiers could consider whether:

- In planning its operations, the company takes an integrated approach to assessing the lifecycle of its fracturing operations from exploration through to production, the disposal of wastes and abandonment in order to anticipate, reduce and mitigate impacts on the natural environment, biodiversity and ecosystems, and the lifestyles and livelihoods of local communities.
- The company discloses its lifecycle analysis and reports on the results and consequences, and involves local communities and relevant stakeholders in its analysis at the earliest possible opportunity, and where necessary invites independent third party review of its findings.
- The company gives due consideration to seismic issues, earthquake and flooding risks as part of its assessment.
- The company has proper well closure policies and procedures in place.

3.6 Well integrity

Cement and several types of well casing are used in the construction of a shale gas well and work to ensure that the gas and substances used in its production cannot leak from the well into the surrounding air or water. Problems with casing or cementing can lead to poor integrity, blow-outs and the escape of fluids or gases into the surrounding rocks. Cement failures can also increase with the age of a well⁴¹. While all types of oil and gas well will have some form of cement casing, shale gas wells are unique in the extremes of pressure – intrinsic to hydraulic fracturing – to which they are subject. Evidence suggests that all wells suffer in integrity over time⁴². **Financiers could consider whether companies**:

- Conduct geological characterisation of the site to identify faults, abandoned mines and wells.
- Confine drilling to targeted production shales and avoid areas where there is risk of contaminating potable water.
- Implement a well construction integrity policy across all operations with the aim of

⁴¹ http://www.slb.com/~/media/Files/resources/oilfield_review/ors03/aut03/p62_76.ashx

^{&#}x27;From mud to cement – building gas wells', Schlumberger, 2003

eliminating the risk of leaks and other incidents, surpassing local regulatory standards (if necessary).

- Disclose key elements of the well construction integrity policy and identify the specific methods that contractors must use to ensure and verify well integrity.
- Pressure test wells prior to fracturing and routinely apply advanced acoustic-testing methods (or their equivalent) on cemented casing.
- Where technically necessary, routinely run cement to surface to assure isolation of the well bore from potable groundwater aquifers.
- Undertake real time flow pressure monitoring and have shut-down systems in place if integrity is compromised.
- Provide for independent inspections of wells and disclose the results of well tests and examinations.

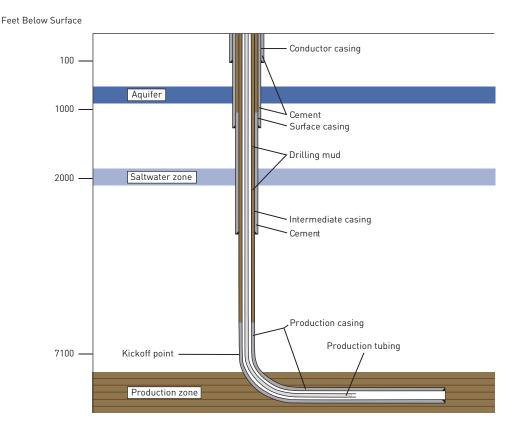


Fig 3: Shale gas well design⁴³

3.7 Toxic chemicals

Responsible companies will comprehensively disclose toxic chemicals used in their fracturing operations and have strategies in place that seek to eliminate toxic chemicals as far as possible, and ensure responsible handling and secondary storage. **Financiers could consider whether**:

- There is appropriate containment and transport of chemicals and provisions to manage and disclose surface spills.
- Explicit qualitative and/or quantitative goals and timetables for lowering the toxicity of chemicals are in use.
- Steps are in place to continually evaluate chemical additives used to reduce toxicity, lower volumes or eliminate chemical use by adopting alternative technical methods.
- In procurement practices, a requirement for all service providers to specify and use reduced-toxicity fluids.
- Public disclosure takes place of all chemicals (including their concentrations) planned for use or used in fracturing operations. (Disclosure should happen both prior to fracturing operations and within 30 days of completion.)
- Full reporting takes place on the above, including:
 - progress made against goals and timetables;
 - identification of specific chemicals that have been eliminated;
 - quantification of the total number and percentage of shale gas wells that use less toxic fracturing fluids for the reporting period;
 - any changes in toxicity scores (where used as a progress metric);
 - the percentage of procurements for fracturing services that include requests for reduced-toxicity options;
 - the percentage of wells where there has been public disclosure of fracturing fluid ingredients, and
 - reports on spills, mitigation and lessons learned.

3.8 Water quality

Responsible companies will identify the baseline conditions in surrounding water bodies and drinking water sources and routinely monitor quality during fracturing and production. **Financiers could consider whether companies**:

- Select sites that are not located close to streams, wetlands and water wells.
- Informed by local geology, apply an appropriate distance between the land surface and the locus of hydraulic fracturing (i.e. the perforated production liner) to ensure groundwater quality is not affected. (e.g. One study recommends 1000 metres between land surface and location of fracturing, in order to take into account a maximum upward propagation of a stimulated hydraulic fracture of 600 metres, and a maximum fluid transportation distance of 200m multiplied by a safety factor of 2.)⁴⁴
- Conduct pre-drilling geological characterisation and water quality testing to determine baseline conditions, including potential risks from biogenic methane close to the surface.
- During initial construction of the top segment of the well, use only air, water or waterbased drilling fluids until beyond the base of potable groundwater aquifers.
- Install spill containment, including back-up containment.
- Report on water quality testing practices, including disclosure of any exceptions to routine testing, any compliance issues, prevention and remediation practices and any associated cost issues.

3.9 Freshwater Use

Responsible companies will draw the minimum potable water necessary to conduct fracturing operations, substituting non-potable sources to the fullest practicable extent. **Financiers could consider whether companies**:

- Use non-potable water sources as the default management choice for fracturing operations, whenever possible. (Non-potable refers to waters drawn from saline aquifers, treated industrial waste waters, flowback waters or other such sources.)
- Evaluate water use in the context of local water availability and overall water demand in the area.
- Fully disclose and report on quantities of water used in each appropriate reporting area (e.g. shale production zone, particular jurisdiction or watershed), giving specifications of the amount / percentage of water used, the nature of the source and implications for water scarcity.

¹⁴ http://www.shale-gas-information-platform.org/nc/newsletter/vorlage-send-single-newsrecord.html?sword_list[0]=1000

3.10 Waste water management

Responsible companies will take steps to store waste waters in secure closed containers, not in pits open to the atmosphere. They will take steps to recycle and reuse wastewater wherever possible. **Financiers could consider whether companies**:

- Have a clear policy on storing wastewater only in covered tanks and minimising other types of disposal.
- Have a program in place to transition wastewater storage from lined pits (if in use) to covered tanks.
- Review existing geological data before drilling deep wastewater disposal wells, and monitor to ensure their integrity and effective containment of waste waters. (*See Seismicity provisions, section 14, below.*)
- Recycle and reuse wastewater wherever possible and / or take care to ensure hazardous waste disposal practices.
- Monitor and disclose the chemical composition of waste waters to assess hazards and inform decisions on recycling, reuse and disposal, and assure compliance with wastewater management standards.
- Have emergency response plans in place to address spills and other waste-water related accidents.
- Report in aggregate on:
 - amount / percentage of water returned from wells;
 - percentage of operations where tanks are used to store wastewater;
 - progress in transitioning from pit to tank storage, and an explanation of the on-going use of pits;
 - percentage of operations where deep disposal wells are used, and explanation of monitoring
 - · any violations or fines associated with waste water storage; and
 - volumes and percentages of water recycling and reuse.

3.11 Solid waste and sludge residuals

Responsible companies will minimise the risks and impacts of solid waste and sludge residuals from drilling and fracturing operations, and fully characterise and track toxic substances.

Financiers could consider whether companies:

- Use closed-loop systems for management of drilling residuals.
- Monitor and track naturally occurring radioactive materials (NORM) in waste streams.
- Dispose of drill cuttings and other solid waste and sludge in licenced disposal facilities or, where regulation and oversight is weak, in facilities that meet recognised standards of best practice.
- Have emergency response plans in place to address spills and other solid waste and sludge residual-related accidents.
- Report on implementation of closed-loop systems and issues raised by monitored radioactive materials.

3.12 Air emissions, including fugitive methane

Responsible companies will monitor ambient air quality prior to and during operations, and seek to prevent and minimise the emission 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.

Financiers could consider whether companies:

- Undertake pre-fracturing atmospheric baseline measurements.
- Monitor, measure and report on air emissions from shale gas operations and the results of specific emission reduction measures to include greenhouse gases, methane, volatile organic compounds, emissions from BETX compounds (benzene, ethylbenzene, tolulene and xylene) and other toxic chemicals. (*See Appendix 2.*)
- Reduce site emissions by powering operations using natural gas or alternatives to diesel.
- Reduce transport emissions by substituting pipelines for truck transport, converting vehicle fleets to natural gas, and transporting chemicals in dry rather than liquid form

- Reduce well site emissions by using green completion practices, which eliminate flaring or venting via a closed loop system.
- Establish ambient air quality monitoring networks to provide routine data and track specific chemicals of concern.
- Establish a baseline for emissions of contaminants and routinely report on reduction strategies and results.

3.13 Local infrastructural impacts

Responsible operators will put a variety of measures in place to reduce and mitigate the impact of their operations on the well-being of local communities and infrastructure. **Financiers could consider whether companies**:

- Use multi-well drill pads where practical to help reduce the number of roads, pipelines and drill sites.
- Locate operations at least 1000 feet/300m from community amenities (schools, hospitals etc).⁴⁵
- Undertake voluntary road monitoring and maintenance programs.
- Schedule truck traffic around commuting hours or busy routes to reduce congestion.
- Provide appropriate workforce training to improve road safety and reduce likelihood of accidents.
- Share access roads and co-ordinate infrastructure planning with other companies.
- Find alternatives to truck delivery and removal, including water pipelines.
- Train the local workforce to fill shale development jobs.
- Provide housing for temporary workers.
- Noise abatement, including remote siting, noise cancelling barriers and equipment designs.
- Undertake dust mitigation measures and practices.
- Channel any impact fees to the appropriate authorities.

- Collaborate with local authorities or NGOs to undertake any additional measures or programs that address issues related to the social, economic and environmental well-being of indigenous populations and communities, and
- Report on the above, incorporating community commentary and feedback on the success of initiatives.

3.14 Seismicity

There are two types of seismicity associated with hydraulic fracturing. Microseismic events are a routine feature of hydraulic fracturing and are due to the propagation of engineered fractures. Larger seismic events are generally rare, but can be induced by hydraulic fracturing in the presence of a pre-stressed fault⁴⁶ or the deep well injection of wastewater.

Financiers could consider whether companies:

- Carry out site-specific surveys to characterise and identify local stresses and faults
- Monitor seismicity before, during and after hydraulic fracturing
- Implement a traffic light monitoring system, with information fed back to well injection operations so that action can be taken to mitigate induced seismicity as necessary
- Share data across operations, operators and regulators in a region to ensure an integrated approach⁴⁷.

3.15 Worker exposure to silica

Employers are responsible for providing safe and healthy working conditions for their workers and, as such, should determine which jobs expose workers to silica and take actions to control over exposure and protect workers. A combination of engineering controls, work practice, protective equipment and product substitution where feasible, along with worker training, is needed to protect workers who are exposed to silica during hydraulic fracturing operations. **Financiers could consider whether companies**:

- Meet the minimum requirements of occupational health and safety best practice (e.g. OHSAS 18001).
- Monitor the air to determine worker exposures to silica.

- Control dust exposures by improving existing engineering controls and safe work practices.
- Provide respiratory protection when needed to protect workers.
- Provide training and information to workers about the hazards of silica and other chemicals.

[NB.OSHA Hazard alert provides detailed advice and options⁴⁸.]

3.16 Biodiversity

Responsible companies will give attention to biodiversity concerns through their environmental impact assessment (see section 2.2.1) and careful ongoing monitoring. **Financiers could consider whether companies**:

- Give full consideration to biodiversity concerns in environmental impact assessments and subsequent monitoring.
- Store all fluids in a manner that restricts wildlife access, for instance by using closed containers rather than pits.
- Limit operating activities to specific time periods to reduce impacts on wildlife and livestock.
- Upon abandonment, restore sites using native plants, flora and fauna.

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4.0 Summary

This Guidance Note aims to identify some of the key responsible business practices whereby operators can mitigate risks associated with shale gas development, and to provide a basis for financiers to consider the performance of shale gas companies and operators based on the quality of their management approach and activities on the ground.

The development of the world's vast shale gas reserves presents a variety of economic, social and environmental challenges and opportunities – at global, national and local levels. While some countries and parts of society may welcome a sense of economic security and lower energy prices due to shale gas reserves, others are concerned about the impacts on their local ecosystems and communities, as well as implications for climate change.

Companies involved in shale gas production need to understand the complexity of risks and regulations associated with their operations – which will vary from community to community, and from country to country. In countries with weak governance or where there may be loopholes in regulation, companies need to take care to ensure a globally consistent standard of engagement and disclosure, and ensure involved communities and stakeholders understand and are satisfied with planned activities and practices.

By employing responsible business practices and collaborating with other operators and contractors across supply chains, companies can do their best to mitigate many of the environmental and social risks associated with shale gas production. However, there are clearly a set of macro-challenges – for instance, to do with the implications of shale gas for the global energy mix and climate change – which cannot be simply addressed by any single operator, but which need attention at the highest levels of government, business and civil society, and to which responsible companies should contribute.

At the time of publication, research and insights regarding the impacts of shale gas operations are fast-moving, and feedback and insights to help improve current levels of understanding are welcomed.

For more information or to provide your feedback and comments, please contact Climate Principles chair Jérôme Courcier: jerome.courcier@credit-agricole-sa.fr.

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- The Investor Environmental Health Network (IEHN) and Interfaith Centre on Corporate Responsibility (ICCR): *Extracting The Facts: An Investor Guide to Disclosing Risks from Hydraulic Fracturing* (2012)
- The Sustainable Investments Institute (Si2) and IRRC Institute *Discovering Shale Gas: An Investor Guide to Hydraulic Fracturing* (2012)
- The Investor Group on Climate Change, the Institutional Investors Group for Climate Change (IIGCC) and CERES' Investor Network on Climate Risk – *Controlling Fugitive Methane Emissions in the Oil & Gas Sector* (2012)
- The Royal Academy of Engineering and The Royal Society *Shale Gas Extraction in the UK: Review of Hydraulic Fracturing* (2012)

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Appendices

1. Regulatory approaches to shale gas development⁴⁹

(Reserve figures based on US EIA data)

- **Argentina** is likely to have the world's third largest reserves of unconventional gas, with some 774 tcf/22 tcm of estimated recoverable reserves The government has launched its Gas Plus programme, which promises to give a price guarantee for newly discovered gas. About 50 projects are approved under the scheme, a large proportion of which correspond to non-conventional gas fields.
- **Australia** has 396 tcf/11 tcm of technically recoverable shale gas reserves, equivalent to about 46% of US reserves. Widespread fears about the impact of hydraulic fracturing on water supplies have resulted for calls in moratoria in several states, and a temporary moratorium is currently in place in eastern New South Wales. Although the shale gas industry has grown in recent years, high costs and a lack of infrastructure mean that significant production is still expected to be about a decade away.
- **Britain** has some shale gas reserves in north west England. A temporary moratorium was put in place after exploration triggered a small earthquake in the area, but after a review, the moratorium was lifted in December 2012. Applicants for a fracking licence in the UK need to obtain environmental, local authority, government and safety authority approvals, and also have to disclose the content of fracking fluids to the Health and Safety Executive.
- The **Bulgarian** government banned shale oil and gas exploration through hydraulic fracturing in January 2012 due to environmental concerns and widespread protests. The government cancelled a shale gas exploration permit to Chevron at Novi Pazar for which estimates showed reserves of 1 to 3 tcf/.28 to .85 tcm.
- In January 2012, **China** approved shale gas as an independent mining resource, a legal status that may allow more Chinese firms to develop the unconventional energy resource. While foreign companies would not be able to participate in the tenders, they could partner with winning Chinese firms.
- The **French** government confirmed a five-year moratorium in the face of concerns about potential environmental damage. As a result, it cancelled several shale exploration licences with major companies.
- In **Germany**, while there is no explicit prohibition of hydraulic fracturing, the country has stopped all work pending the findings of a working group of scientists, industrialists and politicians.

- **Poland** does not have any laws relating specifically to shale gas, but has launched work on a new tax on shale gas and other hydrocarbons. Its estimated reserves of 187 tcf/5.3 tcm are Europe's largest of known unconventional gas and could feed domestic consumption for some 300 years. The government has awarded over 100 concessions to mainly foreign companies.
- **South Africa** lifted a moratorium on shale gas exploration in the Karoo region in September 2012⁵⁰.
- Shale gas drilling in the **United States** is mainly regulated on a state-by-state basis The Environmental Protection Agency is currently studying hydraulic fracturing and its impact on drinking water, with final analysis due in 2014. The Interior Department is also updating rules for fracking on public land. A few states do not allow fracking; New York has a moratorium in place. Other states have implemented regulations to pay more attention to drilling until federal regulations are clarified. Many states, including Texas and Colorado, require at least some disclosure of the chemicals used in fracking.
- Ireland, Austria, the Netherlands, Sweden, Denmark, Spain and Hungary are all open to exploration.

2. Methane Leakage & Venting Avoidance

 $(Drawn from: Oil \& gas sector methane leakage \& venting avoidance – best practice disclosure framework^{51})$

Methane can leak from a wide variety of locations in oil and gas installations, and can often go unnoticed, particularly if leakage is to the open air. Various fugitive emission abatement technologies exist to help control such emissions. The following technologies and techniques could reportedly account for nearly 80% of methane leakage in the gas sector:

- Regular monitoring can cut leakage, together with leak sensors in the most leakprone areas.
- Reduced emission well completions (REC) also known as 'Green Completions' eliminates venting during hydraulically fractured gas well completion and workovers, by introducing a closed loop system.
- Over time, gas wells accumulate water and condensate, reducing productivity. Blowing down wells to remove this build-up leads to venting methane. Plunger lifts and other artificial lift systems avoid this venting by lifting liquids to the surface without opening the well to the atmosphere.

⁵⁰ 'South Africa warms to shale gas,' Sylvia Pfeifer and Andrew England, The Financial Times, 24 September 2012

^{&#}x27;Oil and gas sector methane leakage and venting avoidance – best practice disclosure framework', Investor Group on Climate Change / Institutional Investors Group on Climate Change / Investor Network on Climate Risk, 2012

- Various pneumatic devices are used to control gas and liquid pressures and flows these are designed to vent methane in certain circumstances and may be high-bleed or low-bleed, according to high or low levels of venting. High-bleed controllers can be replaced by low-bleed ones to reduce methane venting.
- Reciprocating compressors used widely in the gas sector leak methane from a component called a rod packing case. Regular inspection and replacement of rod packing equipment greatly reduces leakage.
- Methane is vented during the maintenance, extension and repair of gas pipelines, and can be avoided using appropriate technologies.
- An additional range of technologies may account for the remaining 20% of methane leakage in the sector, such as: desiccant dehydrators to capture emissions from dehydrators; dry seal systems to reduce emissions from centrifugal compressor seals; vapour recovery units above storage tanks; and controls that capture emissions from tri-ethylene glycol (TEC) dehydrators.

3. Truck Traffic Volumes

52

The Division of Mineral Resources⁵² within the New York State Department's Environmental Conservation Department has appraised the volume of truck traffic associated with building a pad for shale gas operations, and also for each well drilled from that pad:

Purpose	Truck trips			
	Per well		Per pad	
	Low	High	Low	High
Drill pad and road construction equipment			10	45
Drilling rig			30	30
Drilling fluid and materials	25	50	150	300
Drilling equipment (casings, drill pipe etc)	25	50	150	300
Completion rig			15	15
Completion fluid and materials	10	20	60	120
Completion equipment (pipe, wellhead)	5	5	30	30
Hydraulic fracture equipment (pump trucks, tanks)			150	200
Hydraulic fracture water	400	600	2400	3600
Hydraulic fracture sand	20	25	120	150
Flow back water removal	200	300	1200	1800

Supplemental generic environmental impact statement on the oil, gas and solution mining regulatory program, published in 2009 by the New York State Department of Environmental Conservation Division of Mineral resources

Guidance note for financiers

4: Case study - The Karoo Risks, concerns and challenges in a shale-gas region

Shale gas development has had a rocky history in South Africa's Karoo Basin, an impoverished, arid and sparsely populated area in the west of the country. The push to open the Karoo to shale gas development, spearheaded by Shell, was controversial from the start. Encompassing a surprising blend of technical, cultural, political and environmental concerns, the case against fracking in the Karoo included:

- Water scarcity⁵³: With agriculture and livestock as the region's largest sources of income, the potential competition for freshwater took on significance.
- Political disenchantment⁵⁴: Local communities held the South African government suspect, so distrusted its negotiations with Shell over their homeland.
- **Unclear local benefit**⁵⁵: While the case for the economic benefits to the country overall could be made convincingly, the same was not true of local rural communities.
- Seismic and radio frequency disturbance⁵⁶: Many national and international astronomers launched objections, given the close proximity of the Square Kilometre Array (SKA), an international space observatory under construction, and the sensitivity of its equipment to disturbance from fracking activity.

Importantly, the anti-fracking campaign was comprised of otherwise lowprofile, highly local, community-based organizations, rather than major international NGOs. Its spokespeople included South African notables and celebrities with roots in the region; and it made effective use of social media to spread its message and keep awareness levels high across the country⁵⁷.

In the face of vocal campaigning from the public and opposition politicians, the government announced a moratorium on hydraulic fracturing across ¥

Linley, Dayna, 'Fracking Under Pressure: The Environmental and Social Impacts and Risks of Shale Gas Development,' Sustainalytics, August 2011.

^{&#}x27;South Africa warms to shale gas,' Sylvia Pfeifer and Andrew England, The Financial Times, 24 September 2012.

Econometrix (Pty) Ltd., 'Karoo Shale Gas Report: Special Report on Economic Considerations Surrounding Potential Shale Gas Resources in the Southern Karoo of South Africa,' January 2012.

^{&#}x27;Mining plans pose threat to South African astronomy site,' Linda Nordling, Nature, 22 March 2011. 57

Guidance note for financiers

South Africa in April 2011⁵⁸. In the year that followed, Shell commissioned independent research to demonstrate the economic benefits to the proposed development; as well as opinion polling on South Africans' disposition toward natural gas extraction. The moratorium was lifted in September 2012, but faces the likelihood of lengthy appeals by shale gas opponents in the months to come⁵⁹.

'S. Africa imposes "fracking" moratorium in Karoo,' Ruona Agbroko, Reuters, 21 April 2011.

58

59