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Shale Gas – A Global Perspective

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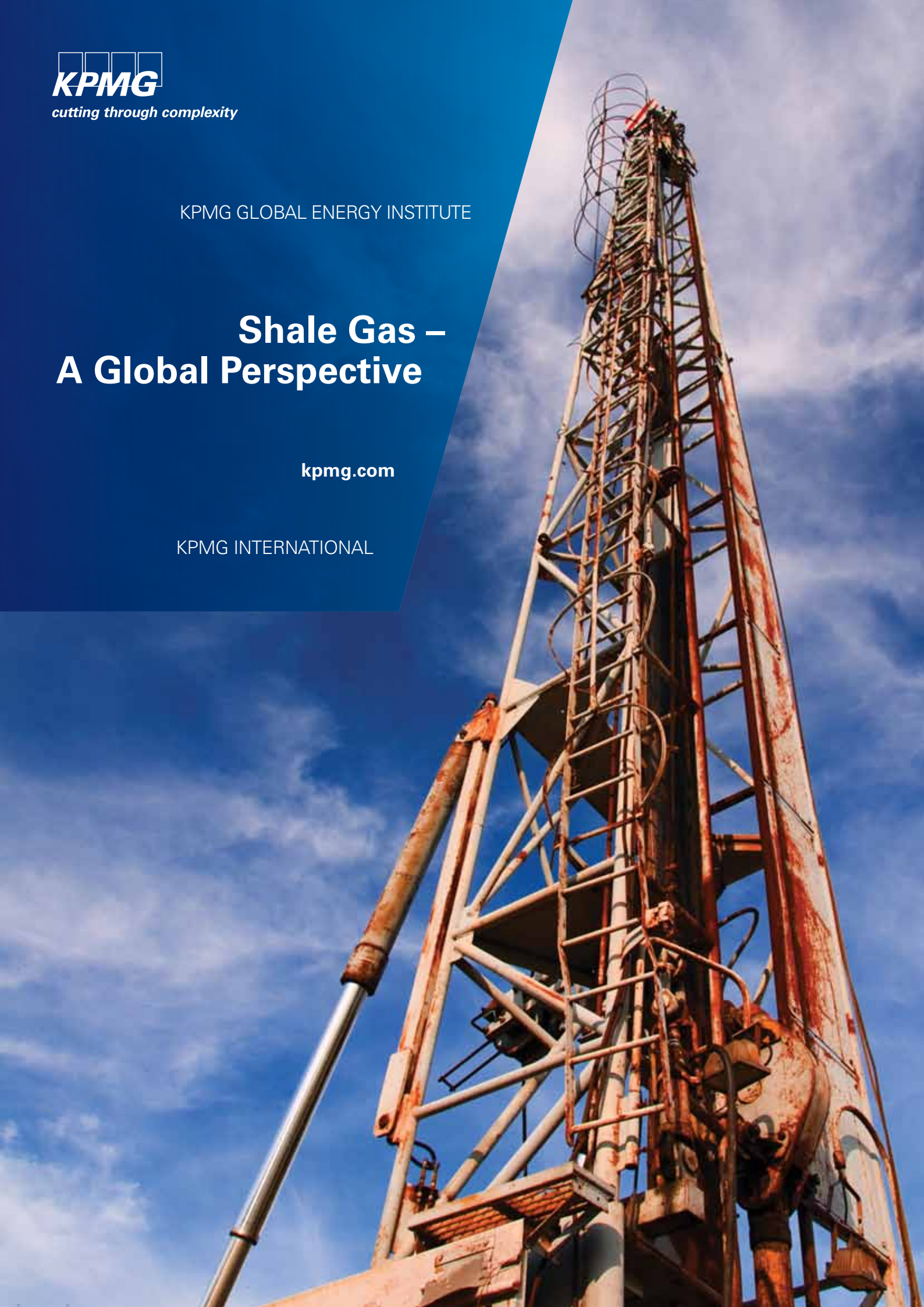

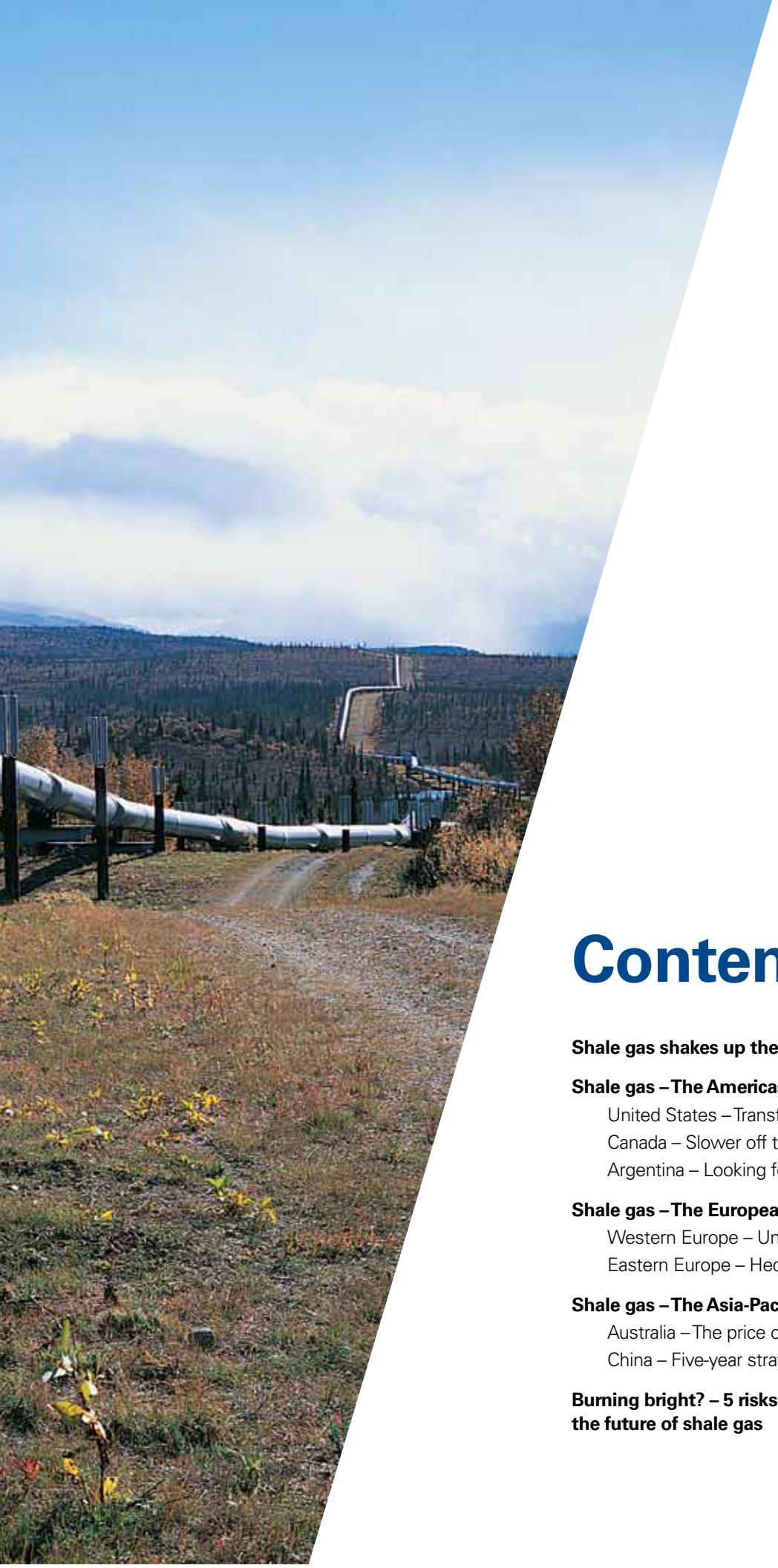

Contents

Shale gas shakes up the **world energy markets**

Shale gas has the potential to turn the world's energy industry on its head. It's abundant. It's cheap. It burns cleaner than fossil fuels. And it's being found almost everywhere.

But for shale gas to become the game-changer that some analysts predict, the industry has to surmount tremendous reputational and regulatory hurdles. And there are no guarantees that natural gas prices will ever rise high enough to make the high costs, financial risk, and extended development periods worth the returns. Even still, with the prospects of substantial profits and stable, secure supplies, players at the national and industry levels are placing their bets.

By offering countries a cheap, carbon-friendly way to help meet their energy needs, shale gas has the potential to displace fossil fuels in selected locations and potentially slow the development of renewable sources. With shale gas deposits being found in areas that previously had no exploitable gas reserves, shale gas production could turn countries that traditionally import natural gas into producers, making them more self-sufficient with domestic supplies. And shale gas deposits are being found in both mature and underdeveloped energy markets, opening the potential to level the playing field when it comes to supply and demand.

For shale gas to become the game-changer that some analysts predict, the industry has to surmount tremendous reputational and regulatory hurdles.

Shale gas has become a viable energy source due to the use of hydraulic fracturing, or "fracking", technology to extract it. Fracking technology, has been used in oil reservoirs and tight formations for many years without raising any significant concerns compared to the more traditional methods of extraction. Increased scrutiny on the environmental impact of the technology and its potential to cause greater environmental harm in the shale gas context – with its shallower deposits, greater permeability and more superficial formations – is a result of the greater role this energy source could play in a country's overall energy mix as discussions about energy security and resource scarcity continue to gain momentum on the world stage.

All energy production creates safety and environmental risks. The extent to which shale gas will be a larger component of the energy mix will depend, to a certain extent, on the environmental protection versus economic growth trade-off. In some countries, such as France, environmental concerns have caused regulators to suspend or ban hydraulic fracturing in some areas completely. Other countries, such as Argentina and China, may be willing to take on greater environmental risks to advance shale gas production in order to become more self-sufficient and to meet rising energy demands. An attractive side benefit of full-scale production is the substantial number of new jobs that full-scale production would open for low-skilled workers in these countries.

For companies subject to greenhouse gas emission reduction targets, natural gas usage may offer more "tick-the-box" benefits than traditional fossil fuel sources.

Once captured and processed, natural gas is one of the cleanest burning and lowest carbon content fossil fuels. In addition to the economic benefits, developing new natural gas supplies may provide a means to help countries meet their greenhouse

gas emission targets. For companies subject to greenhouse gas emission reduction targets, natural gas usage may offer more "tick-the-box" benefits than traditional fossil fuel sources. At the consumer level, regions that rely on oil-based heating, such as parts of the United States, could bring their emissions down by encouraging homeowners to convert to natural gas heating. Additional incentives could be granted to encourage the development and sale of natural gas-powered vehicles.

In the following pages, we examine the current state of shale gas development in selected countries of the world. We also offer our views on the prospects of shale gas as part of the world's energy mix – and whether this source of energy really is the game-changer that some have claimed. In the final section, we highlight five key risks that could impact the future viability of shale gas production:

1. If and when natural gas prices will rise in North America is the big unknown – currently supply outstrips demand.
2. How shale gas development will impact investment in renewable energy sources and how much environmental regulation shale gas-related activities will attract are also uncertain.
3. With price uncertainty, managing costs and financing risks are top priorities for the industry.
4. The level of future shale gas development will hinge on the industry's ability to control reputational risk and manage public opinion by minimizing environmental and community impact.
5. As shale gas transforms supply and demand of the world's energy mix, geopolitical factors will continue to create risk.

Shale gas production – Key success factors

In this publication, we examine the current conditions and outlook for the shale gas production in the Americas, Europe, and the Asia-Pacific regions. In evaluating the environment and prospects for the shale gas industry in various parts of the world, the following factors are critical.

Supply	Shale gas plays must be big enough to warrant the tremendous investment in time and money required to extract and fully exploit it. The play should be sufficiently close to markets to facilitate distribution.
Demand	Natural gas prices are currently depressed in some regions (e.g. the Americas), and the wealth of newly viable shale gas plays could drop prices even farther. But as oil and gas production from conventional sources continues to decline, the local price of natural gas relative to other energy sources will dictate whether the long-term investments required to develop and exploit a play will produce sufficient returns.
Infrastructure	Shale gas production and distribution requires more than wells. Production sites must be adequately serviced by roads and pipelines, for example, and special processing and transportation facilities are required to liquefy natural gas for marine transport.
Regulatory support	Private companies need their country's support to develop large-scale shale gas production capacity. A well-developed, stable regulatory regime, predictable access to permits and licenses, and government subsidies for exploration and development are crucial.
Reputational risk	While the environmental safety of shale gas production is still under study, many shale gas developers are meeting strong opposition from environmental groups on the basis of health and safety concerns related to hydraulic fracturing technology and water usage.
Geopolitical context	For many countries that rely on natural gas imports, energy security is a concern. Shale gas could help them become more self-sufficient. On the other hand, countries that are traditional oil and gas exporters will need to react to their changing markets. The resulting political issues could radically alter relations between countries.

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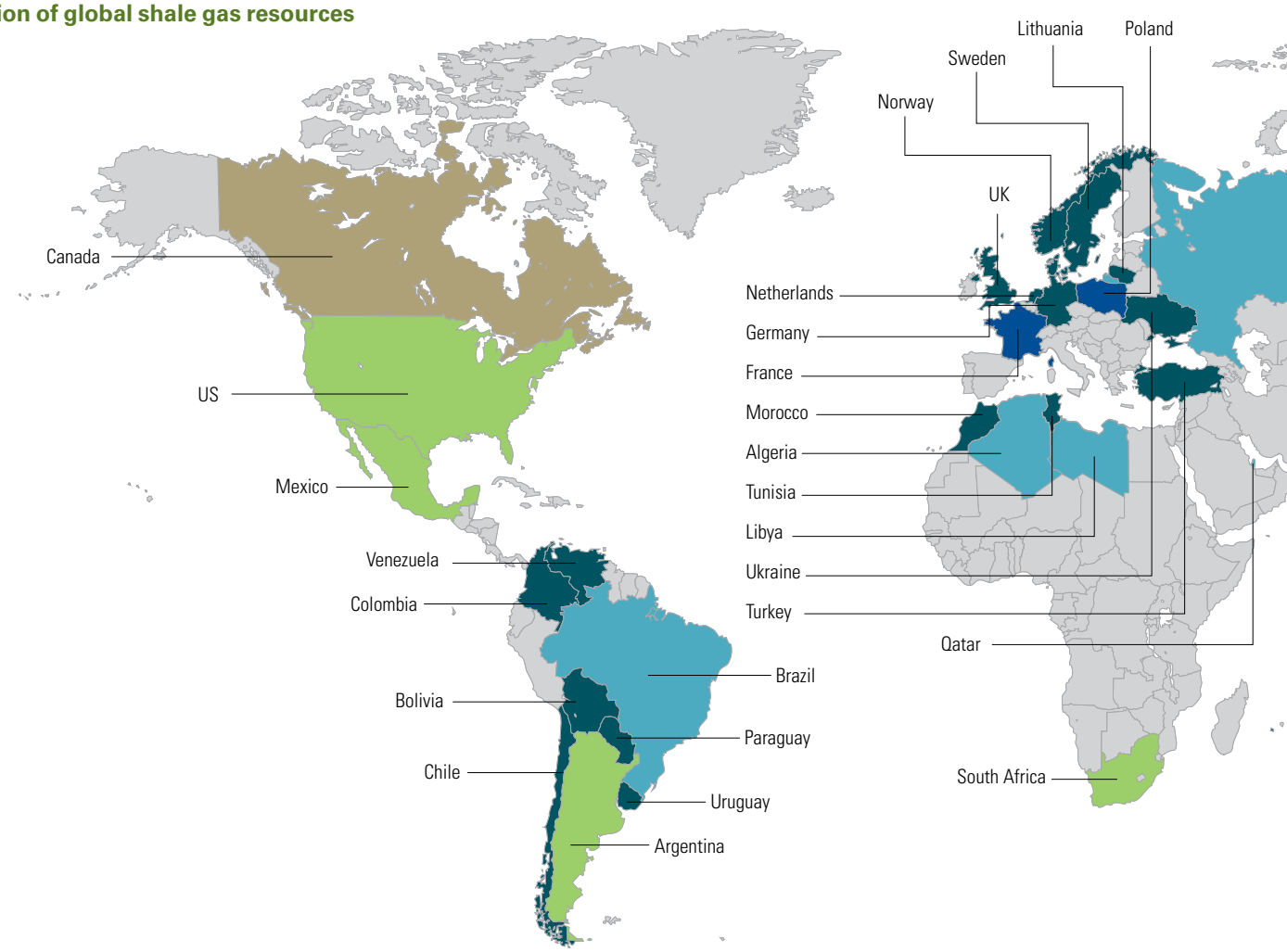
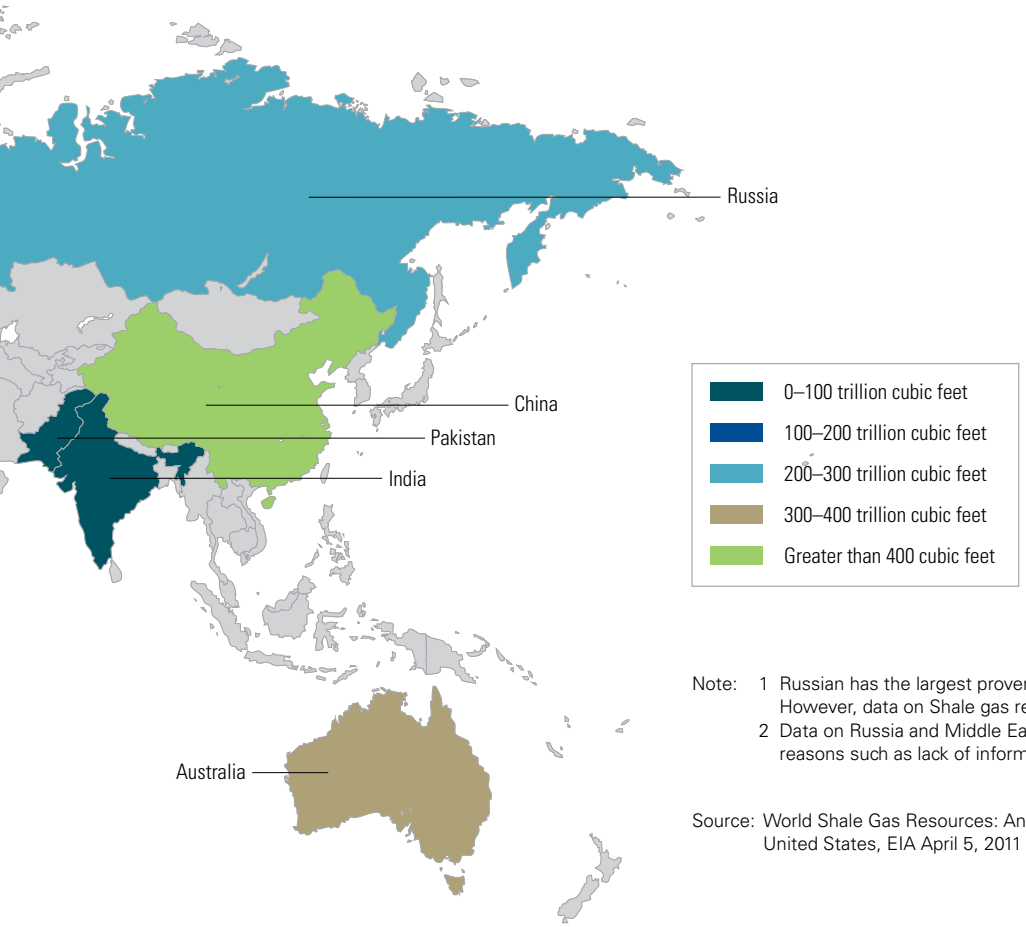
Distribution of global shale gas resources



Technologically recoverable global shale gas reserve estimates

Country	Shale Gas Reserves, Trillion cubic feet
France	180
Poland	187
Brazil	226
Algeria	231
Libya	290
Canada	388
Australia	396
South Africa	485
Mexico	681
Argentina	774
US	862
China	1,275
Others	647

Source: World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States, EIA, April 5, 2011



Note: 1 Russian has the largest proven natural gas reserve of nearly 1570 tcf. However, data on Shale gas reserve is not available.
2 Data on Russia and Middle East was not provided by EIA, due to reasons such as lack of information availability.

Source: World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States, EIA April 5, 2011

Hydraulic fracturing – What are the environmental risks?

Natural gas is in many respects a clear and efficient burning fuel and has the potential to lower carbon emissions with fuel switching plays. However, risks remain since shale gas development around the world has met with fierce opposition from local residents and environmental groups due to environmental concerns over the hydraulic fracturing, or "fracking", process.

Fracking involves drilling a well bore into the reservoir rock formation and then forcing water, sand and chemicals into the well at high pressure to create fractures or fissures in the rock. Once the fracture is open, the released gas flows out of the fractures and into the well bore. In addition to shale gas, the process has recently been applied to extract gas from coal seam and tight sand deposits.

With the impact of fracking operations still under study, the jury is out on the extent to which the process may be harmful to the environment. Some specific concerns being raised by environmental groups, media, and regulated companies are as follows:

Groundwater Contamination
Some have asserted that fracking chemicals used in the process could leak into underground rivers and reservoirs and ultimately into drinking water supplies. The health effects of long-term exposure to chemicals commonly used in fracking are being evaluated by regulatory agencies.

Gasification
When gas migrates into groundwater, the build-up of pressure due to gasification may lead to tremors or explosions. Aquifer gasification due to shale gas development has been cited as a potential cause for recent minor seismic activity in the United Kingdom, though these claims are largely uncertain at this point and being investigated.

Water Usage Risks
Fracking can be water intensive depending on the water management methods used. This may pose risks in water restricted areas.

Surface Water and Soil Risks
Risks may also arise from the volume of chemicals that need to be stored at the drilling site and from the liquid and solid waste produced during drilling and fracking.

Spills and Blow-outs
Well blow-outs can cause spills that could spread into the surrounding soil and into wetlands, streams and waterways. There are also concerns that wastewater kept in storage ponds could overflow in high rains.

Shale gas – The Americas perspective

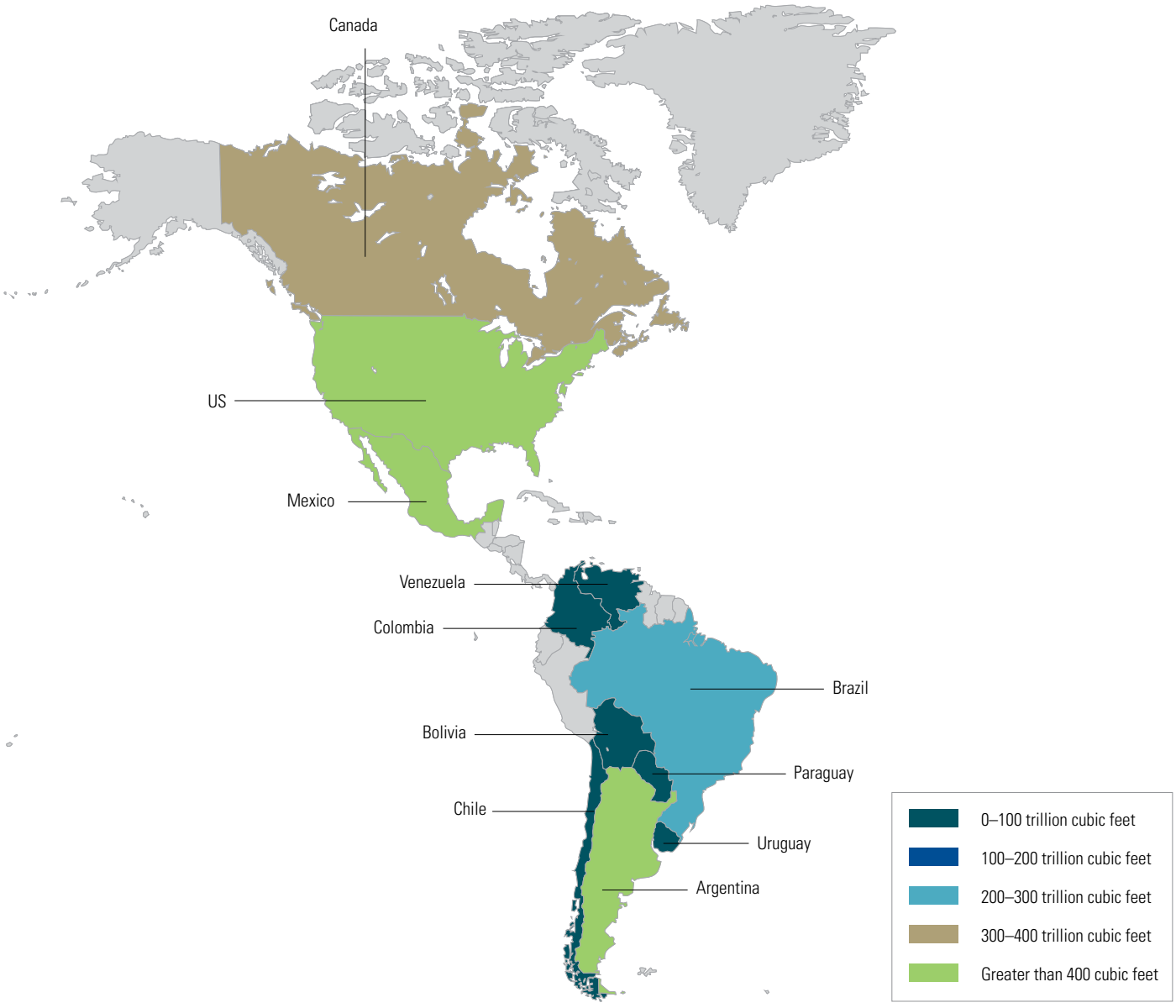
United States – Transforming from importer to exporter?

In the United States, companies have unlocked access to rich shale gas reserves and there is tremendous activity as the country ramps up for full-scale production. Shale gas is in the midst of a boom across the country, with existing reserves being put into full production in Pennsylvania, Louisiana and Texas, and with new reserves being discovered, recently, for the Marcellus, Eagle Ford, and Utica reserves.

The United States mostly relies on oil, gas and coal—which are less expensive and more abundant. Renewable energy technologies, such as solar, wind, geothermal and biomass power generation, are gaining traction, but are not yet viable at a utility scale level to play a significant role in the country's energy mix in the near future.

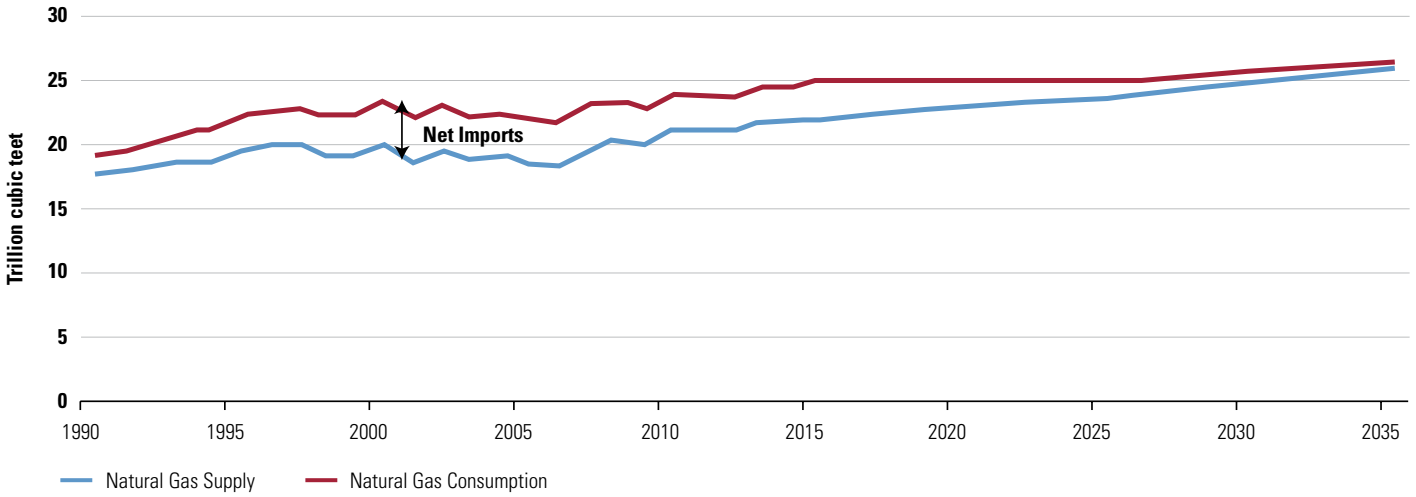
There are signs that the United States is poised to become significant player in the global natural gas market.

Therefore, shale gas production has the potential to transform the energy market in the United States and beyond. The United States has traditionally relied on imports, primarily from Canada, for its natural gas needs. The size of US shale plays and the recent investments in developing them could make the United States self-sufficient. In 2008, the country imported 13 percent of its natural gas supply. That figure is expected to drop to nearly 1 percent by 2035. There are signs that the United States is poised to become significant player in the global natural gas market. The United States has been working to repurpose some natural gas processing and conversion facilities, originally designed for imports, to handle exports of shale gas in the form of LNG.



Source: World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States, EIA April 5, 2011

Projected US net imports of natural gas



Sources: Annual Energy Outlook 2011, Reference Case Presentation, EIA, Decemeber 26, 2010, Technically Recoverable Shale Gas Resources Jump 134 Percent. Canadapress, May 16, 2011

Forecasts for Consumption of Various Energy Sources in the US, Figures in Quadrillion British Thermal Units (Btu)

Year	Natural gas	Oil	Coal	Nuclear	Wind	Hydro
2015	25.77	39.10	19.73	8.77	1.40	2.92
2020	26.00	39.38	20.85	9.17	1.41	3.00
2025	25.73	39.84	22.61	9.17	1.49	3.04
2030	26.58	40.55	23.39	9.17	1.54	3.07
2035	27.24	41.70	24.30	9.14	1.59	3.09

Note: Oil includes petroleum-derived fuels and non-petroleum derived fuels, such as ethanol and biodiesel, and coal-based synthetic liquids and Petroleum coke. Also included are natural gas plant liquids and crude oil consumed as a fuel.

Sources: Annual Energy Outlook 2011, EIA.

The speed and scale of US shale gas development is straining the resources of potential producers, requiring them to quickly boost their manpower and technological capabilities. The average age of US oil patch workers is rising, and the pool of workers with the right middle management skills is shrinking. Specialized equipment for drilling, processing and transporting shale gas is in short supply. Companies are wrestling with growth and struggling to continue to meet internal business needs. Keeping up with the volume of activity is straining their internal systems and processes. Other issues include procurement and strategic sourcing issues, reorganizing capital spending, and tax planning.

More regulation is expected that will require more disclosure related to environmental impacts in general and water issues in particular.

As with all energy sources, shale gas in the United States is receiving strong focus from NGOs (non-governmental organizations) and government agencies, and such opposition can delay the permitting and production schedule.

For example, many states such as New York, Texas and Pennsylvania, which have sizable plays near populated centers, are poised to potentially impose additional state-level regulation regarding water and air emissions on existing and new operations. In addition, the US EPA has been petitioned by environmental groups to regulate disclosure of chemicals used in the fracking process and is also in the process of drafting regulations for additional regulation of air emissions.

It is expected that the trend of new regulations and disclosure requirements will continue with respect to water usage and fracking chemicals, in addition to air emissions (specifically Volatile organic compounds (VOC) emissions).

The risk remains that an issue in one company within a shale play quickly becomes the issue of the entire shale play due to the degree of NGO attention in these shale play geographies. However, US producers can take steps to manage public perceptions and potential reputational harm by proactively educating local officials and working with community groups to understand and mitigate concerns where possible. These companies can also help maintain a positive image by adopting transparent corporate sustainability reporting processes, proactive operational practices, and strong stakeholder engagement processes.

Despite these concerns, US energy companies are moving full steam ahead to develop domestic shale gas capabilities. Some of these companies are also looking beyond their borders to invest in countries like China and Argentina, which have sizable shale gas reserves but largely undeveloped production capabilities.

Canada – Slower off the mark

Canada is the world's third largest producer of natural gas, with an average annual production of 6.4 trillion cubic feet.[1] Canada has traditionally been known to possess significant conventional gas reserves, and the country was a key supplier of natural gas to the United States for decades until the recent shale boom in the country. Canada now trails the United States in developing its nascent shale gas resources. But with conventional natural gas sources in decline, Canada's industry is turning to unconventional sources, including shale gas.

While large-scale commercial production of shale gas in Canada has not yet started, many companies are now exploring for and developing shale gas resources in Alberta, British Columbia, Quebec, and New Brunswick. According to Canada's National Energy Board (NEB), development of shale gas, and other unconventional resources, will help ensure supplies of natural gas are available to the growing North American natural gas market for many decades. The NEB predicts that shale gas will likely help the country meet its domestic requirements for natural gas "far into the 21st century."[2]

Forecasts for delivered energy consumption by sources in Canada, Quadrillion British Thermal Units (Btu)

Year	Natural gas	Oil	Coal	Nuclear	Renewable
2015	3.6	4.5	1.0	1.3	4.3
2020	3.8	4.4	1.0	1.4	4.9
2025	4.3	4.4	1.0	1.5	5.2
2030	4.7	4.5	1.0	1.7	5.7
2035	5.2	4.7	1.1	1.8	6.0

Sources: International Energy Outlook 2011, EIA.

Early drilling at Quebec's Utica shale reserve shows promise. Preliminary estimates suggest the reserve could hold more than 20 trillion cubic feet of recoverable gas. Producers are proceeding with caution, but if estimates are correct, shale gas development in eastern Canada could tilt the balance of production away from the western provinces. Quebec now has next to no infrastructure to support extensive production, but the province's proximity to the Ontario and northeastern US markets make it well situated to exploit its shale gas deposits.

1 Canadian Association of Petroleum Producers, at http://www.capp.ca/canadaIndustry/naturalGas/Pages/default.aspx#6eM9ROT7pZEr
2 National Energy Board, *A Primer for Understanding Canadian Shale Gas* (Government of Canada, November 2009).

With US production rising, Canada will need to develop other markets for its excess natural gas supplies.

Canada currently exports about 50 percent of the natural gas it produces, but it lacks the processing facilities to liquefy and ship liquefied natural gas (LNG) beyond North America. With US production rising, Canada will need to develop other markets for its excess natural gas supplies, and there are signs that the industry is preparing to invest in the necessary infrastructure. In October 2011, the NEB issued the first long-term license to export LNG, clearing the way for a proposed $5 billion project to develop an LNG export terminal in northeastern British Columbia. This terminal would allow Canada to export LNG to Japan, South Korea and China, allowing Canadian producers to enter markets beyond the United States for the first time.

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With their rising energy demands and higher natural gas prices, the rapidly developing countries of Asia could present strong prospective markets for Canadian LNG. In 2010, for example, Japan's LNG prices averaged USD$10.91 per million British thermal units (MMBtu), compared to Canada's natural gas price average of USD$3.69/MMBTU.[3] However, Canada can expect to face fierce competition in the region if Australia and China also boost production to serve the Asian market.

Argentina – Looking for a rise

Deposits in Argentina are projected to be so big that development will be very important to the country's economy.

Preliminary exploration in South America suggests that sizable shale gas deposits lie beneath several countries including Argentina, Brazil, Colombia and others. In fact, shale reserves in Brazil are estimated to be the second biggest in the region after the United States, but there has been little interest or investment in exploring this resource. Argentina is the only South American country that seems set to embark on full-scale shale gas production, primarily in the Neuquén Basin.

Deposits in Argentina are projected to be so big that development will be very important to the country's economy. Although some shale gas wells have already been developed, Argentine producers will need to conduct more drilling and hydraulic fracturing to develop its shale gas reserves. In a 2011 survey of oil and gas executives conducted by KPMG in Argentina, most respondents said they expect shale gas production to occur within three to five years.[4] As in other parts of the world, most shale gas projects in Argentina are being undertaken as joint ventures, including large global energy entities.

Argentine politicians appear to support shale gas development. Given Argentina's current reliance on expensive natural gas imports from Bolivia and Qatar, Argentina is putting a priority on developing its own sources. In fact, all shale gas projects that come on line will be included in Argentina's Gas Plus framework – a government initiative that allows better selling prices for new offers of this fluid.

While some opposition to fracking technology has been expressed in the media, most reports echo concerns being raised in the United States and local opposition on the ground seems to be minimal.

In our view, the development of shale gas in Argentina will be valuable to the country and occur at reasonable prices. Further, given the Argentine government's willingness to support these projects, we expect that shale gas field development will continue to be allowed.

[3] German Federal Office of Economics and Export Control (BAFA); Energy Intelligence Group, *Natural Gas Week*.
[4] KPMG in Argentina, Energy and Natural Resources Survey 2011, available online at: www.enr-kpmg.com.ar

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Shale gas – The European perspective

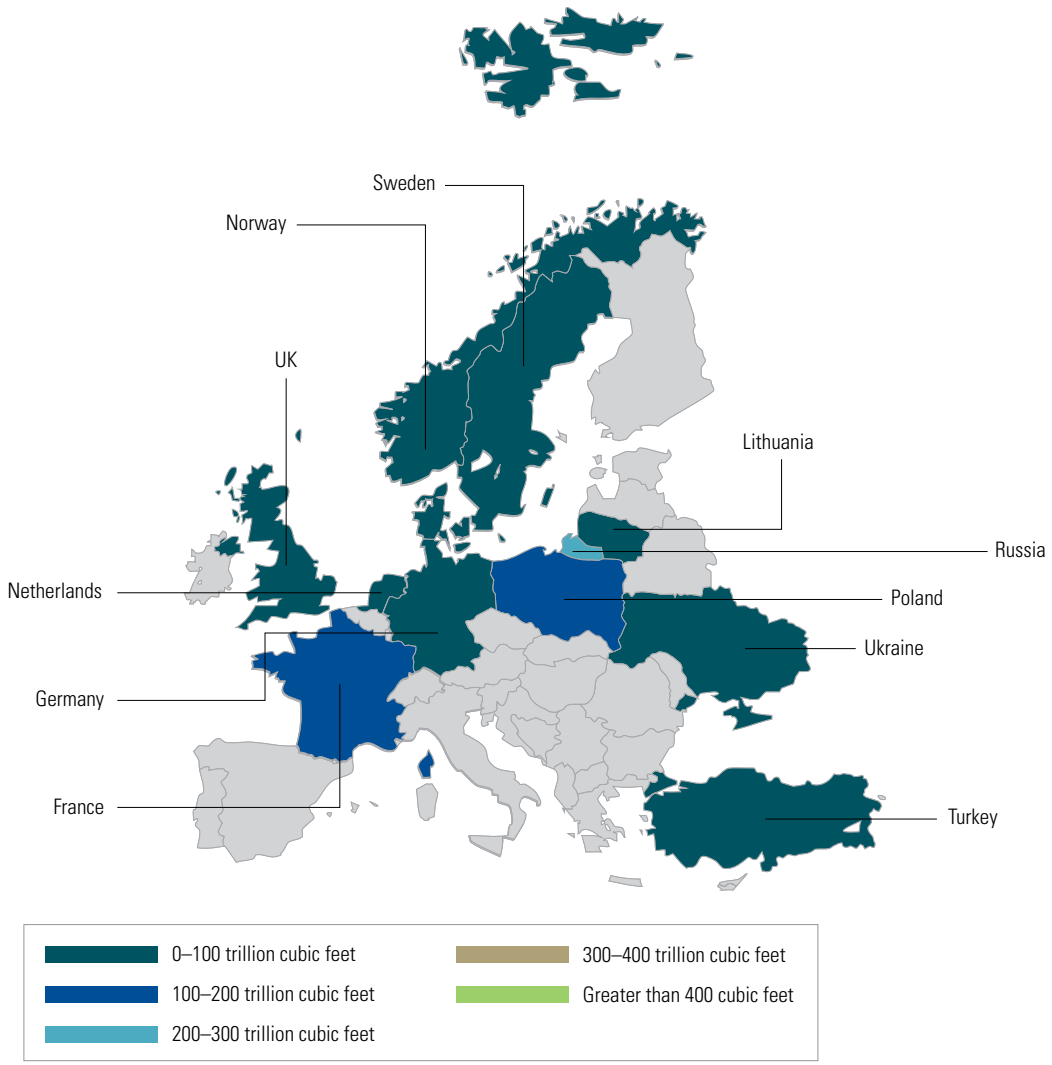
Western Europe – Uncertain future

Greater competition, high production costs and low margins are curbing the appetite for investment shale gas production start-ups.

In Western Europe, sizable quantities of shale gas and other unconventional fuel supplies have been reported in the United Kingdom, the Netherlands, Germany, France, Scandinavia and Norway. Exploration activity is occurring, primarily through joint ventures to share risk and know-how. But due to a wide range of economic, environmental and regulatory obstacles, the prospect of large-scale shale gas production remains doubtful. Additionally, European investors are watching the United States to see if US players decide to develop the country's capabilities as a natural gas exporter. Greater competition, high production costs and low margins are curbing the appetite for investment in shale gas production start-ups.

France banned hydraulic fracturing, as of July 1, 2011, including its use for research purposes.

Compared to the United States and Australia (discussed in the next section), the regulatory regime in Europe is relatively undeveloped. Companies are forced to work without a predictable regulatory framework, and, even within the EU, there is no universal approach. Access to exploration permits and development licenses is uncertain, creating significant regulatory risks.



Source: World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States, EIA April 5, 2011

As reserves in France, Scandinavia and elsewhere in Western Europe tend to be close to populated areas and as European environmental laws tend to be quite strict, the potential for significant shale gas development there in the near future seems unlikely. Even though shale gas production is largely undeveloped, the US environmental debate has crossed over to Europe, and environmental groups have been publicizing concerns over the chemicals used in fracking techniques. France banned hydraulic fracturing, as of July 1, 2011, including its use for research purposes.

Environmental concerns aside, European countries also lack skilled resources and the infrastructure, creating questions over the long-term economic viability of shale gas ventures. While there is a hope that technological innovations could bring down the costs of shale gas production, this is not likely to happen in the short term.

In the United Kingdom, shale gas production has commenced at the Blackpool aquifer in Lancashire, and new shale gas deposits have been recently found in the Mendips. Production at the Blackpool aquifer was voluntarily suspended due to concerns that the operation was causing seismic activity, but this claims has not been proven.

In May 2011, a UK parliamentary committee has said it found no evidence that fracking poses a direct risk to underground water aquifers, provided the drilling well is constructed properly.

In May 2011, a UK parliamentary committee looking into the risks and benefits of shale gas said it found no evidence that fracking poses a direct risk to underground water aquifers, provided the drilling well is constructed properly. The committee concluded that, on balance, a moratorium in the UK is not justified or necessary at present.

The committee also concluded that, based on estimates of the UK's onshore shale gas resources, there will not be a "shale gas revolution" in the UK based on domestic resources alone – nevertheless, developing shale gas reserves could make the country more self-sufficient by reducing its reliance on imported natural gas.

Eastern Europe – Hedging bets

In eastern Europe, Poland's shale gas development potential is high on radar screens, while Turkey and the Ukraine have some potential. Russia's dominance of the conventional gas production could present obstacles for companies seeking to develop shale gas production capacity in the region. Ultimately, the future of shale gas production in Europe rests on whether US producers decide to develop their potential to export liquefied natural gas to European markets.

Perhaps more than any other European country, Poland has sizable shale gas reserves that it is actively seeking to exploit.

Shale gas poses a significant threat to Russian interests in conventional gas production, and Russian politicians have become quite vocal in European debates over shale gas production's environmental safety. Further, nearly 25 percent of the natural gas flowing into Europe via Ukraine is transported by Gazprom, the Russian national gas transmission company. In the past, Europe has often been held hostage to decreased gas supplies due to contract disputes between Russia and Ukraine.

Perhaps more than any other European country, Poland has sizable shale gas reserves that it is actively seeking to exploit. Seeking to diminish the country's reliance on Russian imports, private companies in Poland are working to develop the industry in cooperation with scientists, private research and development, state labs and geological services and regulators. If Poland, Hungary, and other countries are able to develop commercial shale gas production capabilities, Russia's influence on Europe could diminish.

In Russia itself, investors in the oil and gas industry are divided about shale gas' long-term potential. Some Russian players do not think the opportunity for shale gas is significant, especially given the current price of natural gas. Other players are hedging their bets. Russia's national oil and gas company, for example, has entered a strategic partnership agreement with Exxon that refers to the transfer of shale gas-related technological know-how and experience, an indication that Russia's state oil producer is at least aware of shale gas's future potential.

Potential eastern European investors in shale gas production are holding their cards in anticipation of US shale gas industry developments.

Potential eastern European investors in shale gas production are holding their cards in anticipation of US shale gas industry developments. If US companies decide to produce shale gas for domestic use only, then the boom in US shale gas production will have little effect in Europe. But in the more likely scenario that US players decide to invest in the conversion and transportation facilities they need to enter the European natural gas market, Europe's current reliance on supplies from Canada and Russia will diminish. In that event, Russia will likely turn its attention to serving the growing Asian markets.

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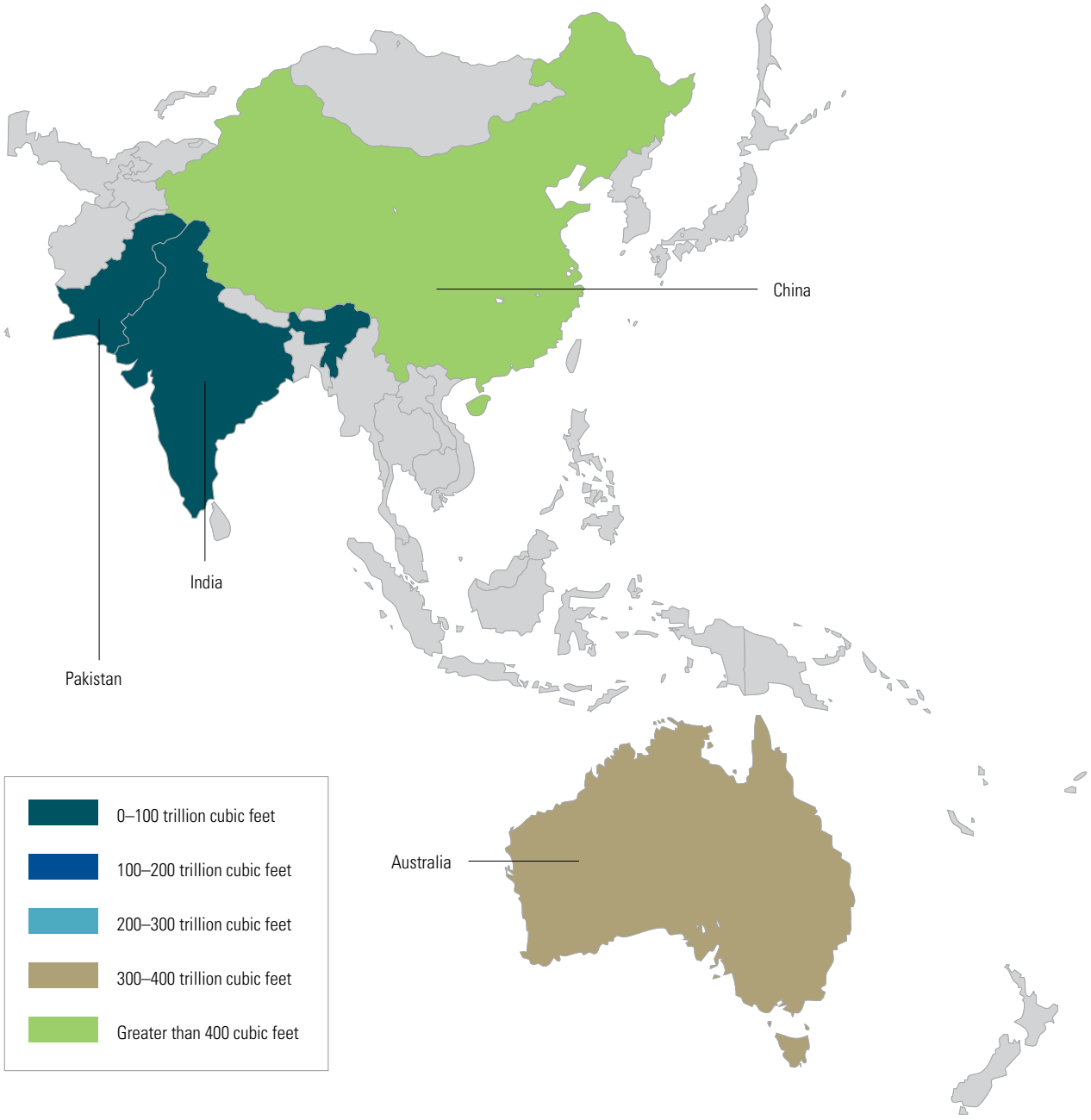
Shale gas – **The Asia-Pacific perspective**

Australia – The price of extraction

Australia is one of the world's richest countries when it comes to conventional gas supplies, and companies in the country have also made significant investments in coal seam gas production. The primary driver of growth in the gas markets is the opportunity to sell gas on the international market through LNG facilities.

Due to Australia's relatively small population, domestic demand for natural gas is limited, and the country produces natural gas for export in liquefied natural gas form. With limited pipelines, natural gas liquefaction plants or other infrastructure, shale gas development is in an early, immature state and its economic viability is uncertain. Further, Australia's shale gas is often located in remote locations, making it even more expensive to commercialize. While a combination of foreign and local companies are exploring for shale gas plays in various locations, there is currently no commercial production of shale gas.



Source: World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States, EIA April 5, 2011

Forecasts for delivered energy consumption by sources in Australia, Quadrillion British Thermal Units (Btu)					
Year	**Natural gas**	**Oil**	**Coal**	**Nuclear**	**Renewable**
2015	1.4	2.3	2.5	–	1.2
2020	1.6	2.3	2.5	–	1.4
2025	1.9	2.4	2.5	–	1.4
2030	2.1	2.5	2.5	–	1.5
2035	2.3	2.5	2.5	–	1.6

Sources: International Energy Outlook 2011, EIA

Many experts feel that significant production of shale gas in Australia is at least a decade away and will face challenges due to the following factors:

- Shale gas drilling costs are about three times those of the United States due to the lack of infrastructure, tight skilled labor and contractor supplies, and a lack of drilling technology and expertise.
- Concerns over fracking are already being raised in the context of coal seam gas, and so it is likely there would be similar concerns with shale gas.
- Shale gas may not be able to compete with coal seam gas because coal seam gas is located close to large east cost population centres while the shale deposits are far away and require transportation.

Since most of Australia's conventional shale gas is remotely located, its production may face less environmental opposition than operations in the more populated areas where coal seam gas is currently being developed.

For the Australian producers, the biggest issue involved with shale gas is the cost of extraction.

For the Australian producers, the biggest issue involved with shale gas is the cost of extraction. Currently, there is not enough incentive for companies to invest significantly in shale gas. If conditions improve, the country is well positioned to develop export markets in countries such as Malaysia, Taiwan, Japan, Korea and China, especially as some of these countries seek to diversify their energy sources. Additionally, Australia's has proposed to introduce a carbon pricing mechanism in 2012, which could ultimately create more demand for shale gas.

In short, if an Australian company were to find a big enough reserve in the right place to extract it and distribute it to market, then economies of scale could make shale gas production viable.

China – Five-year strategic plan

In 2010, the Chinese government began to explore shale gas production. While there are no official statistics, it is estimated that China has over 1,275 trillion cubic feet of shale gas deposits. Shale gas could be China's largest onshore source of energy, and the country is looking to develop this resource in order to decrease dependence on Russian and other foreign natural gas sources.

China's target is to fulfill most of its energy needs from alternative sources by 2020.

China's latest five-year plan places great emphasis on the exploration of non-traditional/alternative energy sources, such as coal seam, petroleum gas and oil sands. China's target is to fulfill most of its energy needs from alternative sources by 2020. (However see International Energy Outlook on facing page) As part of this strategy, China will enter into strategic partnerships with foreign companies in order to help China acquire the skills and technologies needed to develop and exploit its shale gas reserves.

Currently, under a joint venture between PetroChina and Shell Oil, 10-15 wells are in operation, producing about 2000 cubic meters daily. The venture started in the last quarter of 2010 and is situated in western China. In October 2011, production commenced in the Sichuan Basin.

China's shale gas deposits are geographically different than those in the United States, and so it is uncertain if U.S. methods of retrieving the gas can be duplicated. While water is relatively abundant in the Sichuan province, it is also needed to support agriculture in the region, which supplies 7 percent of China's rice, wheat and grains.[5]

China's Ministry of Resources has invited some major oil and gas companies to pitch for shale gas exploration work, offering four licenses for exploration in western China. As shale gas production is in its infancy, there is no regulatory framework in place in China. China is pursuing joint ventures with foreign companies to help build up know-how in shale gas exploration and extraction, and it appears likely that the Chinese government will continue to promote and support shale gas development.

Forecasts for delivered energy consumption by sources in China, Quadrillion British Thermal Units (Btu)

Year	Natural gas	Oil	Coal	Nuclear	Renewable
2015	5.6	24.5	80.7	2.3	11.2
2020	7.1	27.7	85.5	4.3	15.8
2025	9.0	31.6	96.4	6.1	17.8
2030	10.6	33.3	106.5	7.8	19.7
2035	12.1	34.4	113.6	9.5	21.6

Sources: International Energy Outlook 2011, EIA

[5] "China Begins to Tap Its Shale Gas, Despite Daunting Technological, Environmental Hurdles", *New York Times*, October 14, 2011.

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Burning bright? – Risks that could dim the future of shale gas

With so many large shale gas deposits already discovered and more being found in new locations, greatly expanded natural gas use around the world seems likely, especially in electricity generation. In the short term, because natural gas burns cleaner than coal and oil, the proportion of natural gas in the energy mix could rise in response to carbon emission targets. Over time, however, these targets will lessen dependence on all fossil fuels, including natural gas, unless technological advances make carbon capture and sequestration techniques more effective.

So how bright is the future for global shale gas production? Despite its abundance and advantages of less clean-burning fuels, a number of risks could impact its future viability. Below we highlight five of the biggest.

1. If and when natural gas prices will rise is the big unknown.

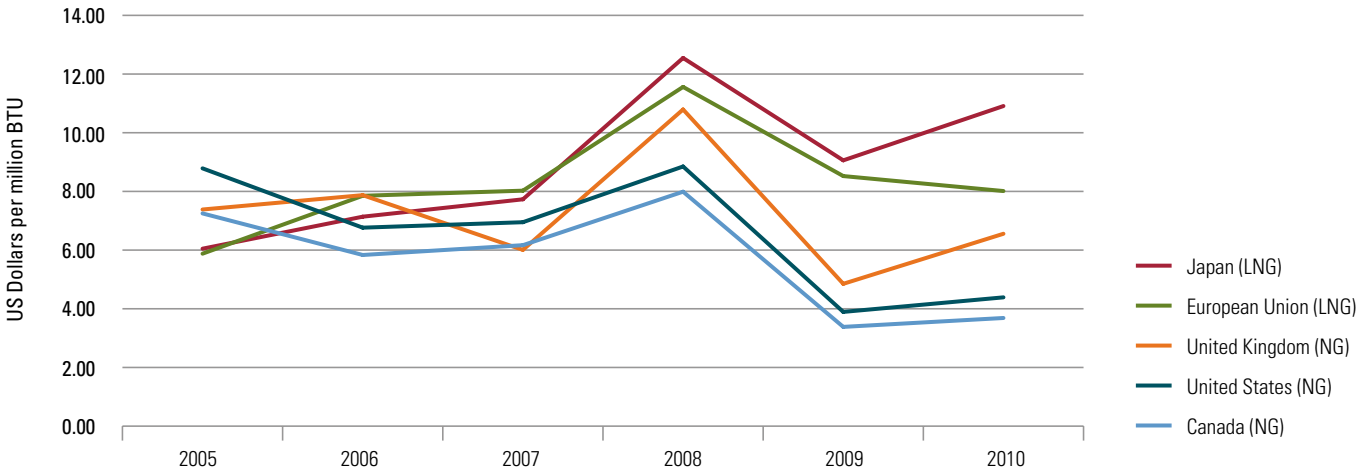
Given the amount of time it may take to explore, develop and exploit a new shale gas source, it can take many years before these investments start to produce returns. Whether natural gas prices move up or down during that extended period creates huge potential for profits, but also significant financial risks.

Despite the current slump in natural gas prices in some markets, some traditional oil and gas companies and newer players are continuing to invest in developing shale gas supplies in the belief that the current oversupply will not last and that prices will ultimately climb higher. As a result, smaller producers run the risk of becoming acquisition targets in a low-price market.

In the United States, natural gas prices are projected to fall to US$4.63 per thousand cubic feet by 2015. By one estimate, however, the spot gas price of shale gas should amount to US$7.50–8 per thousand cubic feet to recover the full cost extraction (Ben Dell, Bernstein Research).[6] Extraction projects require huge amounts of capital. The limited availability of infrastructure is expected to push costs even higher.

Further, shale gas reserves tend to decline faster than conventional gas wells. As a result, producers may have to resort to making profit in a shorter period, leading to more price risks concentrated in the early months of production than for conventional gas.

Average Natural Gas Prices – 2005–2010



* Source: 1984-1990 German Federal Statistical Office 1991-2010 German Federal Office of Economics and Export Control (BAFA).
† Source: Heren Energy Ltd.
‡ Source: Energy Intelligence Group, Natural Gas Week.
Note: Btu = British thermal units; cif = cost+insurance+freight (average prices).

[6] Ben Dell, Bernstein Research, quoted in "The True Cost of Shale Gas Extraction", *Financial Times,* March 7, 2010.

Private companies cannot develop a full-scale shale gas industry on their own.

Realizing the potential for shale gas as a profitable alternative energy source requires significant investments in technologies, equipment and infrastructure. Private companies cannot develop a full-scale shale gas industry on their own. They need their local governments to support them with a combination of direct financial subsidies, investments in transportation infrastructures, and favorable regulatory environments. Given the current economic environment, whether governments will be willing to commit to these investments is uncertain.

2. Shale gas could slow investment in renewables and attract costly regulation.

In an informal KPMG poll of oil and gas industry clients,[7] 88 percent of respondents agree that climate change and sustainability issues will continue to have a strong impact on how corporations invest in the energy sector. However, some critics suggest that the industry's focus on developing shale gas and other unconventional sources is taking attention and resources away from the development of renewables. Low-cost power generated with abundant natural gas supplies could disrupt the economic viability of wind, solar and geothermal projects. As a result, some worry that increased shale and other unconventional gas production could delay the shift to renewables by many years.

As you can see from the energy consumption forecasts for individual countries throughout this publication, fossil fuels are expected to make up a significant portion of overall energy supplies into the foreseeable future. As long as natural gas prices remain low, there will be less incentive to invest in greener sources. To meet their carbon reduction targets, there is a risk that governments could compel the industry to make these investments through regulation. Such moves could dramatically increase costs across the entire oil and gas industry, with particularly impact on highly cost-sensitive shale gas development operations.

3. Due to price uncertainty, managing costs and financing risks are top priorities.

The two risks above lead to the third: companies getting into shale gas production now will need to survive for an extended time period before they can turn a profit. At the same time, costs for shale gas producers continue to spiral. As they ramp up production, these companies need to streamline their procurement costs and invest in productivity, technological and capital improvements. Tax costs across their supply chains also need to be managed, including complex indirect tax and transfer pricing obligations and rising fuel and resource extraction taxes. More costs will arise from the need to comply with new greenhouse gas reporting and verification requirements and participation in energy trading systems in some locations.

To maintain their financial viability, these companies need to keep a close eye on cash flow, carefully forecast and identify future financing needs and funding options, and assess their liquidity risk. They will also need to conduct complex economic modeling and forecasting to analyze risks related to future changes in demand, pricing, costs, return on capital and other key performance indicators.

4. The industry needs to control reputational risk and turn public opinion around.

Negative public opinion about the environmental safety of the hydraulic fracturing process could undermine the development of this industry, particularly where the process is used in – or directly under – populated areas. In fact, the process has already been banned in France and parts of the United States. As noted, a UK parliamentary committee cautiously endorsed this method of shale gas extraction after finding no evidence that the process endangered water supplies, provided the operations were conducted with proper safety procedures.

According to the KPMG poll of oil and gas industry executives noted above, environmental and sustainability concerns are perceived as the biggest challenge facing shale gas development (41 percent), with regulatory concerns voted as the second (27 percent).

[7] This informal poll of oil and gas industry executives was conducted in the course of the KPMG Global Energy Institute webcast "Shale Gas – A Game-Changer for World Energy Markets" (November 10, 2011). To replay the webcast, visit the Institute's website at www.kpmginstitutes.com/global-energy-institute/events/2011-11-shale-gas.aspx.

Clearly, many industry members realize that more needs to be done to change public opinion and promote public confidence. Producers need to show that they fully understand the geology of shale gas formations and know how to model the impact of hydraulic fracturing with accuracy. As the reputational impact of the recent Gulf of Mexico oil spill and Japan's nuclear disaster on offshore drilling and nuclear energy production show, any environmental or safety lapses could tarnish the entire industry and attract more regulation. All industry players will need to consider adopting leading practices to mitigate environmental impact, preserve reputation, and avoid more stringent regulation which could preclude growth of the industry.

For example, Shell Oil has attempted to instill better industry practices and improve public perception by releasing its set of "Global Onshore Tight/Shale Oil and Gas Operating Principles". These principles comprise a framework for how Shell and other oil and gas producers should protect the environment and the communities in which they drill for and produce natural gas and oil. These principles include:

1. Safe well design and operation
2. Protection of groundwater and reduction of water use
3. Emissions reduction and fugitive emissions control
4. Reduction of surface impact
5. Transparency and community engagement

By developing and demonstrating a commitment to such a framework, shale gas producers can forestall future protests and negative regulatory repercussions for the entire industry.

5. As shale gas transforms supply and demand of the world's energy mix, geopolitical factors will continue to create risk.

Shale gas will undoubtedly have important – and unpredictable – strategic implications on geopolitics and the energy industry. For example, the development of shale gas production in Europe and potential imports from the United States could help ease European reliance on Russian gas. In turn, Russia will need to develop its capacity to deliver its natural gas to new markets. Before doing so, however, Russia could try to exert political or economic pressure to preserve its access to existing markets. Russian politicians are already quite vocal in European debates over shale gas production's environmental safety. With nearly 25% of the natural gas flowing into Europe via Ukraine is transported by Gazprom, Russia's natural gas transmission company, the country could go so far as to thwart future shale gas production in countries like Poland by threatening to cut off current natural gas supplies.

Elsewhere, countries like the United States and China have traditionally depended on fuel imports from politically sensitive regions, constraining their foreign policy options. Abundant natural gas can help these countries gain security of supply, which could dramatically change their relationships with other nations. On the other hand, exporting countries like Canada – which could soon see its biggest natural gas customer transform into a competing supplier – will need to make huge investments in infrastructure to create new outlets for their excess supplies.

Finally, exploiting shale gas deposits in new less developed, politically sensitive frontiers, such as Libya and Mongolia, could open up a whole new set of geopolitical challenges and risks.

Economic and population growth will continue to put pressure on the world's energy supplies, and so all fuel sources will be needed.

Production of various energy sources in the World, Figures in Quadrillion British Thermal Units (Btu)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Oil	135.43	133.91	131.66	136.51	143.90	145.91	145.86	143.26	145.80	137.46
Natural Gas	90.96	92.84	95.87	97.68	99.92	102.87	106.62	108.87	113.24	109.77
Coal	89.09	93.85	97.56	105.28	116.58	123.24	127.64	134.03	142.02	145.25
Nuclear	25.65	26.38	26.67	26.37	27.32	27.54	27.76	27.15	27.16	26.82
Hydro Electricity	26.72	26.51	26.46	26.75	27.86	28.94	29.75	29.56	30.73	24.25
Wind	0.31	0.38	0.51	0.63	0.81	1.00	1.25	1.62	2.07	NA

Sources: International Energy Statistics, EIA, accessed on September 28, 2011

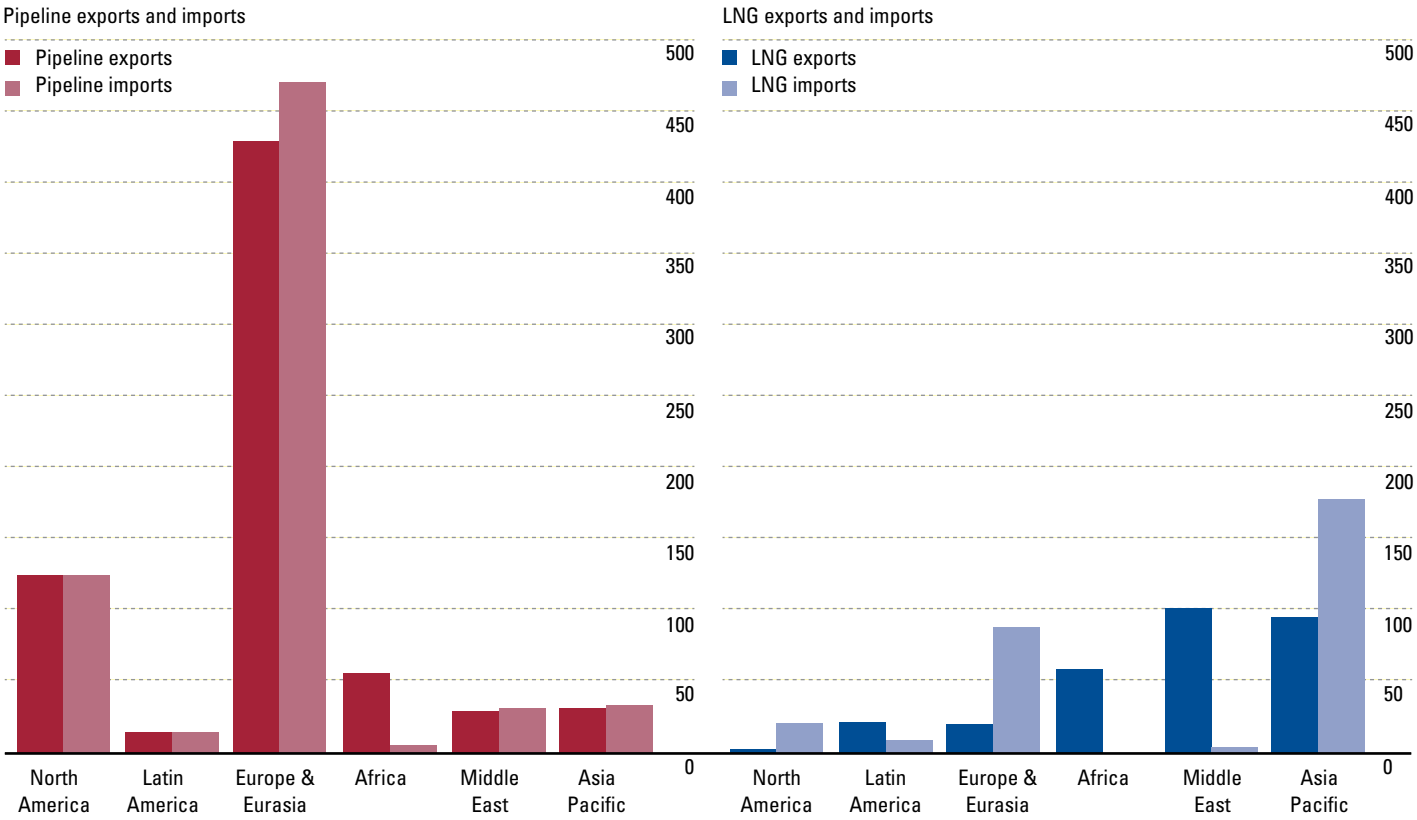
Whether or not shale gas turns out to be a game-changer, it seems certain that it will soon comprise a larger share of the world's energy markets. In our informal poll of industry executives, 77 percent of respondents agreed that the term "game-changer" applies, and 93 percent expect that companies will shift toward more investment in shale gas development in the future. This is clearly evident by the recent announcement that BHP Billiton will spend about US$4.5 billion to develop shale gas in 2012.

What's more, by 2030, the world primary energy demand will be 40% higher than in 2007 (according to the International Energy Agency). Couple this with world population expected to reach 9.2 billion people by 2050 and it's clear that all energy sources (traditional fossil fuels and alternative energies) will be required to keep pace with this demand.

In addition, as countries seek to follow through on their commitments to move away from coal-fired gas plants and reduce greenhouse gas emissions, shale gas may provide an important alternative energy source.

The extent to which shale gas comprises a larger or smaller piece of the energy-mix pie will depend on its economic viability and environmental impact and the trade-offs countries are willing to make to secure their energy supplies and sustain long-term growth.

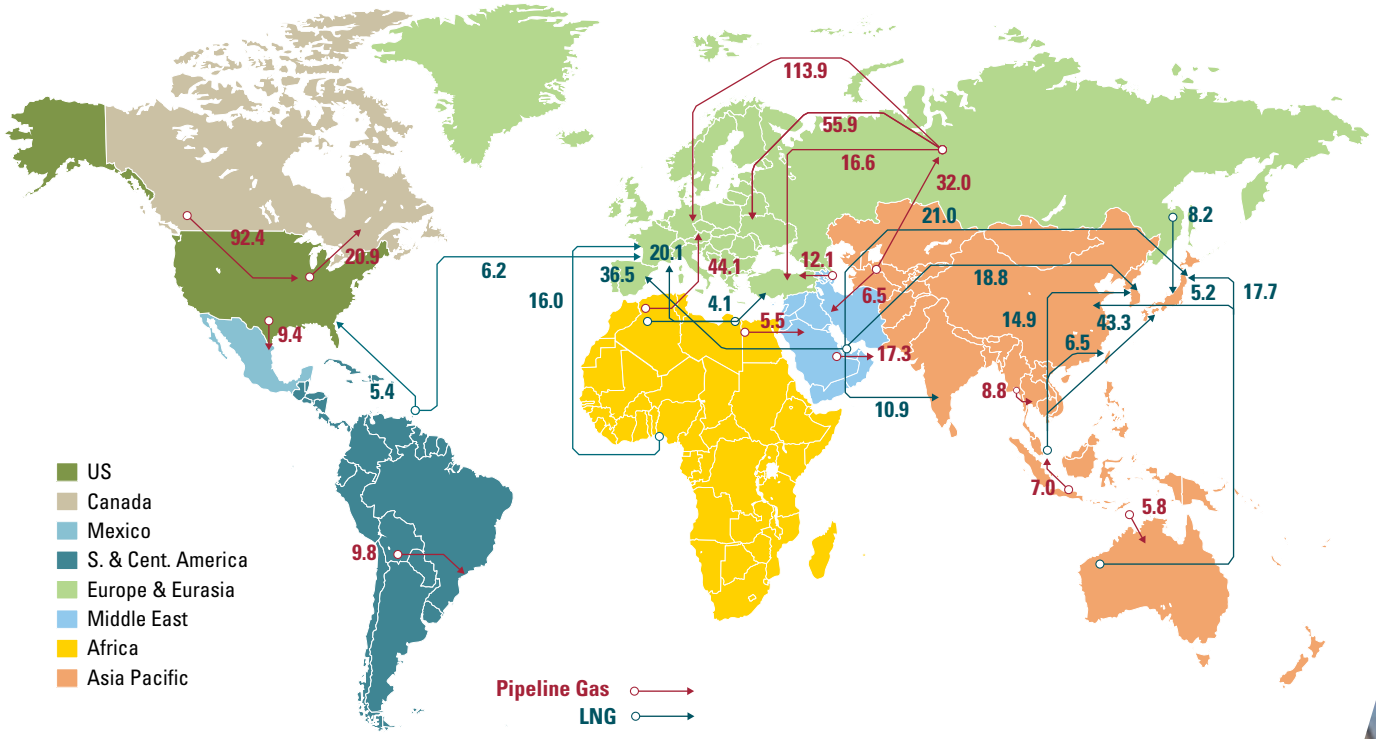
Natural gas trade



Source: *BP Statistical Review of World Energy* (June 2011).

Major trade movements

Trade flows worldwide (billion cubic metres)



Source: *BP Statistical Review of World Energy* (June 2011).

Further insight

Recent KPMG Oil & Gas Thought Leadership

1. After the Gulf of Mexico Oil Spill: recent developments in the oil and gas industry. This paper reviews some of the many impacts of the spill, including changes to operating models, contractor relationships, business risks and a number of new and proposed regulations.

2. Procurement in Oil & Gas, published by KPMG's Global Energy Institute, focuses on procurement in the oil and gas industry and highlights trends and tools as well as issues and challenges in both up-stream and down-stream sectors of the industry.

3. Accounting for Carbon discusses the impact of carbon trading on financial statements. It provides insights and strategies to help organizations understand and manage the business implications of climate change.

4. Impact of IFRS – Oil and Gas (September 2011) This publication provides assistance to companies in the oil and gas sector who are considering converting to IFRS. It gives an overview of the IFRS conversion process and looks at impact of conversion on IT systems, people and business processes.

Recent Global Energy Institute Webcasts

1. Oil & Gas Trends and M&A Landscape

2. Transfer Pricing Issues in the Oil & Gas Supply Chain

3. Key Tax Developments and Issues Affecting the Oil and Gas Industry

4. Shale Gas – A global perspective

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