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Breaking new ground

A special report on global shale gas developments

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Introduction

Worries about climate change are deepening in many countries. Proponents of gas, which burns cleaner than coal, suggest that it could be part of the answer—but preferably indigenous gas, for the sake of energy security. At the same time, even as energy demand surges ahead, the giants of the oil industry are finding it harder than ever to tap new reserves, which is forcing them to look to previously neglected, harder-to-reach hydrocarbons. Among these, hitherto disregarded shale gas reserves are generating the most enthusiasm.

The groundwork for this has been a remarkable upswing of activity in the US, where over the past decade innovative techniques have propelled shale gas from irrelevance to a position where it now makes up one-quarter of all natural gas production. The US Energy Information Administration, an official government body, forecasts that this proportion will roughly double by 2035. And although the shale gas story has been overwhelmingly a US one to date, the search for shale is accelerating around the world. In this special report, we bring together a collection of recent articles looking at fledgling shale gas developments worldwide, with a focus on the countries thought to hold the largest reserves.

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CORPORATES

Gas attack

Supermajors' hot pursuit of shale gas is one of several reasons to be cautiously optimistic about the industry's prospects.

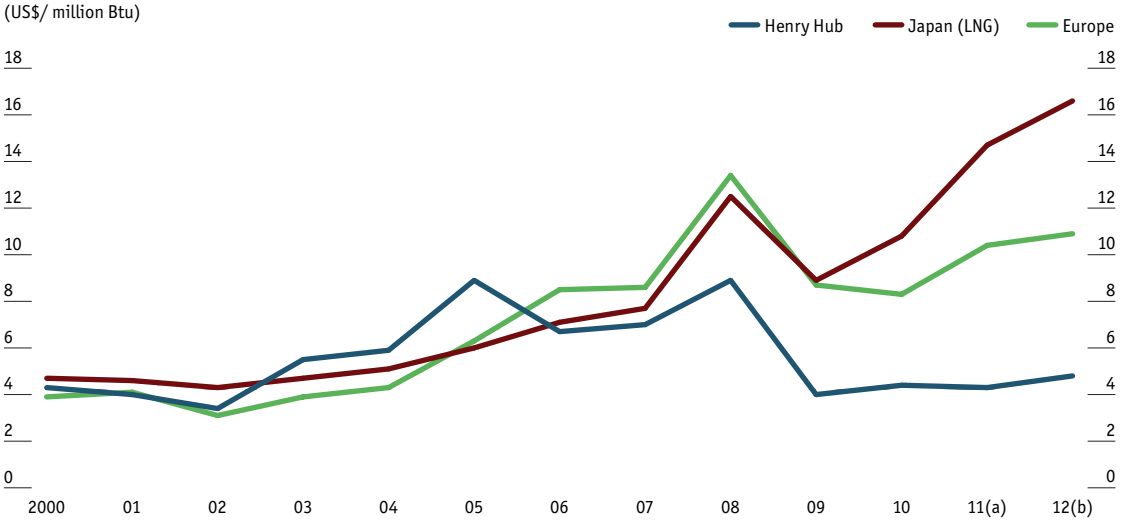
The shale gas industry might be held up as a paragon of free-market, US entrepreneurialism. Deregulation of the US natural gas market in the late 1970s created the conditions for pioneering small companies to dream up new techniques to get natural gas out of apparently impossible places deep below the ground. Industry heavyweights were slow out of the blocks and even today the shale gas industry remains fragmented with plenty of smaller players. Visibly, though, big energy corporations are aggressively seeking to carve out a bigger share of the shale phenomenon.

In recent years, supermajors and other resources giants have made up for their previous apathy by buying their way into the US shale gas market. ExxonMobil became North America's foremost gas producer when it paid US$36bn in 2010 for XTO Energy, a US company with stakes in a number of major US shales. Exxon has followed up with smaller deals and remains on the prowl. Supermajors have set their sights on the gigantic Marcellus Shale, with Royal Dutch Shell snapping up East Resources and Chevron inking a deal for Atlas. Total and BP have also invested billions in shale plays, while Australia's BHP Billiton, the world's largest mining company, in August 2011 completed its acquisition of Petrohawk Energy, a US shale gas producer, for US$12bn.

Such enthusiasm might seem counterintuitive, bubbling over as it did while oil prices were recovering from their slump in 2008-09, but US (Henry Hub) gas prices had been driven down to bargain basement levels by a shale-fuelled supply glut (see chart), meaning that oil might have looked a more attractive investment than gas. These contrarian-looking bets on shale are explained in no small measure by the supermajors' paucity of other means to stem the decline in their reserves. Many of the most promising remaining crude oil resources are in OPEC countries where Western majors are relatively unwelcome (as in most of the Middle East) or in which it is difficult to operate (Venezuela under Hugo Chávez). Companies have therefore been forced to look to costlier and more technically problematic resources, including shale gas. The relative cleanliness of gas in relation to oil also gives the supermajors' shale efforts a green sheen; in its marketing material, Exxon describes natural gas as "a viable solution for helping meet our collective environmental, energy and economic goals".

Yet to critics of shale gas it has begun to look uncomfortably as if desperation may have driven some

Natural gas prices
(US$/ million Btu)



(a) Estimate. (b) Forecast.
Sources: World Bank; Economist Intelligence Unit.

of these mighty companies into bold but foolish bets. Despite edging up a little from their 2009 trough, US gas prices are still low—too low, perhaps, to vindicate supermajors' massive shale gas investments. Many think that prices of between US$5.50/mBtu and US$6/mBtu are needed for shale gas production to be economically sensible. Henry Hub prices were hovering at around US$4/mBtu at the time of writing.

That is not stellar news for very big resources companies—but is likely to be greeted as even worse tidings by those with smaller fiefdoms. Some of these have managed to bring in funds by teaming up with foreign firms, but consolidation is evident, not least in the mergers cited above. Currently, many small players reputedly hope to sell their shale plays to bigger fish for a handsome profit.

Larger players' vast treasure-chests mean that they will generally be better placed to weather low prices, and their financial might will also help them to absorb the greater cost of extracting shale gas. (The use of hydraulic fracturing, or "fracking", in extracting shale can alone add US$2.5m to the cost of drilling a single Marcellus well, according to one recent study.) They will also be able to deploy swarms of geologists to get a better measure of the likely productivity of sites, as well as scientists and engineers to develop cheaper drilling techniques.

Price pressure relief?

Shale gas producers' breakeven costs are already falling as they find ways to be more efficient: Canada's Talisman Energy, active in US shales, estimates its costs will fall to roughly US$3-4/mBtu this year, while Exxon-owned XTO claims that it drills twice as quickly and cheaply as five years ago and has no loss-making wells (though it declines to provide figures). It is sticking by bullish plans to double gas production this decade.

Further bolstering the commercial case for shale, attention is now shifting to sites rich in natural gas liquids (NGLs), such as the Eagle Ford Shale in Texas, which are more lucrative given current gas prices. In the case of more "traditional" shale plays, such as Barnett and Haynseville, however, where

NGLs do not feature prominently, the pivotal question then becomes, how long will US (Henry Hub) natural gas prices remain low? The answer provides some grounds for cautious optimism.

Although prices have been depressed by a flood of new unconventional gas onto the market, the greater availability of supplies is starting to stimulate demand from industry. To general amazement, new chemicals plants are being built in the US: Dow Chemical, for instance, is one of a number of firms investing in projects to capitalise on plentiful and cheap supplies of shale gas by setting up a new plant manufacturing ethylene and propylene from gas. Other factories can be expected to switch from coal to gas, in addition to more gas being used as fuel for power generation.

Thus, although average prices are expected to be largely stagnant in 2011, climbing US demand means that the Economist Intelligence Unit forecasts price rises of over 20% in 2012 and 8% the following year, nudging them up by late 2012 or 2013 towards the US$6/mBtu territory where "drier" shale gas plays are currently thought profitable. (One risk to this forecast is that a pronounced global slowdown cuts energy consumption and depresses energy prices, perhaps even as new gas floods the market; conversely, prices could revive more strongly than we expect in response to proposed oil and gas subsidy cuts or the possible tightening of environmental regulations.)

There are further causes of cheer for the titans—namely the healthy long-term outlook for US exports of liquefied natural gas (LNG). It is an attractive market: we forecast that LNG prices will be, on average, three times higher than those for Henry Hub gas in 2011. US LNG exports more than doubled in the first half of this year, and a growing number of companies are building facilities to make it possible for the US's new-found shale bounty to reach promising markets in Asia and elsewhere, although significant levels of exports could be a few years away. We think that this will have an added welcome implication for US gas producers: as more US gas flows onto the international markets, Henry Hub and LNG prices will tend to converge throughout 2012-15, pushing up US prices.

Moreover, as overseas shale gas exploration begins in earnest, opportunities will surface for those with shale expertise, whether large or diminutive. But the supermajors have been early movers in some hopeful markets (such as Shell's September 2011 investment in exploration in South Africa, or Chevron's and others' activities in Poland). And in difficult markets to crack, like China, which could have the biggest shale reserves in the world according to the US Energy Information Administration, existing partnerships with the state-owned energy behemoths will be crucial.

But this is looking some way into the future. For now, shale gas drillers will mainly focus on the gas below the ground in the US, while hoping that prices begin to point more decisively in the direction of their aspirations: upwards.

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China

Preparing for opportunity

Chinese policymakers and state behemoths are laying the groundwork to begin extracting the country's apparently mighty shale gas resources.

China may eventually produce more shale gas than any other country. By some estimates it has the world's biggest reserves: the US Energy Information Administration (EIA) reckons there are 1,275trn cu ft of shale gas beneath Chinese soil—nearly 50% more than lies under second-ranked US. If this is correct, China's shale gas reserves are a dozen times greater than its conventional gas resources. For China, that is a very useful windfall that potentially promises to relieve its reliance on foreign energy and hasten a diminution of coal's role in feeding the country's skyrocketing energy needs.

Policymakers appear to grasp the possibilities. China does not yet produce any of the gas, but its current five-year plan (2011-15) lists exploration and development of shale gas as a key component. The state machinery is creaking into action: July 2011 saw China's first shale gas tender of blocks mostly in the south-west of the country, and one or two more rounds are expected this year.

The state-owned enterprises that dominate the oil sector—Sinopec, PetroChina and China National Offshore Oil Corporation (CNOOC)—show every sign of sharing the government's enthusiasm. It is true that they are motivated not just by political but also by commercial imperatives, and shale gas currently suffers from many uncertainties, not least pricing. Yet difficulties in their refining businesses—government controls mean that petrol is currently priced at less than it costs to make—are doubtless boosting their interest in gas. Their keenness does not look like a fad.

Sinopec, which won rights to explore a block in parts of Chongqing and Guizhou in south-west China, sounds particularly bullish. "Future growth will mainly come from unconventional gas," its chairman, Fu Chengyu, said in August 2011, reporting that results at 20 exploratory wells had been "better than expected". For CNOOC, regarded as the most international in outlook among the big three, this is a chance to diversify into onshore gas at home. It was the first to venture into overseas shale gas plays, having struck two deals with the US's Chesapeake Energy since late 2010. PetroChina's foray into foreign shale ended less happily when in June 2011 it pulled out of negotiations to buy billions of dollars' worth of shale gas assets from Canada's Encana. It is, however, partnering Royal Dutch Shell in the Sichuan Basin, and a unit of its parent company, China National Petroleum Corporation (CNPC), was the first Chinese outfit to explore for shale gas at home.

Bringing in foreign technology and know-how will be critical. In 2009 China and the US signed an agreement designed to help China measure its shale gas reserves, encourage "technical co-operation", and promote Sino-US investment in shale gas in China. State-of-the-art drilling technology allows US companies to complete shale gas wells in a matter of weeks, whereas CNPC took 11 months to complete China's first well. "Our technology and experience still lags behind Western oil companies, but we don't have to wait until our technologies mature," Sinopec's Mr Fu (until recently head of CNOOC) said. "We can hire them to work for us."

Great wall of worry

Yet whether the foreign help will be lured by sufficient incentives is one of several doubts raised about China's shale gas plans. Chinese officials have said that local players will apply for permits to explore for and develop shale gas sites, after which foreign interlopers may seek to partner them. Bidding rights are not on the table. (China's initial shale gas tender was open to a small clutch of state-owned companies including, naturally, the big three, Shaanxi Yanchang Petroleum and two coal-bed methane firms.) Foreigners also complain that China's monopolistic pipeline network allows discrimination against foreign and private gas output.

Perhaps a greater worry for foreign firms, including specialist services companies such as Halliburton and drillers such as Baker Hughes, is protection of intellectual property (or a lack thereof). Oil executives have their own complaints about intellectual property theft, but will also bear in mind another burgeoning China energy story: in less than a decade China's wind-equipment firms have become a force to be reckoned with—which some foreign companies complain was achieved through purloining their technology. As China's market for turbines blossomed, foreign companies watched their shares of it shrink dramatically and are now wondering when Chinese companies will become serious turbine exporters. In another industry tipped for a global boom, foreign oil and gas companies will not relish the possibility of losing their edge to China's big three.

Then there are the barriers that affect everyone. Gas pricing in China remains a mess, with different mechanisms for setting domestic onshore gas, regasified liquefied natural gas and imported pipeline gas. Critics complain that the upshot is that domestically produced gas is disadvantaged. Neither has China yet devised a system of preferential policies to help kick-start the industry, as was seen in the US. More pipeline capacity will also be needed if shale gas reaches large volumes.

Compared with the US, moreover, little exploration work has been carried out in China, so estimates of what is under the ground vary: in contrast to the EIA's optimistic assessment, some Chinese industry studies place domestic shale gas reserves at a less heady 26trn cu metres (about 920trn cu ft). It will probably take a few years to assess accurately the comparative costs of domestic shale gas production and imports of foreign gas—which will also be judged with reference to protracted negotiations over plans to pipe in gas from Russia.

All's well that ends well?

On the whole, these objections do not look insurmountable. Some elements of the shale gas policy architecture, such as putting in place fiscal incentive schemes, can be introduced relatively easily. Existing market distortions will not be swept away, but shale gas pricing policies and subsidies are

currently being investigated, according to officials at the National Energy Administration, China's top energy body. And although competition in hydrocarbons is usually only between state behemoths, officials at the Ministry of Land and Mineral Resources said in September 2011 that private companies could be allowed to participate in the sector.

What of those vital foreign majors? Some think that a fee-sharing arrangement—whereby their expenses will be covered and they will receive a share of the profits based on the volume of gas sold—is the best that they can hope for. Yet even if the terms were not ideal, it would be hard for them to turn down a slice of China's market; the same probably goes for the services companies and drillers. Indeed, BP and Chevron are reportedly negotiating with Sinopec and its parent, and Norway's Statoil is also trying to find a way in.

As for the risk of losing intellectual property, wind-industry experience might suggest alternative conclusions: foreign turbine manufacturers were sure not to build their bigger, newer models in China, slowing Chinese makers' catch-up while securing a piece of a big market. China desperately needs to bring in foreigners' techniques and expertise if it is to exploit its shale gas riches, so it is likely to endeavour to do enough to lure them in. Some level of sacrifice will probably be acceptable to them in exchange for market access.

Even if this logic prevails, exploration work and mastery of the technology to become proficient in shale gas production could take until 2015 or so. The bullishness of the likes of Mr Fu at Sinopec therefore looks a little premature: significant production is unlikely until at least the second half of the decade.

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United States

Unconventional conflict

Despite an environmental backlash and other concerns, the shale gas revolution in the US will continue to gain ground.

"Revolution" is an over-used word, but in the case of the rapid rise of the US shale gas industry it is apt. Innovative drilling techniques have made it possible to tap into an estimated 862trn cu ft of previously disregarded natural gas reserves trapped in rock formations far below the surface. In one fell swoop, this represents a quadrupling in the amount of natural gas thought to reside under US soil. One shale alone, the Marcellus Shale (straddling Ohio, West Virginia, Pennsylvania, New York and several other states), which may be the US's largest such reserve, holds enough gas to meet the country's energy needs for 15 years by some estimates.

Drillers are piling in. US shale gas firms reportedly attracted US$40bn in 2010 alone, driving output of the gas from a mere 0.39trn cu ft in 2000 to 4.87trn cu ft in 2010, according to the US Energy Information Administration (EIA), a government body. The revolution is gaining momentum: between 2007 and 2010, production nearly quadrupled to stand at one-quarter of the US's natural gas production. By 2035 the EIA reckons the gas will account for 46% of total US natural gas production (subject to the caveat that critics of the EIA accuse it of being overly optimistic on shale).

This upheaval is sending deep tremors through gas markets in the US and elsewhere. Greater recourse to gas brings the promise of comparatively lower carbon emissions (gas burns cleaner than oil or coal), enhanced energy security (more domestic gas means less need for imports) and even opportunities to export (both excess US gas supply as well as expertise and technology). As overseas interest in shale gas grows, the US's pioneers stand to profit.

Given these many celebrated qualities, what is not to like about shale? Quite a lot, judging from recent controversies. Doubts about the gas are multiplying, dire press is abundant and common industry practices are being subjected to high-level reviews.

Fractured consensus

Critics fall broadly into two camps: environmentalists who question the greenness and safety of the methods by which the gas is extracted; and pundits who doubt the business case for shale in a well-supplied US natural gas market where gas fetches historically low prices. The sum effect is to spawn

doubts about the sustainability of current shale gas investments.

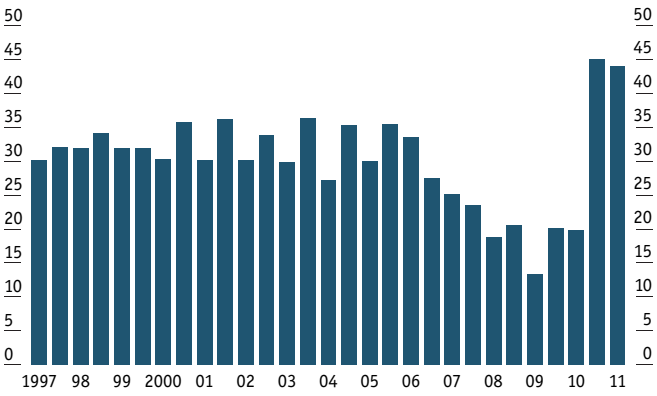
Take the gas's green opponents first. Their ire is drawn both by emissions released during its extraction and by the waste products pumped out during that process, known as hydraulic fracturing (or "fracking"). This entails blasting apart shale formations with a mixture that contains chemicals, sand and potentially millions of gallons of water per well. Fears arise that this can contaminate local water supplies. The depth of drilling is supposed to ensure that water aquifers are not polluted, but some industry officials admit that there are risks. This has prompted a flurry of local regulations on shale and moves in some state legislatures to ban it outright. Production has already been affected in New York, where a partial moratorium on some types of drilling has been imposed since December 2010.

As (often disputed) reports of environmental damage and human health problems mount, the green lustre surrounding shale is increasingly tarnished. The ecological case against shale has been fuelled by recent high-profile investigations by The New York Times, which have also cast doubts on the commercial merits of shale. Performance at many wells has disappointed, the newspaper found, raising questions about eye-popping estimates of how much of the gas can be extracted economically. At three major US shales—Barnett, Haynesville and Fayetteville—less than 20% of the area expected to be profitable has so far proven to be so by The New York Times's reckoning. Thus, rents paid by some companies to drill the land look disproportionate. And all this is at a time when gas prices are being driven down by plentiful supply of shale and other unconventional gas (such as "tight" gas).

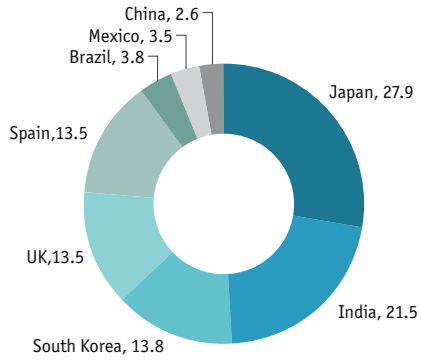
Yet this is contentious ground. Data on the effect of fracking on water supplies are erratic (itself a problem that there are early moves to redress). Reserve estimates vary according to the source and different methodologies can give rise to controversies, but the history of extractive industries shows that reserve estimates tend to rise over time. Production costs, too, fall as techniques are honed: wells are now being fracked many times, and other saleable products like butane and propane are being recovered.

And although the surge of new sources of gas in the US market has kept prices low, exerting pressure on some firms, there is scope for some supply to be redirected to the global market in the

Ramping up
(US LNG exports, half-year totals, bn cu ft)



(Destination of US LNG exports, percentage of total, Jan-Jun 2011)



Source: US Energy Information Administration.

form of liquefied natural gas (LNG), at a far more attractive price. Compared with the same period last year, US exports of LNG grew by 120% in the first half of 2011, and China and other Asian economies are expected to continue stoking demand (see chart). Given expectations of strong domestic demand for gas and the immaturity of export capacity, significant shipment volumes will not be achieved overnight. But the US is at least ahead of potential competition from Canada when it comes to putting LNG infrastructure in place: Houston-based Cheniere Energy received approval in May to export LNG from the Gulf coast, and a handful of other companies await the nod from regulators.

Revolutionary counter

Yet arguably the most persuasive reason to expect US shale gas production to keep up its strong momentum is politics. Shale gas generally enjoys bipartisan support, and in the face of a jobless recovery in the US, the president, Barack Obama, is striving to shrug off his image among some voters as a job-killing, regulation-addicted green—he recently ordered the Environmental Protection Agency (EPA) to drop stricter regulations on ozone, for instance. And polls show that even in states where drilling has been controversial, such as New York, a majority still support it. Shale gas brings jobs, together with the added patriotic appeal of cutting reliance on foreign energy.

Current hand-wringing over shale is likely to provoke changes to regulations, although given the government's current stance it would be surprising if these placed onerous burdens on drillers. So far, the Obama administration's handling of the controversy over fracking demonstrates a desire to manage public unease about the process while giving industry every chance to clean up its image. (Some companies, though far from all, are voluntarily transparent about the chemicals they use in the fracking process.)

In January 2011 the president called on Steven Chu, the energy secretary, to create a high-powered committee to suggest ways to improve industry oversight, which released its preliminary report in August. The report recommended better tracking and more careful disposal of waste; stricter air pollution standards; the creation of a federal database allowing the public to monitor drilling activity; and establishing an organisation to set safety standards and address environmental concerns. Alongside this, the EPA is conducting a study of the impact of fracking on people's health and the environment, but its results are not expected until 2012.

The disconnect between federal and state legislation, which are often at odds, is another area that policymakers are being called on to address. In the meantime, in some localities objections to shale gas could slow the industry's progress. Overall, though, the resources being thrown at the US's new-found gas deposits, in tandem with the stalwart political support it attracts, mean that the Economist Intelligence Unit expects continued, strong growth in US shale gas output. Above all the noise, the cry will remain "Vive la revolution"—or, to borrow a more recent political slogan, "Drill, baby, drill".

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ARGENTINA

Untapped potential

Unconventional hydrocarbons meet familiar problems in Argentina.

An energy revolution has swept North America in recent years, altering the dynamics of global energy markets. Now, development of unconventional oil and gas is gaining pace elsewhere. In May 2011 Argentina announced that it would become the site of the first large-scale development of oil from an unconventional reservoir outside of the US and Canada. Yet, for all its potential as a source of unconventional energy, Argentina will need to address two large problems.

In June 2011 Repsol, a Spanish oil major, announced that its Argentinian subsidiary, Yacimientos Petrolíferos Fiscales (YPF), will drill 17 new wells and fracture 14 existing ones this year in the Vaca Muerta, an oil-bearing shale formation in the prolific Neuquén Basin. (In developing shale fields, an unconventional drilling technique known as hydraulic fracturing, or "fracking", is used to unlock previously inaccessible hydrocarbons caught in rock formations deep underground.) The programme will cost over US$250m to access estimated resources of 150m barrels of oil equivalent.

Argentina is widely recognised as having enormous unconventional resource potential. It is not just oil. A recent report by the US Energy Information Administration shows that the country has 774trn cu ft of shale gas reserves, the third-largest in the world behind China and the US. Unlike in these two countries, oil and gas production in Argentina is stagnant; the discovery of unconventional resources could change this.

Poorly priced

A change is needed: the Economist Intelligence Unit expects electricity consumption in Argentina to grow by more than 4% a year this decade. But if shale is to meet much of this new demand, producers argue that federal authorities must tackle two key blockages.

One of the industry's long-standing complaints is the country's pricing regime. Gas prices have been kept well below global levels for years, discouraging investment. So, despite its considerable reserves, Argentina depends on imports from neighbouring Bolivia, plus liquefied natural gas shipments. Oil prices, too, are kept artificially low. The basket price for Neuquén crude averaged around US$58/barrel in the first three months of 2011, about half the international level. Even by depressed Latin American standards, this is cheap: Venezuela's basket price was US$90/b.

Pricing reform will be especially important for shale development, as exploration and production costs are markedly higher than at conventional sites. Shale wells tend to be around three times more expensive to drill than normal holes. (Repsol has placed average costs for each well in its current campaign at US$7m, in line with US industry estimates.) Authorities have taken some measures, awarding higher prices for new production and unveiling plans to deregulate the distribution sector. Industry leaders complain, though, that schemes are not being implemented extensively or rapidly enough.

Labouring to succeed

The other big problem, particularly prominent in recent weeks, is labour relations. A month-long strike by oil workers in Santa Cruz province caused national output of the commodity to fall by 15% in April 2011; stoppages in the same area in December 2010 had an even bigger impact. This left YPF, the country's biggest producer, unable to hit the levels needed to qualify for prices at the higher regulated rates.

These are not isolated incidents. Although recent strikes took place in the south of the country, industrial action is common across Argentina. Further disputes in the distribution and refining sectors last month led to shortages, forcing the closure of petrol stations across Buenos Aires.

Service companies are particularly hard hit by these disputes. Many contractors are unwilling to increase their presence in the country for fear of having to endure lower rates during periods of labour unrest. This will keep the prices of the rigs that they operate high, making shale development in Argentina more expensive than it would otherwise be.

What are the chances that these conditions will improve? The government at least seems to recognise the problems. It has promised to encourage more dialogue between provincial regulators, companies and unions to try to end strikes more quickly (or avoid them altogether). In an election year, though, the populist administration of the president, Cristina Fernández de Kirchner, is unlikely to take any decisive action to curb politically important unions.

Similarly, price deregulation is unlikely to deliver the results sought by producers: Argentina's leaders remain sensitive to the economic concerns of an electorate already feeling the pinch of inflation. (We expect consumer price inflation to average about 10% this year.) Until a presidential vote on October 23rd, at least, the future direction of shale development in Argentina will remain uncertain.

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MEXICO

Great expectations

Enormous shale gas reserves offer hope to Mexico's moribund energy industry.

In March 2011 Mexico's national oil and gas firm, Pemex, began producing shale gas from its Emergente 1 well, in the township of Hidalgo, Coahuila. Although the well is exploratory, and produces only 2.9m cu ft/day of gas, it is generating considerable excitement at Pemex, given the company's goal of evaluating the full potential of the Eagle Ford shale gas formation on the Mexican side of the border with the US.

As Mexico's national hydrocarbons industry continues to be handicapped by fiscal, administrative and legal restrictions—oil production has fallen from 3.4m barrels/day (b/d) in 2004 to 2.5m b/d in 2011—the prospect of significant new reserves is raising spirits. And the new shale gas reserves are indeed significant. According the US Energy Information Administration (EIA), Mexico has the world's fourth-largest deposits of shale gas, after China, the US and Argentina. With around 681trn cu ft of shale gas waiting to be released in a number of locations in eastern Mexico, the country now stands a realistic chance of becoming one of the world's major gas producers. Mexico's previously identified conventional natural gas deposits were measured at only 12trn cu ft.

Shale gas deposits in Mexico are found in the border region in the Sabinas-Burros, Chihuahua and Burgos basins, and also along the Gulf coast in the Tampico-Misantla and Veracruz basins. The challenges of developing the huge, rural areas are enormous, entailing the drilling of thousands of wells, an investment of up to US$80bn and thorny environmental concerns. Pemex is already stretched, managing complex oilfields such as Chicontepec and stepping up the search for new reserves. At the same time, the company needs to focus on shoring up its declining oil production, and is further distracted by both the controversial issuance of new incentive-based contracts and Mexico's presidential election in 2012.

Despite the enormous investment required, Carlos Morales Gil, head of exploration and production at Pemex, is confident that within a few years Mexico will produce shale gas profitably via special incentive-based contracts awarded to the private sector (similar to those already issued for oil). He has also made it clear that the experience of firms active in shale gas on the US side of the border will be crucial. Among the most likely partners for Pemex are Lewis and Halliburton (long-standing subcontractors in Mexican energy that are already involved with drilling and fracturing at Emergente 1) and Alpha, a Mexican firm

that has been operating across the border in the Eagle Ford formation in Texas.

Thanks to its experience in the Chicontepec oilfield, Pemex has experience drilling a large number of wells in a short period of time, as well as working in environmentally sensitive areas. Juan José Suárez Coppel, Pemex's chief executive, has said that shale gas will bring about a "true transformation" of Mexico's energy sector.

Will demand meet supply?

This transformation will not be easy. Most notably, Mexico faces a problem of what to do with its gas once production begins. Domestic demand is low; natural gas consumption in Mexico is only one-third that in Canada, a country with less than one-third of Mexico's population. Mexico's pipeline network is underdeveloped, with almost the entire west of the country lacking access to natural gas.

Furthermore, with gas prices plummeting on the back of surging supply, Pemex has found it cheaper in recent months to import shale gas from the US than to produce it from its own fields in the Gulf of Mexico. When Mexico's shale gas comes online, the price outlook will not be any more favourable, so Pemex will have to decide between restricting production and building expensive gas liquefaction facilities for exporting liquefied natural gas. Low prices for shale gas will also have a negative impact on Mexico's blossoming renewable energy sector, one of the domestic energy industry's few bright spots in recent years.

The benefits of Mexico's shale gas reserves will extend beyond simply reducing energy costs. There is the possibility of replacing coal-fired electricity generators, and even of developing a transportation fleet based on natural gas instead of diesel. Meeting post-Kyoto emissions targets will therefore become easier. Exploiting Mexico's shale gas reserves will also strengthen Pemex. Lacking the cutting-edge technologies required to develop shale gas basins, closer collaboration with the private sector should help to speed up the long-overdue modernisation of Mexico's oil monopoly.

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South Africa

Game changer?

Shell and other shale gas contenders meet stiff resistance in South Africa, which has the continent's most promising reserves of the gas.

Energy companies will have to wait until at least early 2012 before they get a clearer idea of whether South Africa intends to stake a claim in the shale gas revolution. In August 2011 the South African government decided to extend a six-month moratorium on licensing for shale gas exploration for another half-year period—a disappointment for those circling what are thought to be the world's fifth-largest shale gas resources. According to the US Energy Information Administration (EIA), South Africa's technically recoverable shale gas reserves amount to 485trn cu ft; the country has negligible conventional gas reserves.

One of those hoping for rich unconventional pickings in South Africa, Royal Dutch Shell, claims that South Africa's shale gas could be a "game changer". The country depends on imports (of oil and some gas) and does not generate enough electricity to satisfy demand. Tapping shale would enable South Africa to diversify away from coal, which is a dirtier fuel when burnt than gas; coal supplies nearly three-quarters of South Africa's primary energy needs.

Still, the business case for shale remains unproven as exploration has been minimal. The EIA notes that the shale-rich areas contain large areas of "volcanic … intrusions that may impact the quality of the shale gas resources, limit the use of seismic imaging, and increase the risks of shale gas exploration". On top of such commercial caveats, green campaigners in South Africa voice strong objections. Like their counterparts elsewhere, they worry about the impact on the local environment of the process (hydraulic fracturing, or "fracking") used to extract gas from shale rock. But opposition in South Africa comes with geographically specific twists.

Fracking is a water-intensive activity, and South Africa's shale gas resources lie in the Karoo Basin, a semi-arid and drought-prone tract of land straddling two-thirds of the country. Without further exploration it is not possible to tell how extensive South Africa's shale gas reserves will be, thus making it hard to tell how great a demand will be placed on local water supplies. Prospective shale gas operators must also contend with potential complications arising from South Africa's bid to host the Square Kilometre Array (SKA) telescope project.

If successful, the SKA would make South Africa a strategic location for astronomic activity and

research, and in 2007 the Astronomy Geographic Advantage Act (AGAA) identified an area of 12.5m ha as a protected area for the project. But some experts worry that radio-frequency interference from fracking could disrupt astronomic observation.

A more universal cause of anxiety about fracking concerns wastewater produced in the process. This contains chemicals that it is feared may contaminate nearby groundwater reservoirs. Not just greens, but farmers also fret about the impact on local water supplies. Hence, the opposition to shale gas exploration and development is robust. Several lobbying groups have sprouted up, such as the Treasure the Karoo Action Group.

Shell fires back

Shell has positioned itself to be a major player in South African shale gas if development goes ahead. Thus, it is singled out by anti-shale activists for particular opprobrium. No exploration licences have been awarded in South Africa, but the company is one of just a handful of operators to have gained a Technical Co-operation Permit (TCP), all within the Karoo Basin. This allows it to conduct so-called desktop studies, covering activities such as the gathering of seismic data on an area.

Shell's TCP, received in 2009, covers 185,000 sq km. In December 2010 Shell submitted three separate exploration licence applications for three areas of around 30,000 sq km each, which requires the submission of an environmental management plan. Given the subsequent moratorium on shale gas activity, however, these have not been granted.

Shell's forays into the Karoo have prompted protests and bad press. To counter this, the company is lobbying hard. It promises not to compete with locals for water resources and to disclose details of its fracking fluids. It has also stated that any exploration would be compatible with the regulatory requirements set out in the AGAA and has met regularly with SKA officials. Should South Africa win the bid to host the telescope project—a decision is expected by March 2012—this would not necessarily preclude the development of a shale gas sector.

Other oil and gas players have also lined up in the hope that the door to shale gas exploration will eventually be opened. Companies that have received TCPs include Falcon Oil and Gas (30,000 sq km), Challenger Energy (4,600 sq km) and a joint venture between Sasol, Chesapeake and Statoil (88,000 sq km). In addition, Anglo-American reportedly applied for a TCP for 50,000 sq km. These areas include a vast belt of land covering the entire southern part of the Karoo Basin.

The potentially vast resources at stake will keep South African authorities and international operators interested, but policymakers are treading carefully. During the current drilling moratorium, the government will conduct its own inquiry into the pros and cons of shale gas. Even if the ban is lifted and exploration is allowed, local opposition to fracking will continue to smoulder, which will continue to make life difficult for operators.

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CANADA

Between a rock and a hard place

Canada's shale gas industry is caught between a gas glut and stiffening environmental opposition.

Canadian companies were involved at an early stage in the shale gas revolution in the US. Encana, Canada's biggest gas company, acquired a stake in the prodigious Barnett Shale deposit in the US in 2004, just as the new technologies were being put into practice. Now, Canadian gas companies are keenly exploring the potential of home resources. These look vast: the US Energy Information Administration estimates that Canada has 388trn cu ft of shale gas reserves, but that could be conservative. Some think the Horn River Basin in north-eastern British Columbia alone holds as much as 500trn cu ft—far outstripping the mighty Barnett Shale.

Tapping this potential could prove tricky, however. Environmental opposition and official efforts to rein in the shale gas industry are putting the brakes on progress. Critics of shale gas are anxious to ensure that regulations keep pace with the growth of the industry. Whereas proponents of shale gas tout the benefits of exploiting an abundant fossil fuel that burns cleaner than either coal or oil, green groups and political opponents voice concerns about the process that makes extracting the gas possible, known as hydraulic fracturing, or "fracking". Their chief concern is that the pressurised fluid of water, sand and chemicals used to blast rock formations and release the gas may contaminate groundwater.

Until now, Canada's producers have not even been required to disclose the chemicals used, but in September 2011 the Canadian Association of Petroleum Producers said that natural gas producers had pledged to do so. This may have been designed to defuse mounting resistance from environmental lobbies, but regulations are being tightened regardless: on the same day, British Colombia's premier, Christy Clark, announced that companies would be forced to detail the make-up of fracking fluids.

It is not only in British Colombia that controversy has been brewing. In March 2011 the Quebec government imposed a moratorium on drilling for shale gas until the impact of fracking could be evaluated, in line with a recommendation from the province's environmental watchdog. Following that, New Brunswick's premier, David Alward, promised he would continue to back the development of shale gas reserves in his province. Yet escalating protests there are taking a toll: in August 2011, Southwestern Resources Canada suspended exploration work after protesters blockaded vehicles

carrying seismic testing equipment.

Fracking hell

For Canadian natural gas companies, this is bad news atop bad news. The industry is already struggling with a gas glut in North America that has depressed prices—by 6% in the US this year. Indeed, in August 2011 Encana put up its Barnett Shale stake for sale to help it weather low gas prices, part of plans to shed US$1bn-2bn of non-core assets. And the recent wave of shale gas production has saturated the export market that existed before new, unconventional resources came on stream.

Despite doubts about the robustness of end markets for Canadian shale gas, several of the country's companies have sought foreign partners to help finance projects in western Canada. Encana flirted with partnering PetroChina, eventually pulling out of the US$5.4bn deal because of disagreements about how to operate the assets. Calgary-based Talisman Energy has meanwhile sold 50% interests in two Montney Shale properties to Sasol of South Africa for US$1bn each since December 2010.

Yet exploiting the bountiful resources of north-eastern British Columbia brings its own set of problems. The region is remote, with little infrastructure: to work there, companies must build roads and pipelines. Areas like the Horn River formation are under muskeg, a type of boggy peatland that is too soft to support heavy equipment when the ground is not frozen. The way forward looks rough and costly.

As to the fundamental question of whether it makes sense to push on with native gas development in a gas glut, there are inklings of encouragement. Plans to increase exports of liquefied natural gas (LNG) from the Cordova Embayment shale deposit via Canada's west coast have been ramped up in the wake of the 2011 earthquake and tsunami in Japan (which caused that country to cut its reliance on nuclear power). Canada is an attractive trading partner for Japan because in Canada, unlike in Russia, the political risks associated with its supplies are relatively low. For Canada, the project could secure one of the world's largest energy consumers as a customer.

Currently, pipelines and liquefaction plants are lacking, but further moves are afoot to enable west Canadian gas to reach customers across the seas. EOG Resources has partnered Apache and Encana to build an LNG export terminal on British Colombia's north-west coast that could load tankers with 700m cu ft/day of gas—rather euphemistically calling the port "a response to a rapidly changing North American market". The companies hope that this facility will allow them to move large volumes of the fuel to promising markets all around the Pacific Rim, where natural gas fetches a higher price than in North America. All being well, shipments could begin in 2015.

Still, if Canadian gas does not penetrate global markets soon, the country's gas industry could face difficulty on account of low North American prices: the Economist Intelligence Unit forecasts that US natural gas prices will remain 60% below those for LNG in Japan in 2013 (the final year for which forecasts are available). For Canada's gas companies, the risk remains that a regulatory impasse due to environmental worries will prevent them from capitalising on the worldwide shale gas rush. The window of opportunity is narrow.

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POLAND

The next Norway?

Shale gas gives Poland a chance to bypass Russia—maybe.

Just as oil companies are drilling ever deeper to grab new deposits, gas companies are greedily eyeing hidden reserves that up to now have been too tricky to extract. In particular, they are looking at so-called shale deposits, the stuff hidden away between layers of rock that until recently was too expensive—and technically difficult—to bother with. That has caused a gas rush in North America, with shale gas helping the US to overtake Russia as the world's largest gas producer last year.

Now, companies are eagerly chasing similar deposits in Europe. In particular, they are looking at Poland, believed to be sitting on the biggest hidden reserves in the EU. For Poles, desperate for money and for a way of escaping energy dependence on Russia, it looks like a godsend. But as no-one knows how much gas is really there, and whether it can be pumped out without ruinous environmental damage, it could yet prove no more than a pipedream.

One of the big problems with shale gas is that it can only be found by drilling a series of speculative wells, some of which will hopefully stumble over some gas. In the US, there are plenty of small, adventurous energy firms willing to take the plunge. But such firms are rare in Europe, and rarer still in the old communist states. Now there are signs that smaller, more adventurous types are trying their luck in Europe's unproven market, although much of the interest so far has been from the energy majors that feel they missed out on the US boom.

In April 2011 a relatively small Canadian oil producer, Nexen, announced that it was buying a 40% stake in the Polish shale gas concessions owned by Marathon, the fourth-biggest US integrated oil company. This is a high-risk business, and Marathon admits it is trying to reduce its financial exposure through this deal. But it also says that it wants to tap into Nexen's expertise on such speculative ventures. The recent boom in shale exploration has centred on Canada as well as the US, and Nexen has had success in developing its own shale gas holdings in British Colombia.

It is at least a partial thumbs-up for Poland's policy of selling off a series of concessions for shale gas development, introducing intense competition for deposits rather than relying on a local developer or a single multinational partner. So far, the government has sold nearly 90 concessions, mostly to multinationals like ExxonMobil and Chevron keen to buy into one of the industry's fastest-growing subsectors. However, it kept a good chunk of them for the local state gas producer, PGNiG, suggesting

it does not want too much foreign ownership of such a vital market. And beneath the hype this remains a highly speculative play: no one knows how much gas is hidden in the shale, or whether environmental concerns could stop the exploration dead in its tracks.

Desperate to escape

Industry analysts reckon there could be 187trn cu ft of gas in the shale, enough to give a huge boost the EU's total gas reserves. As importantly, from Poland's point of view, there could be enough to satisfy the country's gas needs for hundreds of years. At the moment it relies on Russia for two-thirds of its supplies, a dependency it is desperate to escape. The fear of Russia in Poland remains deep enough for it to have largely spurned gas-fired power stations in favour of more polluting plants using locally produced coal.

The wider EU is equally keen to escape its reliance on Russian energy, meaning there is a big drive across the continent to develop shale gas fields. However, for all the excitement, there are some important caveats. The true level of Polish reserves will not start to be known until the end of 2011, meaning the multinational explorers could still end up finding little of worth. Therefore shale gas can do little to satisfy Poland's energy needs for the foreseeable future, and certainly it will be of little help in weaning the country off coal power as it tries to slash carbon emissions over the next few years. The export potential could prove tricky to unlock, too. Poland is a vital transit route for Russian gas shipments to western Europe, and much of its gas network is in effect controlled by the Russians—who might be reluctant to play ball over Poland's own exports.

The biggest problems might prove to be environmental, however, with pollution concerns already halting shale gas extraction in countries such as France and the Netherlands. The industry says that shale gas is a useful way of cutting carbon emissions, producing little more than half as much CO2 per unit of energy as coal. However, some researchers say that so-called "fugitive" methane emissions from shale gas production more than wipe out any benefits. Methane is a powerful greenhouse gas and some academic research suggests that it makes shale gas significantly more polluting overall than coal or oil.

So for all the excited government talk of Poland becoming the next Norway, some very serious questions remain over the viability of shale gas production in the country—and in other east European states such as Ukraine and Romania that have lured multinational investment into the sector. In fact, both Poland and the EU have been careful not to rely too heavily on shale gas in the long term as they try to escape their reliance on Russia for energy: Poland, for example, aims at a three-way split between local production, Russian imports and alternative suppliers such as Qatar to safeguard its gas supplies. The US shows that shale gas could transform Poland's energy production in the long term. But it will be a while before it worries the Norwegians.

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India

Shale of the century?

Excitement about a potential Indian shale gas boom is building. As yet, there is not enough evidence to justify the hype.

In January 2011 India's state-owned Oil and Natural Gas Corporation (ONGC) found the country's first shale gas at an exploratory site near the city of Durgapur in West Bengal. This promptly encouraged talk of an Indian shale gas revolution to mirror that in the US. Cited as evidence are estimates that India could have as much as 2,100trn cu ft of shale gas reserves—the equivalent of nearly 1,000 years of gas at current levels of usage.

Excitable pundits have since posited that India could emerge as an energy giant able to export gas to key markets across Asia. At the very least, big shale gas finds would help India satisfy its demand for gas, which the Economist Intelligence Unit forecasts will more than double by 2020 (see chart). Albeit belatedly, India's government also jumped on the bandwagon, promising to revamp the regulatory regime for shale gas development and announcing in May 2011 that six blocks would be auctioned for exploration before the end of the year. But there are many reasons to question the credibility of India's high hopes for shale.

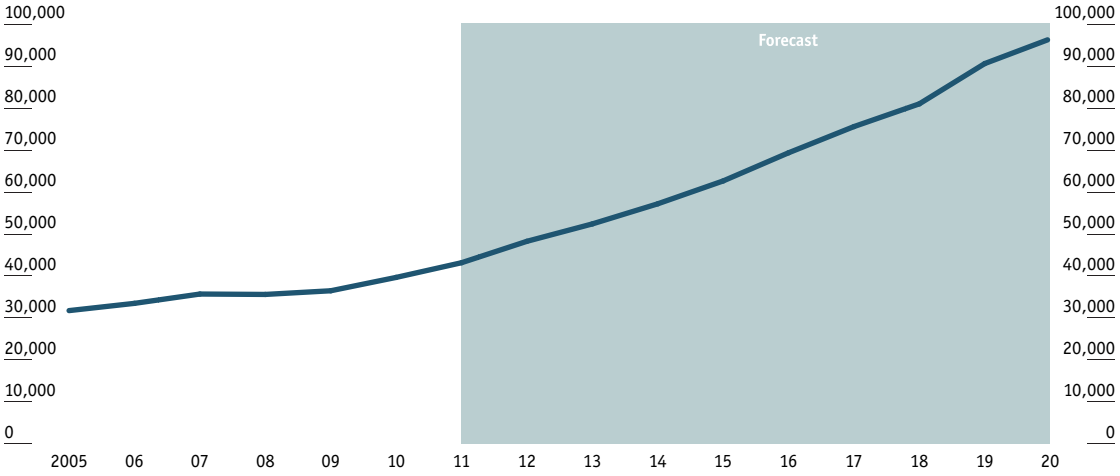
Wobbly figures

On the positive side, India has positioned itself to tap the US's pioneering shale gas capabilities. An agreement to promote knowledge transfer was signed last year with the US Geological Survey, a government body. This was followed by a US-India Memorandum of Understanding on technology sharing. Meanwhile, ONGC has called in international expertise to help with exploration by partnering the world's biggest oil services company, Schlumberger.

Yet, on closer examination, to date very little actual exploration work has been done to justify the bullish projections. By July 2011 ONGC (the country's largest explorer) had drilled just a handful of wells, one of which came up dry, according to reports. Unsurprisingly, only negligible quantities of shale gas have been found so far. Indian officials speak vaguely of around 9trn cu ft having been found in 33 other blocks, but even if this were true it does not amount to much gas and there are scant reports of actual drilling.

The gap between the upper and lower bounds of estimates of Indian reserves is telling. Judged by

Gross domestic consumption of natural gas in India
(ktoe)



Source: Economist Intelligence Unit.

figures from a study of global shale resources by the US Energy Information Administration, India's reserves are small by global standards: technically recoverable shale gas resources stand at just 63trn cu ft, or about 30 years of supplies at current rates of consumption. This pales in comparison to China's estimated reserves of 1,275trn cu ft. India's relatively low number is no doubt partly attributable to the limited exploration work done to date. But it also throws into doubt the more optimistic figures being bandied about.

India's government recognises that better data are required. But even if gas levels beneath the surface prove to be great enough to make extraction worthwhile, the work will have only begun. India's policy framework for shale—or, more accurately, the lack thereof—will need to be developed. Not only must existing laws be amended simply in order to allow production to take place, but a new fiscal policy regime may be needed (tax incentives have been a feature of the US shale gas boom). India's exploration licensing regime will also have to be adjusted to take account of unconventional energy sources.

So far, the consequences of an absence of enabling policies have been reflected in a singular lack of significant action by Indian companies in their own country. Overseas, they are making some headway: Reliance Industries entered into three shale gas joint ventures in the US in 2010; Oil India (OIL) has sought opportunities there and in Argentina; and the Gas Authority of India (GAIL) has pursued assets in the US market. By comparison, these players have been remarkably inactive at home.

More fracking problems

The policy framework is not the only obstacle to unlocking India's (largely unproven) shale gas reserves. Land acquisition promises to be another stumbling block: infrastructure projects in India are infamously vulnerable to local opposition concerning land-use rights, and shale gas extraction requires large tracts of land.

Environmental fears that have become prominent elsewhere will no doubt also be mirrored in

India. (Controversy chiefly stems from the use of chemicals in the process of hydraulic fracturing, or "fracking", used to fracture the rock in which shale gas is trapped deep beneath the surface.) Green activists can also be expected to obstruct projects more successfully than in neighbouring China. Yet, if shale gas is ever to stand a chance of booming in India, arguably the biggest issue with which policymakers must grapple is gas pricing.

India artificially depresses gas prices, partly to subsidise supplies to the poor. Under the so-called Administered Pricing Mechanism covering fields owned by ONGC and OIL, prices more than doubled to US$4.2/mBtu in May 2010, and in March 2011 an inter-ministerial panel agreed to elevate the rate for industrial users to US$5.25/mBtu. But gas still trades below market prices in many cases.

Compounding the problem for shale gas investors is the fact that the cost of technically complex unconventional gas production is higher than that of regular gas production. An inkling of the difficulties lurking ahead can be glimpsed from the government's difficult juggling act in continuing subsidies while trying to promote Australian liquefied natural gas imports, which can cost almost three times as much as subsidised domestic gas. It was this that prompted the decision to raise prices for some customers in March 2011. Similarly, to make exploration and extraction of unconventional gas attractive, it may be necessary to contemplate raising tariffs further.

Yet hiking gas prices is a political hot potato. The current administration will be less likely to do so as it courts the support of the majority rural poor (its core vote) ahead of general elections in 2014. Unattractive pricing is therefore likely to continue to dampen interest in the capital-intensive shale gas sector until at least that time. Perhaps by then there will be a clearer picture of how much gas is trapped beneath Indian soil. Given the prevailing policy uncertainty, however, even that is far from assured.

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RUSSIA

Bearish implications

A global shale gas bonanza could cause big headaches for Russia.

In January 2009, when a Russia-Ukraine energy dispute triggered a Europe-wide gas supply crisis, many of the continent's capitals became convinced of the need to shift gas supplies away from those controlled by Russia. At the time, it is unlikely that shale gas was in many policymakers' minds. But now, just a couple of years later, Europe is busy examining its unconventional gas options.

Shale's rapid climb up the European energy agenda is partly driven by a somewhat clearer reckoning of its potential. The initial assessment by the US Energy Information Administration (EIA) of shale gas resources in 32 countries found that several import-reliant European countries have sizeable estimated shale gas resources. These include Poland (with 187trn cu ft in technically recoverable resources), France (180trn cu ft) and Norway (83trn cu ft).

Yet the underlying momentum behind shale comes from a heightened desire to reduce dependence on Russian gas—notably among countries in Eastern Europe that were formerly under Soviet control. They fret about Russia's propensity to use its dominant-supplier status to distort prices; Russia has also been widely accused in the region of using its monopolistic status as a political weapon.

In Poland, which—despite a recent warming of relations—has historically had troubled ties with Russia, the hope is that the gas could bring long-term energy independence. It could even be harnessed for export to neighbours. Accordingly, Polish authorities have issued around 100 permits for exploration. International energy majors are already involved.

Similarly, in Ukraine the advent in 2010 of a more pro-Russian presidential administration has not stalled plans to diversify energy supplies, and tapping shale (the country has 42trn cu ft, according to the EIA) is one aspect of this. Ukraine's energy security looks particularly precarious under the status quo. Spurred on by bitter disputes in recent years over gas, Russia is pursuing plans to build alternative gas pipelines to Europe that would bypass Ukraine, currently a key transit route: the first phase of Nord Stream, piping gas to Germany, opened in September 2011. This threatens to diminish Ukraine's leverage over Russia, which, according to Ukraine, overcharges for gas. Presently, Ukraine is firming up plans to issue shale gas exploration licences; a number of international energy majors are thought to be interested.

Dissipating Russian power?

What, then, does the shale gas "revolution" mean for Russia, for which conventional gas exports are a crucial pillar of its economy and energy strategy? A recent report by the Baker Institute for Public Policy at Rice University (financed by the US Department of Energy) reached some striking conclusions about shale's potential to reduce Russia's energy—and geopolitical—influence.

The study considered several scenarios. In a world with unfettered shale gas development, it found that Russia's share of Europe's gas market (excluding former Soviet countries) would decline to 13% by 2040, from 27% in 2009. (This assumes that, among the various Russian gas pipelines to Europe currently under consideration, only Nord Stream would be built, and that there would be little demand for Russian Arctic gas until at least 2030.) By contrast, without the advent of large-scale shale gas developments, the authors reckoned that Russia's share of the European market would stabilise at around 19%. Russia would be able to secure higher prices in Europe.

Moreover, the impact will not only be felt by Russia in European markets. Shale gas also has the potential to slow inroads by Russian gas in Asia, notably China. Russia, which wants to diversify its energy exports, hopes energy-hungry China will become a big market for its gas. The two countries have been negotiating a gas deal for several years, with Gazprom planning to supply 30bn cu metres/year to China through a new pipeline from 2015, but the agreement has been blocked by squabbling over prices. Both sides regularly express optimism about an imminent breakthrough, most recently aspiring to reach a deal by mid-2011. But a shale gas boom will put a further brake on proceedings—especially if it extends to China, which the EIA believes has even greater resources than the US.

Growing pressure on Gazprom

Russia may take some solace from continued doubts about whether the conditions that have sped shale's progress in the US will be replicated in Europe. In its *World Energy Outlook 2011 Special Report: Are we entering a golden age of gas*, published in mid-2011, the International Energy Agency said that it did not expect substantial amounts of shale gas production until after 2020, owing to the need to evaluate and develop resources, along with environmental and regulatory issues. Already, France has imposed a moratorium on shale gas development because of environmental worries.

This has raised concerns, especially in Poland, which is enthusiastic about shale gas, over the potential introduction of some form of EU-wide restriction on shale gas development. Regulatory restraints could also present daunting obstacles to progress in Ukraine: development by international majors of Ukraine's potentially sizeable oil and gas reserves in the Black Sea has been held up for years by such controls.

But even if Europe proves slow on shale, the rapid development of the industry in the US has significant implications for Russian gas. Knock-on effects are already being felt: liquefied natural gas (LNG), mainly from the Middle East, that was previously meant for the US has been freed up for the European market.

This has added to pressure from Gazprom's European customers to reform the current system of long-term contracts under which gas prices are linked to oil prices. Gazprom has been forced into concessions, in early 2010 allowing some indexation to spot gas prices. Although the long-term price

implications of a concerted move towards such a pricing system are unclear, the effect in the short to medium term would be to place downward pressure on prices. (Greater availability of LNG is also believed to be contributing to China's tough stance in negotiations with Russia over the price of future gas deliveries.)

The US shale boom has also already directly affected one of Gazprom's main strategic projects, its giant Shtokman gasfield in the Barents Sea. Around 90% of the LNG to be produced from Shtokman was destined for the US. But in February 2010 it was announced that the launch of output had been delayed until 2016, and in February 2011 the authorities suggested that it may be delayed until 2018 because of reduced US demand for LNG.

Despite this, Russian officials are keen to underplay the potential of shale gas. They argue that the cost of exploiting it will be much higher than expected and cite environmental objections. This bravado masks increasing concerns. As the shale gas phenomenon goes global, from eastern Europe to the US and China, the implications for Russia are dramatic.

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Appendix

Technically recoverable shale gas resources, top 20 countries (trillion cubic feet)

China	1,275
United States	862
Argentina	774
Mexico	681
South Africa	485
Australia	396
Canada	388
Libya	290
Algeria	231
Brazil	226
Poland	187
France	180
Norway	83
Chile	64
India	63
Paraguay	62
Pakistan	51
Bolivia	48
Ukraine	42
Sweden	41

Source: US Energy Information Administration

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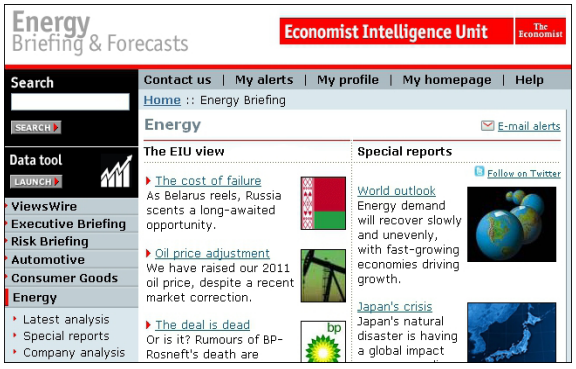

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