SHALE GAS, EXPLORATION IN EL DORADO

"Are we entering a golden age of gas?" The question was posed in the latest IEA report and if the experts are to be believed the response is firmly positive. They have made predictions of a bright future based largely on the emergence of unconventional natural gas. The United States has witnessed a gold rush more commonly associated with the nation's frontier past, one that is raising some serious concerns for the environment.

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In the recently published report, the International Energy Agency (IEA) presented a scenario under which the global use of natural gas could rise 50% by 2035, at which point it would represent one quarter of global energy demand. The resource hungry emerging economies will play a significant role with demand in China expected to reach parity with the entire European Union by 2035 and India's current demand multiplied four-fold.

What logic underpins these spectacular claims? Sheltered from the general opprobrium leveled at the oil and nuclear industries in the wake of the blowout at Deepwater Horizon and the disaster at Fukushima, natural gas has emerged as the energy sector's unlikely poster child. Cleaner and more flexible than other

hydrocarbons natural gas possesses a number of advantages that other technologies are finding hard to match.

Global natural gas resources are vast and widely distributed. In recent estimates the IEA has predicted supplies sufficient for the next 250 years at current levels of production. Across five continents the potential is there and in a statement made by Nobuo Tanaka, Executive Director at the IEA during the presentation of the aforementioned report he indicated that recent developments have shifted more attention to the increased role natural gas could play in the global energy mix. Indeed, he stated the potential for, "the global gas market to become more diversified, and therefore improve energy security."

Unconventional gas, a key role in the expansion

Only a few years ago it was rare to hear such optimistic claims and it has been the rise of unconventional gas that has completely reshaped the playing field. Reserves have been estimated by the IEA to be at least as widespread as the conventional natural gas that currently accounts for 85% of world production. One of the primary sources is shale gas named for the non-porous rock in which it is found. Another is the so-called "tight gas" produced from reservoirs with low permeability, under extremely high pressure, and grouped in compact pockets throughout rock deposits. Less promising sources are coal bed gas found in seams underground or methane hydrates, buried in the sediment of the world's oceans.

The existence of these resources buried just beneath the earth's surface has been known for years but it is only recently that advances in exploration techniques intersected with rising energy prices to force them from the shadows. "The petroleum industry has known about unconventional gas for years but because of the available technology and the market conditions was unable to exploit the resource," notes Jean-Michel Gauthier, Chair in

Energy and Finance at HEC and Senior Partner in charge of Energy and Resources at Deloitte. “In the trade, some were heard to say [the market] would arrive ‘post-nuclear’ ...”

Thinking underwent a radical shift over the course of the last decade and “suddenly, we began to witness significant levels of unconventional gas and were made aware of the vast potential represented by structures such as the Barnett Shales in Texas,” explains Gauthier. “Forecasters have completely changed their tune and are now making predictions that unconventional gas will represent at least 45% of production within the next few years.”

Shale gas, rising star

The exploitation of shale gas ignited a genuine revolution in the United States. In a country that only recently witnessed massive investment in terminal infrastructure to receive imports of liquefied natural gas the Americans now find themselves sitting on enormous reserves. Economist Jean-Marie Chevalier of the Centre of Geopolitics of Energy and Raw Materials (CGEMP) at University Paris-Dauphine notes, “The United States was viewed as a massive importer and now finds itself on the verge of becoming an exporter. Gas prices have been cut in half.”

With doubts over the potential of these new resources, large oil multinationals played a negligible role in the initial development of the sector. “Unconventional gas has arrived by way of small American firms,” admits Gauthier. He mentions that the North American petroleum industry presents a stark contrast to the European market and is populated by a multitude of small independent operators, particularly in Canada. “They are in many ways the ‘cowboys’ of the exploration, of which they are the masters, putting new techniques to the test.”

As possibilities have become clearer, there has been a rush of activity as other actors attempt to catch up. “Over the last two or

three years shale gas has become a major component in the strategy of large multinationals," confirms Gauthier. "The recent wave of mergers and acquisitions, the large transactions on the Oil & Gas market, are for the most part related to unconventional gas. Look at ExxonMobil on XTO or Total on Syenco and UTS Energy. Large groups are either signing joint ventures with small operators or buying them. Most of the current investment in unconventional gas is coming from large multinationals."

At the moment, the United States is the only country to have made significant strides in the development of the new resources but other countries with promising conditions are making up ground. In Asia, China is in the process of approving a first wave of permits for exploration, and Indonesia has plans to do the same by 2012. In Europe, Poland is leading the way due to its promising geological characteristics and has already granted 86 permits.

And yet shale gas has seen its image somewhat soiled in recent months by a foul smelling odor that colors otherwise enviable qualities. The reason: a whiff of danger surrounding the practice of hydraulic fracturing, or "fracking", a key technology at the heart of the entire process of exploration and exploitation.

The controversy surrounding hydraulic fracturing

Conventional natural gas deposits are found in pockets of porous and permeable rock and can be extracted through a simple vertical well. Shale gas, like tight gas, requires a different approach as gas containing cavities are scattered throughout the rock and are not interconnected.

"If you just dig a hole you won't get anything," states Hedi Sellami, Director of Research in the Geosciences Department at Mines ParisTech and a specialist in underground mining techniques. Sizable quantities of trapped gas must be released through drains that are drilled horizontally to form pathways over

which the gas can flow into the well. Yet this is only part of the picture, in order to really 'suck up' the natural gas hydraulic fracturing needs to be used. Fluids are pumped into the shale under high pressure to create fissures. "Cracks need to be created and the fractures must remain open," specifies Sellami. "The composition of the material injected, the 'propellant', plays a key role, relying on mixtures composed largely of water and sand." These techniques are what make the whole process possible.

Hydraulic fracturing and horizontal drilling have been deployed on a much smaller scale in the exploration and production of conventional gas deposits, primarily as a means to "push" wells nearing the end of their productive life. For use exploiting shale gas "the difference in relation to conventional gas is that a much larger number of wells are required." This is done to multiply points of contact with the reservoir, explains Jean-Louis Durville, a member of the French corps of engineers responsible for bridges, water resources, and forests, and co-author of a report ordered by the French ecology ministry on the subject. France could indeed possess significant reserves and to draw inspiration might want to cast a glance east. In Poland, "wells have sprung up very two, three, or four kilometers."

Recently, the repeated process of well digging and hydraulic fracturing has been accused of causing significant and unpredictable consequences to the subterranean world, particularly in respect to underground aquifers. Criticism was heard from specialist corners as early as the mid-2000s but the rapid diffusion of the documentary Gasland, release in 2010, served as the fuse for the firestorm that followed. The film depicts areas where the industry has already matured and where residents are crying out about the rapid degradation of their health following the implantation wells. A number of the subjects of the film possess carefully guarded samples of brownish water as evidence of their claims. In one spectacular scene a homeowner

demonstrates his ability to ignite the water that flows from the household tap and the image is emblematic of the film's overall tone.

The film received the Special Jury Prize in the documentary category at the 2010 Sundance Film Festival and created a media sensation over the way energy concerns, in their heady rush to exploit the new resource, neglected the implementation of sufficient environmental safeguards.

A poor understanding of environmental consequences

American activists have raised an outcry over a number of incidents but have yet to provide any definitive evidence for their claims. Under the Bush administration, the American authorities initially made an assessment that the environmental consequences of hydraulic fracturing would have a negligible impact on groundwater supplies. A loophole in the 2005 Energy Bill exempts drillers from Environmental Protection Agency (EPA) guidelines such as the Safe Drinking Water Act. The agency has sincereconsidered its position and was directed to launch a far reaching investigation in 2010 to determine if there are any shortcomings in the current policy.

In the meantime, public wariness in the face of the new technology has grown more animated, particularly in France where an initial offering of exploration licenses had only just been approved. The government has since ordered a moratorium on all permits for exploration until further review.

Some observers have expressed regrets over the level of public outrage and its arrival before the extent of reserves has even been determined. Jean-Marie Chevalier reflects this disappointment and has orchestrated a debate on the subject for the newspaper *Le Monde*. "I believe we should first make an estimate of the potential," he explains. "As an economist, I'm very sensitive to the

fact that right under our feet there could be a cheap and abundant source of gas, as well as opportunities for job creation."

"In the United States the lack of any real controls along with the rapid pace of [well digging] has led to incidents that are clearly linked to gas exploration," Durville states. "And yet, it could also be said that in relation to the level of activity the number of incidents has in fact been negligible." The specialist advised a cautious approach until the release of results from the American study but would also like to underline that, "the causes are not always linked to hydraulic fracturing and can often be traced to problems cementing the well."

An opinion that is shared by Hedi Sellami, who emphasizes the depth at which hydraulic fracturing takes place: "in the well architecture [for shale gas extraction], a vertical hole is drilled as with any other type of well, and this is what passes through any superficial aquifers. Once a depth of about two kilometers is reached a fork is created, a horizontal well [...], then fracturing. Fractures commonly extend some ten meters, sometimes more. It's difficult to imagine how reserves buried so deeply underground could have an impact on superficial aquifers. On the other hand, problems with cement and well casings have been known to arise in the vertical shaft, and gas can escape." This problem, while it remains rare, becomes more probable when thousands of wells are being installed as has been the case in the United States.

Other dangers exist in addition to the problems with fissures. Hydraulic fracturing requires incredible amounts of water and chemicals to be blasted into the rock in order to optimize the process. For all wells the risk "that weighs most heavily is for contamination of ground water supplies through poorly sealed wells or accidents at the surface," explains Jean-Louis Durville. "The number of big rigs required to service a well, for example, is

staggering. We could easily imagine a tanker carrying dangerous chemicals overturning or pipe leakage during routine transfers."

Continuing research within a structured regulatory framework

Today, with a lack of any competing technology to hydraulic fracturing for the exploitation of shale gas resources, natural gas companies have been compelled to develop their capability for so-called "clean exploration". "In the face of increasing environmental and media pressure, companies have made the decision to invest in R&D as a way to improve their practices ,though given the stakes involved many have remained rather quiet on the subject," explains Jean-Louis Durville. A number of possibilities exist, particularly through restricting the number of chemicals involved or reducing water dependence through recycling programs.

A more extensive investigation into the mechanism of fracturing could lead to greater control of the technology, and could be achieved through techniques like seismic monitoring. "Through an analysis of acoustic emissions during fracturing we arrive at a more nuanced understanding of where the fissures are located," Hedi Slimani explains. "The technology is advancing rapidly and promises a range of improvements, allowing treatments to be targeted accurately and ensuring they affect only the desired zones."

In the opinion of Jean-Louis Durville, the American experience has clearly demonstrated the need for a robust regulatory framework. He continues, "if regulation is weak, we shouldn't be surprised if problems arise."

In the report he authored along with three other specialists, Durville has suggested a research phase based on strictly regulated exploratory work and recommends "waiting for results

from this initial research phase, before allowing any further use of the most controversial technique, hydraulic fracturing, restricting its use solely to what is necessary for scientific purposes."

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