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THE °CLIMATE GROUP

UNCONVENTIONAL GAS

Insight Briefing | Analyzing the issues that matter to the Clean Revolution

ABOUT

This briefing reviews the pros and cons of the exploitation of unconventional gas resources, in particular from the perspective of addressing global climate change. It highlights the economic benefits as well as the environmental challenges associated with extraction and use. It then looks at regional responses around the world and concludes with an analysis of the role of unconventional gas in the Clean Revolution.

SUMMARY

The spectacular growth in unconventional gas reserves and increasing levels of extraction in recent years is changing the international energy and climate landscape. The use of cheap and abundant shale gas in the US has helped deliver major economic benefits, which other countries are now seeking to emulate. As the 'cleanest' fossil fuel, natural gas, particularly from unconventional sources, could displace large amounts of coal from the power sector, reducing greenhouse gas emissions in the shift to lower carbon energy systems. But unconventional gas is no panacea to climate change. Its potential as a transition fuel depends on dealing with substantial challenges relating to fugitive emissions and its impact on global greenhouse gas targets. Any sustainable, long-term exploitation of unconventional gas can only take place within the framework of strong and increasing national and international emission reduction targets. Without the cost-effective commercialization of carbon capture and storage (CCS) technology in the short to medium term, the use of unconventional gas will be limited to a brief, transitory role in the shift to lower and then zero carbon energy systems. Critical to all of this is early action by policy and decision-makers. The necessary parameters for the sustainable use of unconventional gas must be put in place today to avoid investments that entrench a high carbon energy infrastructure of tomorrow.

INTRODUCTION

Technological advances by the oil and gas industry in horizontal drilling and hydraulic fracturing ("fracking") have unlocked vast global reserves of low-cost shale, coal bed and tight gas in recent years. Full extraction and use of these unconventional natural gas resources in the coming decades has potentially huge economic and environmental implications. Proponents of unconventional gas have touted its potential to reduce carbon emissions, acting as a transitionary fuel to replace coal, while at the same time delivering low cost energy to business and household consumers. Opponents have highlighted local environmental impacts from drilling, displacement of renewable energy investment, potentially limited carbon savings compared to coal, and significant price uncertainty over the medium to long-term. Different regions are approaching unconventional gas in different ways, creating a varied overall impact on the global energy mix.

ECONOMIC IMPACTS

The extraction of unconventional gas has the potential to create major economic benefits. In the US, where commercial drilling is now well established, the primary economic impact has been to dramatically drive down natural gas prices, with ripple effects across the whole of the energy sector. The US now enjoys gas prices that are half those of Europe's and nearly a third of China's and Japan's

WHAT IS UNCONVENTIONAL GAS?

Unconventional gas refers to shale (a type of rock formation), coal bed and so-called 'tight' gas resources that have traditionally been uneconomical to extract. This is because they are more diffuse, with the gas trapped in rock formations with low permeability. Like conventional natural gas, unconventional gas is principally composed of methane, a powerful but short-lived greenhouse gas.

THE KEY TECHNOLOGIES

The boom in unconventional gas production is due in particular to the emergence of two key technologies:

- Horizontal drilling, where wells can follow along thin shale or coal seams and;
- Hydraulic fracturing ("fracking"), which increases the permeability of rock near the well through the injection of water, sand and several additives under high pressure. This creates clear conduits along which gas (and oil) can move.

GLOBAL RESERVES

All regions, except the Middle East, possess more unconventional than conventional gas, although total global reserves of the latter are still estimated to be greater (421 versus 331 trillion cubic meters). IEA, 2012

The size and accessibility of unconventional gas reserves remains poorly understood in most regions, and is likely to change as technology and exploration activities develop. In the US, for example, estimates of natural gas reserves have been upgraded for eight consecutive years due to greater exploration of existing gas fields and discoveries of new ones. In 2010, proven US gas reserves increased 17% on 2009, representing the largest volumetric rise on record.

(see Figure 1). As recently as 2009, the US experienced similar price levels to Europe. The current price differential reflects the fact that, unlike oil, the international natural gas market is fragmented and regionally based. The lack of sufficient export or import facilities in key markets (the former in the case of the US) has prevented a convergence in price. World trade in liquefied natural gas (LNG), however, is expected to more than double by 2030, which should drive greater price convergence. Whether this leads to a common international price remains to be seen. Recent analysis suggested that unrestricted LNG exports from the US would raise the domestic gas price by at most US$1.1 per MMBtu[1], which would still leave prices significantly lower than in other markets.

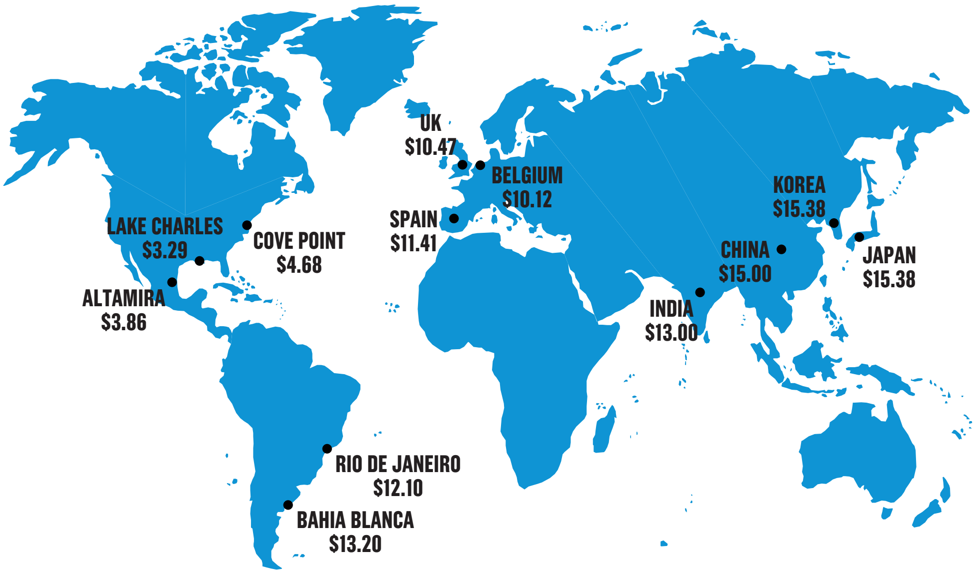

FIGURE 1 Estimated world prices for liquefied natural gas (LNG), January 2013. ($US/MMBtu) Source: FERC

MORE COMPETITIVE ECONOMIES

The reduction in natural gas prices has direct knock-on effects. Lower energy costs help to reduce production costs for companies, particularly in energy intensive industries, while households benefit from reduced energy bills. The improved performance of the US economy in recent years can be partly explained by these effects. Bank of America, for example, calculated US businesses and consumers saved US$566 million per day in 2012 as result of cheap shale gas supplies. Changes in energy prices also drive changes in the industrial mix of an economy. PwC has predicted that the shale gas revolution will spur the return of energy intensive industries to the US, creating 1 million additional manufacturer jobs by 2025.

CHANGE IN ELECTRICITY GENERATION MIX

Cheaper gas also has important implications for the generation mix in the power sector. The dramatic falls in gas prices witnessed in the US have made investment in gas-fired generation compelling for many. The impact on coal fired power, for example, has been substantial. Between 2009 and 2012, coal's share of total US electricity production fell from around 50% to 34%. The precise shift in mix, however, will vary from country to country depending on the existing portfolio of generation technologies, energy and climate policy, as well as international trading connections. In general, though, abundant cheap gas from unconventional sources has the potential to displace coal, nuclear and renewable power generation by lowering the cost of electricity and undercutting other forms of generation. See the 'Regional Responses' section for further information on regional effects.

[1]One million British Thermal Units.

CLIMATE IMPACTS

Set against the economic benefits of cheap unconventional gas are two substantive climate issues. These relate to fugitive methane emissions and the increased use of gas on global greenhouse gas (GHG) reduction targets. Local environmental effects, meanwhile, have raised additional questions about the sustainability of unconventional gas extraction.

"WHILE NATURAL GAS IS THE CLEANEST FOSSIL FUEL, IT IS STILL A FOSSIL FUEL. ITS INCREASED USE COULD MUSCLE OUT LOW-CARBON FUELS SUCH AS RENEWABLES AND NUCLEAR... AN EXPANSION OF GAS USE ALONE IS NO PANACEA FOR CLIMATE CHANGE."

Nobuo Tanaka,
former Executive Director,
International Energy Agency

FUGITIVE METHANE

Natural gas is recognized as the cleanest of all fossil fuels at the point of combustion. However, methane leakages ('fugitive emissions') along the supply chain, and particularly at drilling sites, can increase the emissions intensity of unconventional gas when assessed on a life cycle basis. There is very little published data on fugitive emission rates for unconventional gas, with a range of between 0.1% and 4% typically assumed. The US Environmental Protection Agency (EPA) currently uses a rate of 2.3% for shale gas.

The high global warming potential (GWP) of methane means that these small numbers can represent significant levels of greenhouse gas emissions. This in turn could mean that any carbon savings (relative to coal use at the point of combustion) from unconventional gas could be substantially reduced or even entirely negated by supply chain leakage. Over a range of plausible assumptions, it is estimated that unconventional gas varies from about 40% less intensive than coal, to negligible or slightly negative benefit (see Figure 2). More field data, specific to resource (i.e. shale vs. coal seam gas), region and local infrastructure, is required.

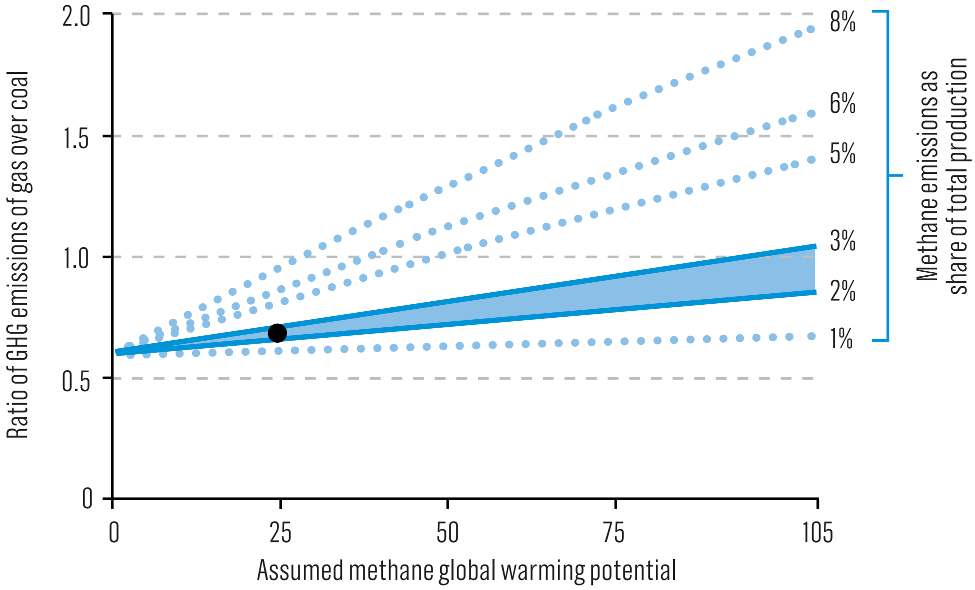

FIGURE 2 Emissions intensity of unconventional gas relative to coal, as a function of GWP and fugitive emissions rate (IEA 2012)

Crucially, the impact also depends upon the timescale over which fugitive emissions are considered. Some scientists favor a 100 year time frame for calculating methane's GWP, arguing that the cumulative (i.e. long-term) impact is most relevant. This gives methane a GWP of 25 (i.e. one ton of methane has the same warming effect as 25 tons of carbon dioxide). Others argue for a 20 year timescale to reflect concern over the proximity to dangerous climatic tipping points. This approach increases the potency of methane's GWP to 72. Immediate consensus on the issue seems unlikely.

Regulation of drilling site design and operation would be the most direct means of addressing fugitive emissions. A sufficiently high carbon price would provide another incentive to regulate fugitive emissions, although this would require the use of project specific data, rather than the generic industry-wide emissions factors currently used. Existing carbon pricing systems tend to use the 100 year GWP for methane, which discounts impacts on a decadal timescale. Given the ongoing absence of carbon pricing in a number of key economies and low prices in regions where a price is in place, direct regulation provides the best policy lever for the immediate control of fugitive emissions.

"LOW-COST GAS ALSO HAS THE POTENTIAL TO DISPLACE ZERO-CARBON RENEWABLES, INCREASE DEMAND FOR ENERGY OVERALL, AND CATALYZE THE RETURN TO THE UNITED STATES OF ENERGY-INTENSIVE INDUSTRIES ... WE ESTIMATE THE NET IMPACT AS RANGING FROM A SLIGHT REDUCTION TO A SLIGHT INCREASE IN OVERALL US GREENHOUSE-GAS EMISSIONS, DEPENDING ON THE LEVEL OF FUGITIVE METHANE EMISSIONS."

McKinsey & Company

The IEA report Golden Rules for a Golden Age of Gas outlines key best practice principles to minimize the impacts of fugitive emissions. These include disclosure of fugitive emissions, and the elimination of leaks, venting and flaring wherever possible.

CARBON EMISSIONS

Supporters of natural gas (conventional and unconventional) have argued that a rapid transition away from coal use in the power sector to gas-fired generation is the fastest and cheapest option for carbon emission reduction in the short to medium term. The significant carbon reductions following the UK's 'dash for gas' in the 1990s and the recent falls in US CO2 emissions (down 13% since 2007 alone) in the wake of the shale revolution lend weight to this argument (although a number of trends have driven US reductions). Repeating this transition in the major emerging economies – not least China – is, on the face of it, very attractive for many governments and businesses.

Studies, however, have underlined that natural gas is no panacea for delivering long-term emission reductions. Although current unconventional gas reserves could supply world energy demand on their own for perhaps two decades, the resulting CO2 emissions would still exceed the remaining 2˚C 'emissions budget' for 2000 to 2050. To put it another way, accounting for the projected increase in natural gas use – even with the adoption of newly announced climate policies – will mean that global energy related CO2 emissions will continue to rise from 31 gigatons (GT) in 2011 to 37GT in 2035. This will increase the levels of GHGs in the atmosphere to 660 parts per million and lead to an average and dangerous global temperature increase of 3.6ºC over the coming century.

Taking into account the continued (but hopefully declining) use of other fossil fuels, it follows that to ensure a safe climate, unconventional gas reserves cannot be fully developed and used as they currently are (i.e. for unabated combustion). This means that significant amounts of gas either stay in the ground, or mitigation technologies such as carbon capture and storage (CCS), are commercialized at the necessary speed and scale to contain and reduce emissions.

LOCAL ENVIRONMENTAL ISSUES

To date the most high profile environmental issues associated with the exploitation of unconventional gas have been local ones. These non-climate related concerns include water use and disposal (during the drilling phase), aquifer disruption (due to leaking well casings), earth tremors (as a result of the fracking process) and land use conflicts. Adhering to best practice can minimize local environmental risks, although not eliminate them, as recent studies have indicated. But given the frequent overlap with agricultural or even residential land use, community engagement is essential for building the social license for the extraction of unconventional gas.

REGIONAL RESPONSES

The tension between economic opportunity and environmental risk has led to different outcomes for unconventional gas around the world to date. Several regions have rushed to exploit unconventional gas resources, while others have implemented drilling bans.

THE UNITED STATES

The US has led the way in developing the economic opportunities offered by unconventional gas. As noted earlier, shale gas has revolutionized the US energy market. Abundant shale gas supplies in the US have depressed natural gas prices, helping to displace coal based power generation but also making renewable energy less competitive in the short to medium term. The same technologies that have unlocked shale gas reserves (such as horizontal drilling) are also opening up new oil resources, contributing to projections of US energy independence by 2035. Meanwhile – and perhaps counter-intuitively – US coal production is expected to recover, despite the shale gas boom. In the absence of sufficient domestic demand, US coal is increasingly being exported, including to Europe, reducing the emission reduction benefits from the US's coal to gas switch. Recent research has suggested that just over half of the emissions avoided in the US may have been exported as coal.

"THERE ARE TWO VIEWS... IT'S A 'BLUE BRIDGE' TO A GREEN FUTURE, OR IT'S THE DEATH OF NUCLEAR AND RENEWABLES. I DON'T THINK WE KNOW THE ANSWER YET."

Michael Greenstone, Economist, MIT

AUSTRALIA

In Australia, a focus on coal seam gas has created an enormous export opportunity, with AUD$45 billion of capital spending planned in northeast Australia alone. This focus on increasing exports means domestic gas prices are likely to double, approaching parity with international gas markets. This would make renewable energy, particularly onshore wind, more competitive. However, it also risks further embedding low-cost coal generation. Precisely how the shift in generation mix plays out remains uncertain and will be influenced by the direction of the carbon price in Australia and other energy policies, such as the Renewable Energy Target.

CHINA

China potentially has the largest shale gas reserves in the world, with the government estimating a 200 year supply at current consumption levels. Exploration thus far has been limited, however. China is currently aiming to produce 6.5 billion cubic meters (bcm) of shale gas by 2015, and 80bcm by 2020, which is modest compared with the 142bcm extracted by the US in 2010. China's focus through 2015 will be on exploration-related activities and testing new technologies to unlock its shale gas reserves. Some analysts believe that China will need to overcome a range of barriers, including higher production costs, infrastructure bottlenecks, and regulatory red tape before it can begin to exploit shale gas on the same scale as the US. HSBC meanwhile has pointed to limitations on extraction imposed by increasing government restrictions on water use. Given that a typical horizontal well uses between 9 and 19 million liters of water, China's water availability and water targets may well be at a mismatch with its shale ambitions. According to officials, China's aim in the short term is to learn from the international community's experiences, both positive and negative, and to strengthen regulations and industry practices to mitigate the adverse environmental impacts associated with shale gas development.

EUROPE

European countries have been among the most cautious in exploring and exploiting unconventional gas resources. Several regions have imposed moratoriums on fracking (some now lifted), following community concern and fears over unintended effects on the local environment. The market dynamics in Europe are less certain given unconventional gas exploration is only just beginning, with future gas prices unknown. In theory, cheaper gas from unconventional sources should drive a shift away from coal.

At present, however, gas-fired generation is being squeezed out of the power sector in favor not only of renewables, but also coal, largely as an unintended consequence of current climate and energy policies. The expansion of renewable generation into electricity spot markets, for example, is capturing what were profitable revenue sources for gas operators. At the other end of the power sector, very low carbon prices make it more profitable for generators to burn coal even though they need to purchase a greater number of carbon credits. The import of cheap US coal will add to the woes of natural gas in Europe, where coal use was up by around 7% in 2011 – a historic high.

THE CLEAN REVOLUTION VIEW

Unconventional gas could either help or hinder the Clean Revolution and the transition to sustainable low carbon economies. On the one hand, the potential for low cost unconventional gas to displace significant amounts of coal-fired power generation globally is substantial. The shift could potentially drive much needed global emission reductions in the short to medium term. But such promise depends on meeting a number of critical conditions, including:

- containing fugitive emissions at levels that guarantee substantial carbon savings;
- ensuring coal displaced from one location is not utilized elsewhere;
- avoiding displacement of renewables (which ultimately need to form the backbone of global energy systems) by ensuring policy environments incentivize renewables as first best energy option;
- fully addressing local environmental impacts through the adoption of best practice procedures;
- and, either developing investment strategies that reconcile short term growth in capacity with the likelihood of early redundancy of assets (as gas enjoys a bright but short career as a transitory energy source);
- or, commercializing CCS technology at sufficient speed and scale – and economical cost – to allow long-term, mitigated gas use.

Each of these conditions provides significant challenges for the unconventional gas industry, power utilities and policy makers. This is particularly true of CCS commercialization, which remains highly uncertain due to both political and financial barriers. It is likely that it may always be a more expensive technology than renewables. Meeting all of the conditions, however, is essential to achieving a low carbon future in which natural gas (both unconventional and conventional) plays a part in the energy mix. Precisely how this is achieved remains to be seen, but three factors which would appear to be critical for success are:

- clear, binding and ambitious emission reduction targets to 2050 in all G20 countries, which lead to sufficiently priced carbon and incentivize clean technologies;
- strong and mandatory standards for monitoring, verifying and reporting fugitive emissions in all countries and which take into account the uncertainty in the GWP of methane; and
- large public-private joint investment in commercializing CCS technology, led by G20 countries.

Within these parameters, the extraction and use of unconventional gas could arguably proceed in a sustainable manner. For this to happen, however, requires policy and decision-makers to begin planning for this future today. This means clear and early signals that the future is a carbon constrained one. Without this, the wrong (i.e. high carbon) investments will continue to be made today and in the short and medium term. The outcome will be bad for the climate and ultimately costly for investors if (but more likely when) high carbon infrastructure is abandoned early. This may not be the golden age of gas that some had hoped for, but a clear, orderly and swift transition to zero-carbon energy sources is essential to avoid dangerous climate change, and must become the yardstick for energy decision-making in government and business alike.