THE OXFORD INSTITUTE FOR ENERGY STUDIES
A RECOGNIZED INDEPENDENT CENTRE OF THE UNIVERSITY OF OXFORD
UNIVERSITY OF OXFORD

Oxford Energy Comment

July 2013

UK Shale Gas – Hype, Reality and Difficult Questions

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Introduction

Many natural gas observers and commentators were resoundingly 'wrong-footed' by the transformation of the US from prospective LNG importer (the view in 2005) to the current expectation of it becoming a major LNG exporter. By the end of 2012 some 183 bcma[1] of US LNG import facilities had been constructed. The parallel growth in shale gas production from 2006, which obviated LNG import needs, was the result of the combined application of horizontal drilling and fracking[2] initially by the 'independent[3]' US upstream companies. In 2006 shale gas accounted for 5.4% of US natural gas production; by 2012 this had risen to 34%[4]. This surge of production ran ahead of demand, resulting in radically lower US gas prices – in April 2012 the monthly average Henry Hub price was $1.95/mmbtu[5]. Although it recovered to $3.50-4.00/mmbtu by June 2013, it was still well below the corresponding UK wholesale price of around $10/mmbtu.

Despite the setback to preliminary exploration drilling for UK shale gas in the vicinity of Blackpool due to an associated earth tremor, recent resource assessments of the UK's shale gas potential have fuelled speculation of an energy transformation for the UK with expectations of regaining a position of self-sufficiency in natural gas and lower prices. Drawing on US data, this Comment seeks to highlight the practicalities to be faced in developing the UK's shale gas resources and provides a 'reality check' on likely outcomes in terms of production volumes and price.

[1] 'The LNG Industry 2012', GIIGNL, http://www.giignl.org/fileadmin/user_upload/pdf/A_PUBLIC_INFORMATION/LNG_Industry/GIIGNL_THE_LNG_INDUSTRY_IN_2012.pdf, P 28
[2] The hydraulic fracturing of hydrocarbon-bearing strata creating a larger surface area for hydrocarbon egress, Contrary to much media comment, this has been established petroleum industry practice for many decades.
[3] Companies smaller in size or market capitalisation than the 'Majors'.
[4] EIA website, from excel sheet download at http://www.eia.gov/energy_in_brief/article/about_shale_gas.cfm
[5] EIA website, from excel sheet download tab 2tab at http://www.eia.gov/forecasts/steo/report/natgas.cfm

Gas in the UK Energy Mix

In 2012 natural gas accounted for 35% of the UK's primary energy consumption, down from 42% in 2010 (primarily due to an increase in coal consumption in power generation)[6]. Since the development of conventional gas production in the UK North Sea, gas has played a key role in space heating, industrial feedstock and process heat, and since the 1990s, in the power generation sector. The decline in the UK's natural gas production from 2001, albeit eminently foreseeable, has been traumatic: resulting in a transition from self-sufficiency as recently as 2004 to the 2012 position of imports constituting some 50% of the UK's requirements. Due to this rapid change and despite its global trading tradition and psychology, the UK appears to have a profound paranoia regarding reliance on gas imports, which for other European nations has been an established fact of life for decades. While increasing pipeline and LNG[7] linkages are rapidly establishing inter-regional connectedness in gas trade, the cyclical nature of LNG supply growth and the reduction in LNG available for Europe, due to increased Japanese demand following the Fukushima disaster, has bolstered the case of gas security of supply alarmists, at least for the period to 2015.[8] This despite the abundant pipeline gas supply capacity of Russia; available but not required, due to Europe's post 2008 crisis gas demand slump.

With this background it is unsurprising that the recent assessments upgrading the UK's shale gas potential have been well received by many constituencies[9].

UK Shale Gas Potential

On June 27th 2013 the British Geological Society doubled its estimate of shale gas resources (in place, as distinct from recoverable) in the north of England to (a central estimate of) 1,329 Trillion Cubic Feet (Tcf)[10]. The UK, one of Europe's largest natural gas markets, consumes some 80 bcma (2.8 Tcf). Assuming a shale gas recovery factor of 10% this implies that shale gas from this area of the UK alone would meet consumption requirements at current rates for some 50 years.

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[6] BP Statistical Review of World Energy, 2013, http://www.bp.com/en/global/corporate/about-bp/statistical-review-of-world-energy-2013/downloads.html

[7] LNG: Liquefied Natural Gas transported on custom built ships. For an explanation of these linkages see ' The Impact of a Globalising Market on the Future European Gas Supply and Pricing and the Importance of Asian Demand and North American Supply', H. Rogers, OIES, 2012, http://www.oxfordenergy.org/2012/01/the-impact-of-a-globalising-market-on-future-european-gas-supply-and-pricing-the-importance-of-asian-demand-and-north-american-supply/

[8] Although this has not translated into the building of significant new UK gas storage capacity as a means of mitigating anticipated short term supply interruptions. see 'Gas Storage in Great Britain', Chris N Le Fevre, OIES January 2013, http://www.oxfordenergy.org/2013/01/gas-storage-in-great-britain-2/

[9] Excluding those who believe that it contributes to carbon emissions and increases various environmental risks.

[10] http://uk.reuters.com/article/2013/06/27/uk-britain-shale-resources-idUKBRE95Q0CD20130627, http://www.bgs.ac.uk/shalegas/#ad-image-0

Such a conclusion is overly simplistic as will be demonstrated below. That the UK possesses considerable deposits of hydrocarbon-bearing shale should not be a surprise. Given the prolific UK North Sea oil and gas production province (now in decline) it logically follows that the source rocks which gave rise to those hydrocarbons should be located within reasonable proximity. Shale gas or oil is essentially hydrocarbon which 'never left home'. Oil and gas is formed when dead algae or protozoa become buried in estuarine or inland lake sediments. As the depth of burial increases, temperature and pressure serve to 'cook' this organic material to eventually form oil and gas. Conventional gas fields, such as those developed in the North Sea contain gas which has migrated underground through porous rocks and faults and which is ultimately trapped, typically in sandstone structures overlain by sealing or non-porous strata.

This highlights the key challenge of shale gas production, i.e. that this resource is contained within low porosity, low permeability rocks from which flow-rates into a well bore would be low (sub-commercial) without the application of fracking (to increase the surface area through which the gas molecules can escape) and horizontal drilling (to allow for multiple fracking zones in each well drilled).

The Viability of UK Shale Gas

Clearly the preliminary Cuadrilla well results were sufficient to persuade Centrica to acquire a 25% interest in Cuadrilla's Bowland licence[11]. In order to commit to full commercial scale investment however requires confidence that the average well flow-rate will be sufficient to provide an acceptable return on development investment. What is clear from the US experience is that well flow-rates can vary significantly within the same shale gas play. Trial and error eventually identified the shale play 'sweetspots' where flow-rates were highest, but even in these locations flow-rate variability between wells was an issue. Clearly many exploratory wells need to be drilled before a reliable average well flow-rate can be ascertained. Poland, until recently regarded as Europe's front runner in shale gas having drilled more than 40 wells, appears to have lost its allure of late with a number of major companies pulling out[12]. Whether this is due to problems in establishing commercial well flow-rates, the challenges of 'above ground' bureaucracy, or an unattractive legal and fiscal framework, is at present unclear. Realistically we should expect a period of two years of exploratory drilling in order to ascertain UK shale gas viability. This is borne out by the announcement on July 6th by Cuadrilla and Centrica unveiling their exploration and appraisal

[11] http://www.centrica.com/index.asp?pageid=29&newsid=2778

[12] http://energytics.wordpress.com/2013/05/23/eulogy-on-polish-shale-gas/

programme for the Bowland play which comprises six wells over 18 months to two years with an additional three wells drilled (but not fracked) to obtain samples.[13]

The Reality of Shale Gas Development

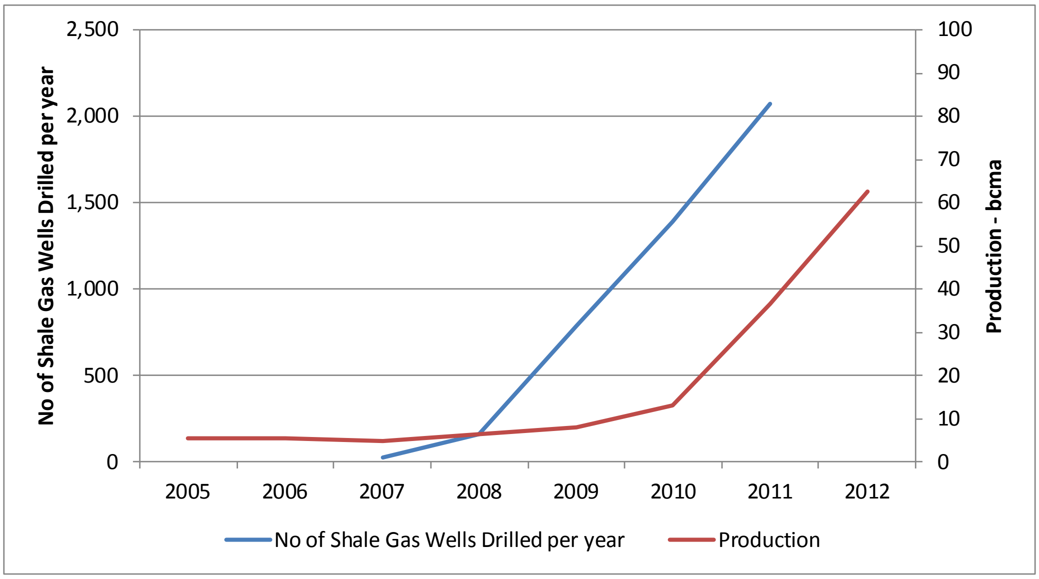
The advent of US shale gas is frequently referred to as a ‘revolution’ and as with most revolutions, it happened due to a combination of circumstances which may or may not be replicable in other political geographies. Clearly the US had a large number of upstream oil and gas exploration and development companies ranging from the super-majors through mid-range ‘independents’ to the small ‘mom & pop’ enterprises. With over 100 years of onshore Lower 48 oil and gas activity these players, in association with a dynamic and technologically adaptable oil and gas service sector, were well placed to take advantage of the shale gas and oil opportunity when its viability became apparent. Much is made of the mineral ownership rights in the US residing (in the main) with land ownership as a key factor. This is correct, however what is not commonly appreciated is the sheer pace with which the development of shale gas activity commenced, under a largely favourable, light touch regulatory framework. The speed with which leases (conferring drilling rights) were secured and wells drilled on numerous plays throughout the US can be likened to several ‘gold-rushes’ occurring in parallel. The data from the portion of the Marcellus play lying in Pennsylvania is illustrative here.

As shown in Figure 1, from 27 shale gas wells drilled in Pennsylvania in 2007 the number has rapidly escalated; in 2011 2,073 wells were drilled. Natural gas production in the state rose from a background level (conventional gas) of some 5 bcma to 63 bcm in 2012. Note that the increase of 58 bcma of shale gas production by the end of 2012 was the result of the cumulative drilling of some 6,000 shale gas wells[14] - in just 6 years.

[13] ‘Cuadrilla and Centrica unveil two-year fracking programme’, Daily Telegraph, 6th July 2013, http://www.telegraph.co.uk/finance/newsbysector/energy/10162416/Cuadrilla-and-Centrica-unveil-two-year-fracking-programme.html

[14] Note that in Pennsylvania production from many wells was held back while pipeline infrastructure was put in place.

Figure 1: Marcellus Shale Wells Drilled and Total Gas Production in Pennsylvania 2005 to 2012

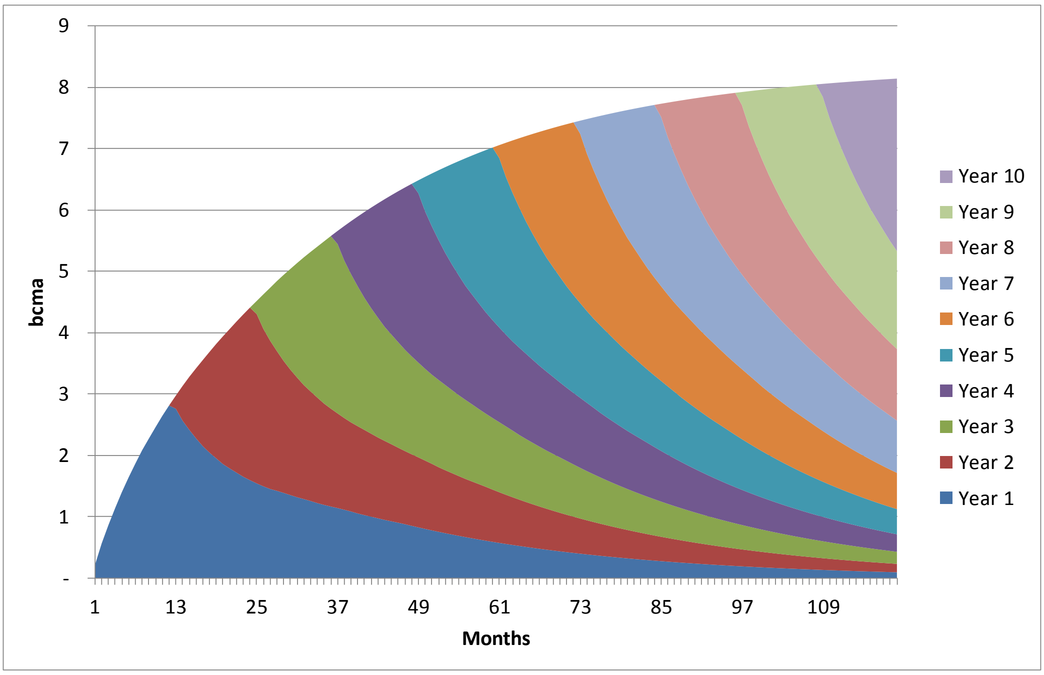


Sources: http://geology.com/articles/marcellus-shale.shtml, http://www.eia.gov/todayinenergy/detail.cfm?id=10471

These statistics starkly illustrate the challenge for the UK. Even if the UK shale gas well flow-rates are sufficient to support commercial development, the sheer number of wells, their visibility during drilling and associated traffic is likely to be a test in terms of public acceptance. While it is likely that this impact would be minimised by drilling up to 12 wells from the same location or 'pad' this would nevertheless represent a step-change in 'industrial activity' in shale play regions in the UK.

For illustrative purposes an average shale gas well production profile from the Texas Barnett gas shale play was used to assess how many new drilling pads per year, (each drilling 12 wells), would be required to achieve a UK shale gas production level equating to just 10% of UK gas consumption requirements. The results of this calculation, in Figure 2, show that after 10 years a production level of 8 bcma is achieved by drilling 300 new wells each year (from 25 new pads per year, each with its own drilling rig). Of course it may be that UK shale gas plays have higher well flow-rates than those of the Barnett play in the US. The main issue however is the drilling intensity, (in part driven by the rapid decline rate which is a feature of shale gas wells), required to achieve meaningful production levels in the context of UK domestic natural gas consumption. This is the key feature of shale gas development which appears to have completely bypassed media commentary in the UK[15]. Realistically, to the timescale required to build to material production shown in Figure 2 (10 years) should be added the initial exploration and evaluation period (at least two years) and the time required to obtain development and environmental approvals and to mobilise rigs and skilled personnel (a further 1 to 2 years possibly).

Figure2: Illustrative Shale Gas Production Profile Assuming 300 additional wells per year (25 Pads) based on an Average Barnett Shale Gas Well Profile.



Source: Analysis based on well data from A. Berman, Labyrinth Consulting Services, Inc

From quantitative analysis let us move to the physical and visual issues. Figure 3 is an aerial photograph of a Marcellus shale gas drilling pad in Upshur County, West Virginia and provides a graphic indication of the physical scale of operations during the drilling phase. With 12 wells on each pad, this phase could last some 12 to 18 months[16].

Once drilling has ceased and restoration activities completed, the shale gas pad, in its production phase, is significantly less intrusive, as shown in Figure 4.

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[15] This was however explicitly addressed on the OIES paper 'Can Unconventional Gas be a Game Changer in European Gas Markets', Florence Geny, December 2010, http://www.oxfordenergy.org/2010/12/can-unconventional-gas-be-a-game-changer-in-european-gas-markets/, P. 65

[16] Based on 1 to 1.5 months per well, a conservative estimate compared to the 25 days or less quoted in this article. http://www.bloomberg.com/news/2013-06-13/shale-drillers-squeeze-costs-as-era-of-exploration-ends-energy.html

Figure 3: Shale Gas Drilling Pad during Drilling Operation, West Virginia

Source: http://www.wvsoro.org/shared/upshur_co.html

Figure 4: Drilling Pad during Production Phase

Source: http://www.wvsoro.org/shared/upshur_co.html

Public Acceptance

The debate on the desirability of natural gas in the UK's energy mix from a decarbonisation policy point of view is beyond the scope of this Comment[17] which will instead touch on other issues of public acceptability.

The UK has an often overlooked history of onshore conventional oil and gas production which, while modest in comparison with the offshore North Sea, nevertheless has established a regulatory framework for hydrocarbon exploration and production. Ensuring well integrity, especially in relation to drinking water aquifers, is a requirement for all hydrocarbon developments and is not specific to shale gas production. The maintenance of a minimum vertical separation distance between shale gas strata (to be fracked) and water aquifers of 600m[18] and the separation of entrained methane from shale gas well water flow-back[19] are measures which address the risks to the environment specific to shale gas development. The UK Environment Agency provides a focal point for the regulation of shale gas activity[20].

It should be noted that it is unlikely that UK shale gas production at the scale indicated in Figure 2 would materially reduce wholesale gas prices, especially given the lead time to reach plateau. The UK is linked to the European regional market and Russian supply via pipeline infrastructure and to the Asian LNG market and future North American LNG suppliers by arbitrage. Whilst any new incremental supply in this system at the margin could be viewed as tending to exert downward pressure on prices this is unlikely to be discernible, and in the event could be offset by a reduction in Russian pipeline gas supplied to Europe if this suited Russia's price-volume strategy.

Setting aside de-carbonisation and wholesale gas price impacts (if any), the debate on the pros and cons of shale gas development (if proved viable) reduces to one of economic benefit versus visual and traffic disruption locally (during the drilling phase) and residual visual impact during the production phase, post drilling pad restoration.

Economic benefits at the national level include taxes and royalties paid by the companies producing shale gas, a positive impact on the balance of payments, (8bcma of production as shown in Figure 2 at today's wholesale prices of some $10/mmbtu would contribute £1.7bn/year to the UK's balance of payments), and a positive effect on GDP which has suffered as a consequence of declining North Sea oil and gas production in recent years.

[17] For a discussion of the potential for Gas with CCS see: 'Gas with CCS in the UK – Waiting for Godot ?', Howard Rogers, OIES, September 2012 http://www.oxfordenergy.org/2012/09/gas-with-ccs-in-the-uk-waiting-for-godot/
[18] http://www.dur.ac.uk/news/newsitem/?itemno=14449
[19] http://www.worldenergyoutlook.org/media/weowebsite/2012/goldenrules/WEO2012_GoldenRulesReport.pdf, P. 55
[20] http://www.environment-agency.gov.uk/business/topics/133885.aspx

In a broader sense, as characterised by a study on the economic impact of US shale gas undertaken by IHS CERA[21] the economic impacts are as follows:

> **Direct Contribution** is the effect of the core shale gas industry's output, employment, and income. For example, the shale gas industry's direct contributions are generated by the exploration, production, transport, and delivery of shale gas to downstream consumers or by providing onsite services. Investments in these activities have a direct contribution to production levels (output), the number of workers employed by the industry, how much those workers are paid and otherwise compensated.
>
> The direct purchasing activities of the shale gas industry initiate the **Indirect Contributions** to all of the supplier industries that support shale gas production activities. Changes in demand (from the direct industries) lead to corresponding changes in output, employment, and income throughout the supply chains, as well as suppliers' inter-industry linkages.
>
> Finally, workers and their families in both the direct and indirect industries spend their income on food, housing, leisure, autos, household appliances, furniture, clothing, and other consumer items. The additional output, employment, and income effects that result from these consumer spending activities are categorized as the **Induced Economic Contribution**

Whether these economic benefits at the national and local level are perceived by inhabitants in the vicinity of shale gas operations to adequately compensate for increased traffic and visual impact during drilling operations is the key issue. Whilst much has been made in the media of the proposed £100,000 payment to local communities for each shale well drilled, this is unlikely to bridge differences of opinion between those who perceive shale gas as providing the potential for local economic stimulation and employment and those who have local or carbon-based environmental objections.

This is a debate which policymakers and the 'would be' shale gas exploration and production companies will have to enter at some point, especially if exploration drilling over the next few years yields encouraging results. Given the UK aspiration to the pastoral idyll, this will not be an easy debate and could easily become polarised if an attempt to impose development by the 'Westminster elite' meets with united local resistance.

[21] 'The Economic and Employment Contributions of Shale Gas in the US', IHS CERA, December 2011, http://anga.us/media/content/F7D1750E-9C1E-E786-674372E5D5E98A40/files/shale-gas-economic-impact-dec-2011.pdf

In the event of promising exploration results the shale gas developers might be advised to focus on:

- firstly being very clear about the impact of activities at the drilling and post-restoration production phase[22]; and,
- secondly, the valuable but very scarce resource which they are able to offer in return to inhabitants of shale prospective areas: training, jobs and economic stimulus.

Conclusions

This Comment has sought to bring a 'dose of reality' to the current media frenzy around UK shale gas which has focussed on resource estimates with no attention paid to the practicalities of achieving material levels of UK shale gas production.

Clearly shale gas production has grown dramatically in several extensive shale plays in the US where a combination of a dynamic existing onshore industry and little in the way of access restriction has allowed for the intensive drilling of wells required to achieve material production levels.

Such practicalities appear entirely absent from the UK debate and are unlikely to be raised by the upstream industry until the results of exploration and appraisal drilling confirm whether shale gas well flow-rates in the UK would support commercially viable development.

If such results are positive, the sheer scale of drilling required to achieve meaningful UK shale gas production will require the industry to engage in a major public persuasion exercise. One currency it does have to offer is the prospect of skilled, well paid employment which with suitable training opportunities could be a compelling offer.

Even in the event of positive exploration results on one or more plays, plateau production is unlikely to be achieved until 10 to 15 years from the present. The levels of UK shale gas production, whilst making a welcome contribution to government revenues and the balance of payments are highly unlikely to influence UK wholesale gas prices, given the physical linkage of the UK to international gas markets. They are also unlikely to reduce gas import requirements from present day levels. These conclusions are broadly in line with a recent statement by Sam Laidlaw, CEO of Centrica, who in January 2013 said 'it would be at least a decade before the UK saw any shale gas production and that, even then, it would not be "the game changer we've seen in North America'[23]

[22] See the IEA's Golden Rules for a Golden Age of Gas, http://www.worldenergyoutlook.org/media/weowebsite/2012/goldenrules/WEO2012_GoldenRulesReport.pdf
[23] http://www.telegraph.co.uk/finance/newsbysector/energy/10117165/Centrica-to-unveil-shale-gas-drilling-plans-with-Cuadrilla.html

Given the above, the sobering conclusion is that UK shale gas, given its timing and perhaps modest scale in terms of production level, in no way changes the critical and pressing nature of UK energy policy challenges, and decisions needed, between now and the end of the decade.