THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

DINNER/DISCUSSION SUMMARY

The impact of the development of shale and tight gas reservoirs on global energy supply

Held at The Royal Society on 9th November, 2011

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the Comino Foundation, The Geological Society and the RPS Group.

Chair: **The Earl of Selborne GBE FRS**
Chairman, The Foundation for Science and Technology

Speakers: **Malcolm Brinded CBE FREng**
Executive Director, Upstream International, Royal Dutch Shell
Professor Paul Stevens
Senior Research Associate (Energy), Royal Institute of International Affairs, Chatham House
Professor Mike Stephenson
Head of Science, Energy Geoscience Programme, British Geological Survey

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MR BRINDED outlined the case for development of shale and tight gas fields - both involved techniques more than mere drilling, such as horizontal drilling and rock fracturing - "fracking". Shale gas rock had lower permeability and porosity than tight gas rock. The case rested on the inevitable increase in world demand for energy, fuelled by population increase and rising living standards in countries such as China and India; the need to reduce greenhouse gas (GHG) emissions; and the estimate that 60% of energy will still come from fossil fuels. The use of shale gas will make more gas available, reduce the price of gas and enhance energy security. USA could have 100 years of additional supply of gas. Globally there would be 250 years additional supply, but development would come about differentially, depending on public acceptance and regulation. In Europe, it could be slower. Huge investment in all types of energy was essential to meet demand, but the need to keep within a global ceiling of 450 ppm of CO_2 emissions (CO_2 concentrations are already at 395 ppm) put the focus on reducing emissions from fossil fuels. This meant moving from coal to gas - at present fossil fuel supply came 44% from coal; 35% from oil; and 20% from gas. Combined cycle gas plants not only produced less CO_2 than coal fired plants, but also less SO_2 and NO_X and used only half the amount of water. Gas could substitute for oil in transport, notably the use of LNG (Liquefied Natural Gas) for trucks, trains and ships as well as fuelling power sources for electrical vehicles. Moreover carbon capture and storage (CCS) was more effective with gas than coal. The use of shale gas gave the US an enormous economic advantage as the fuel price for industry was much lower than in Europe, in particular in the UK. There were environmental and safety concerns, but they could be addressed - proper regulation, a safety case approach to new wells, examining each risk systematically, and, above all, involving local communities and being transparent about techniques and possible pollution worries. These worries had been overstressed - it was very unlikely that aquifers could be polluted from shale gas wells - which could be 2km lower than the aquifer, and there was no evidence that chemicals had leaked from the wells. But the construction and maintenance of wells must be to the highest standards.

PROFESSOR STEVENS agreed that reduction of GHG emissions depended on reducing the amount of fossil fuel from coal by enhancing the supply from gas. There were huge deposits of coal which would continue to be mined cheaply, and efforts must be made to demonstrate the efficiency and environmental benefits of gas. He recommended a move from gas comprising 25% of fossil fuel sources of supply to 50% in the future. Although the sudden development of shale gas is thought of as a revolution, it had been 20 years in coming. But the consequences of the use of shale gas in the US had been huge - gas prices had fallen by half (but the recession may be an influence); imports of oil had collapsed, and industry greatly benefited. In Europe gas prices had fallen and strained the traditional connection between oil and gas prices. Could the further progress of shale gas exploitation continue in the US? There were two concerns. If prices continued to fall would investment continue? Some investment was already not producing a return. But future price worries could always be hedged, and new investment was still coming in and rapid technological changes meant costs were diminishing. Past development had benefited from the "Halliburton Loophole" - i.e. the exemption for shale gas from the requirement to have an Environmental Impact Assessment. There were now demands that future wells should have them. There was no evidence that fracking, rather than poor well construction, had caused problems. Because every well was different, it would be difficult to mount an Environmental Impact Assessment until the well was operative. Meanwhile the benefits, not only of using shale gas but also by exploiting fallow oil fields through horizontal drilling ere evident. Would the exploitation of shale gas develop rapidly in Europe? There were reasons to doubt it would. First, the rocks were not as good for extracting shale gas; second, the regulatory framework had to be established - this would take time; third, there were tax breaks in the US which did not apply here; fourth the common carriage regime in the US made it easier for operators to access pipelines; fifth, there was a lack of service capacity; sixth, property rights in the US favoured sub-surface exploitation; and finally, there were stronger environmental and local lobbies in Europe - note the moratorium in France and much higher density of population.

PROFESSOR STEPHENSON said he understood concerns about safety and environmental damage from the development of shale gas. These concerns could only be met through rigorous scientific analysis of the various risks, establishing those which were low and those which were not, ensuring complete transparency about construction and operations and establishing a trust between the public, operators and regulatory authorities. Low risks were a blow-out in the well; failure of casings in the well (provided it had been properly constructed) and pollution of aquifers from chemicals and water used in the fracking process (because the aquifers were well above the shale gas rocks - over 2km in the Cheshire basin, where the aquifers were very shallow). The British Geological Society (BGS) study had concluded that the Blackpool earthquakes had been caused by fracking, but there was very little chance that they had been severe enough to cause damage (such as cracks in the road), although continuing monitoring was desirable. A greater concern was pollution of water supplies through methane escape. Methane could be either biogenic (i.e. already in the rocks or ground water) or thermogenic (i.e. released by fracking or from storage wells). Chemical analysis could in many cases distinguish the type of methane, but not where there were mixtures. Two peer reviewed scientific studies had examined the problem. While they indicated that there were possibilities that fracking might affect methane escapes, they were not conclusive, because there was no adequate baseline from which to measure the existing biogenic methane or thermogenic methane coming from storage wells. The conclusion was that whereas many risks were low, well understood and could be safeguarded again, there were new risks which should be the subject of scientific research to establish their source, their significance and what needed to be done to reassure the public their and consequences.

Several speakers in the following discussion raised concerns that the emphasis on increasing the use of gas would still lead to further GHG emissions, even if they were less than using coal. In countries such as China, which had large reserves of coal which could be mined cheaply, and where there was less concern about environmental impacts, would the exploitation of gas really displace coal use in power plants? The fast growth in energy demand in China and India meant pressure to exploit all energy sources and gas could form only a small part of the mix compared with coal. However the Chinese government were concerned about pollution, they were driving forward a shale gas programme with a determination to produce new gas supplies equivalent to other fossil fuel sources.

Speakers suggested that the emphasis on a fossil fuel such as gas, even if it were less harmful than other fossil fuels, would inhibit the development of renewables, and lessen the drive to achieve greater energy efficiency in industry and domestic use. But the most important argument about renewables related to cost; as long as gas demonstrated that it was cheaper than renewables, and quicker to develop, it would have advantage, renewables must exploit all technological changes which reduced costs, but we cannot ignore present cost advantage. We cannot forecast what changes will take place in the next ten years and it is possible that some renewable sources - notable solar - will begin to be price competitive with gas. We should not try to pick winners, but be aware that change will happen more quickly than we expect (as with shale gas) and be able to seize opportunities. Nothing should get in the way of improving energy efficiency; with inevitable increases in energy prices, even if they were smaller than they otherwise might have been because of the use of gas, there would still be a great incentive to be more efficient in the use of energy.

Other environmental concerns were raised:

1. Shale gas wells used water, and water was becoming an increasingly valuable resource; did regulators take sufficient account of water use? Wind did not use water; did not this make it preferable to gas? No doubt, but base power was still needed when other sources were intermittent gas powered plants could come into operation more quickly. Furthermore water use in shale gas extraction was lessening and was recycled as far as possible. However, it was important to consider the use of any natural resource, whether air, water or land. Any exploitation of a single resource had multiple consequences.

2. Gas had to be carried in pipelines which could leak. Although in some countries - notably Russia - there were significant leaks, there had been minimal leakage in the UK.

3. CCS had been said to be more effective with gas, and had been advanced as another reason for using gas, but the closure of the CCS proposed project at Longannet had led to doubts that it would ever be commercially viable. In any case the pipeline network and disposal issues would raise local opposition.

4. Earthquake fears were based on a misunderstanding of risk. There had been many small earthquakes caused by coal mining, and little damage had resulted.

5. What would be the legacy of large numbers of shale gas wells which would be left after gas had been extracted? How would the responsibility of operators to clear the land and dispose of equipment be enforced?

Economic issues centred around the life time of assets, and the return expected on them from the future price of gas. Again, it was important to recognize the scale of technological. Most assets would, indeed, be obsolete in 20 to 30 years time, but demand for rapid technological advance did mean that expensive assets could become valueless - look at the LNG terminals in the US. But investment must balance increasing demand for energy against quick technological change. This could mean a demand for quicker return than rationally had been accepted. This was already factored into investment decisions.

The biggest problem was public acceptance. Government needs to make the case about energy demand, GHG emissions, and fuel security, but sustained effort was needed by companies and regulators. The problem was that the public did not trust companies, or regulators, or government bodies. The public did not understand the different responsibilities of such bodies as the Health Protection Agency, the Health and Safety Executive, the Environment

Agency and local authorities. The industry had not been clear about what risks the understood and those on which further work needed to be done. They had paid inadequate attention to the fear of earthquakes and failed to convince people of their rarity. There had to be some acceptable independent analysis of risks and consequences; it could only come from peer reviewed scientific work that would demonstrate the distinction between science and myth,

While speakers shared the presenters' doubts about rapid development of shale gas in Europe, the US regime was not as favourable as had been suggested. Although property rights were important, and the state control of sub-surface resources meant that in the UK a landowner could not extract the same benefit as in the US, he could still extract a price for use his surface land (although not if horizontal drilling was being used). Moreover, environmental assessments were insisted upon by many States, even if not by the Federal Government.

Speakers agreed that there were substantial advantages in exploiting shale gas reservoirs but there were significant problems to be overcome, notably public acceptability. There was a balance to be struck between securing adequate energy, food and water supplies, and a recognition that people need to be convinced that any exploitation will in the end be to their advantage. This meant calming unnecessary concerns, showing what risks we understand and which need further scientific research, and ensuring that there is a stable, well respected regulation regime.

Sir Geoffrey Chipperfield KCB

Useful web links:

Biotechnology and Biological Sciences Research Council
www.bbsrc.ac.uk

British Geological Survey
www.bgs.ac.uk

BP
www.bp.com

Chatham House Report on shale gas:
www.chathamhouse.org/publications/papers/view/178865

Comino Foundation
wwww.cominofoundation.org.uk

The Foundation for Science and Technology
www.foundation.org.uk

The Geological Society
www.geolsoc.org.uk

House of Commons Select Committee on Energy and Climate Change
www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/795/795.pdf

Parliamentary debate on shale gas on 3rd November
www.parliament.uk/business/news/2011/november/debate-on-shale-gas-and-electricity-market-reform/

Medical Research Council
www.mrc.ac.uk

Natural Environment Research Council
www.nerc.ac.uk

Research Councils UK
www.rcuk.ac.uk

The Royal Academy of Engineering
www.raeng.org.uk

Royal Institute of International Affairs, Chatham House
www.chathamhouse.org

The Royal Society
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