Tyndall Centre
for Climate Change Research

Shale gas: an updated assessment of environmental and climate change impacts

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Executive Summary

This report, commissioned by The Co-operative, is an update on our January report, *Shale gas: a provisional assessment of climate change and environmental impacts* (Wood et al 2011). Whilst some of the analysis remains relatively unchanged from the original document, other areas having undergone important revision, not least because industry estimates of shale gas reserves at the UK and global scales have markedly increased. For example in the UK industry reserve estimates published for a single licensing area are an order of magnitude greater than national estimates published by DECC in December 2010. New papers detailing fugitive emissions have also emerged raising concerns that shale gas production may involve greater greenhouse gas emissions than previously thought.

The analysis within this new report addresses two specific issues associated with the extraction and combustion of shale gas. Firstly, it explores the environmental risks and climate change implications arising from shale gas extraction. Secondly, it outlines potential UK and global greenhouse gas (GHG) emissions arising from an updated range of scenarios built using the latest predictions of shale gas resources.

Since our earlier analysis, a range of reports and journal articles on shale gas have been published, giving the impression of a substantial increase in meaningful data alongside a more developed understanding of the issues. However, whilst the knowledge base has certainly improved, closer scrutiny of the 'new' information reveals that much of it builds on similar and very provisional data sources, and accordingly represents only a small improvement in the robustness of earlier analyses. Consequently, and despite there now being a much wider literature on shale gas, the earlier report's cautionary note, "that a key issue in assessing… shale gas ... has been a paucity of reliable data", still holds.

To date the only significant development and exploitation of shale gas has been in the United States (US). However, even there significant environmental issues remain unresolved, and reserve estimates show little sign of stabilising (increasing seven times in the last four years). Inevitably therefore, assessments of the environmental impacts, reserve potential and subsequently the greenhouse gas emissions for the European Union (EU) and the UK's fledging shale gas sector, remain subject to significant levels of uncertainty. In view of continued ambiguity as to the robustness of quantitative data, considerable effort has been made to ensure the veracity of the information in this report. Ultimately however, the analyses can only be as accurate as the information and the assumptions upon which it draws.

Despite these uncertainties, several clear conclusions arise and can be used to inform decisions on the appropriateness or otherwise of developing a shale gas industry within the UK. It is evident that shale gas extraction does not require the high energy and water inputs at the scale of other unconventional fuels, such as oil derived from tar sands. Nevertheless, there are several routes by which shale gas extraction may pose potentially significant risks to the environment. Concerns remain about the adequacy of current UK regulation of groundwater and surface water contamination and the assessment of environmental impact. Although amenable to stringent regulatory control, risks of contamination cannot be fully eliminated.

Consequently, if shale gas is to make a significant contribution to the UK's energy mix, a rigorous monitoring regime is essential to contain the risks of contamination, from thousands of wells, within 'acceptable' levels. Similarly, fugitive emissions arising from the hydraulic fracturing process and emitted around the wellhead could be significant and increase the footprint of shale gas substantially, although with effective capture and process technologies, emissions levels not dissimilar from those associated with natural gas extraction appear possible in principle. If fugitive emissions are to be kept to 'acceptable' levels and not significantly skew the balance between upstream and point of use emissions, it is again paramount that appropriate regulatory, monitoring and enforcement regimes are developed and in place prior to full scale extraction.

Turning to the climate change implications of shale gas extraction and combustion, the report demonstrates that in an energy-hungry world (e.g. EIA energy demand projections 2011)[1] and in the absence of a stringent global emissions cap, large-scale extraction of shale gas cannot be reconciled with the climate change commitments enshrined in the Copenhagen Accord (2009). This is principally an issue of the very short time frames remaining in which to reduce emissions to levels, "consistent with the science", and which would "hold the increase in global temperature below 2 degrees Celsius". Given the Accord also stipulates mitigation efforts need to be on the "basis of equity", the constraints of the Accord are germane particularly to the industrialised (Annex 1) nations. Shale gas subject to best practice extraction and subsequently combusted in high efficiency combined cycle gas turbine (CCGT) powerstations will deliver power at lower emissions per unit of electricity generated than is possible from coal fired generation. However, even if there were to be a rapid transition from coal to shale gas electricity, this could still not be reconciled with the UK's 2°C commitments under either the international Copenhagen Accord or its own national Low Carbon Transition Plan. If instead, conservative rates of recovering shale gas from the latest estimate of global reserves were achieved and only half subsequently combusted by 2050, shale gas could occupy *over a quarter* of the remaining CO_2 emissions budget associated with a reasonable chance of avoiding 2°C of warming. Atmospheric carbon dioxide levels would be expected to rise by between 5 and 16 parts per million by volume (ppmv), with a mid-range of 11ppmv.

Whether shale gas substitutes for higher carbon energy supply or meets new energy demand in the UK, it risks doing so at the expense of investment in much lower carbon supply. Energy companies, investment markets and broader UK institutions are all familiar with fossil fuels, and any short-term financial benefit that may accrue to shale gas heating and electricity risks reinforcing lock-in to established supply routes. This has two further implications. Firstly, it reduces the drive for innovation and the scope for 'learning by doing', with the UK subsequently less well equipped to compete in renewable and low-carbon markets elsewhere. Secondly, any investments in shale gas infrastructure over the coming decade would rapidly become a stranded economic asset if the UK were to respect its 2°C commitments. Alternatively, government may be persuaded to withdraw from national and international obligations, and instead sanction continued use of existing high capital value, and high carbon, shale gas infrastructure. This report illustrates how a £32bn

[1] EIA Annual Energy Outlook 2011, http://www.eia.gov/forecasts/aeo/pdf/0383(2011).pdf

capital investment in shale gas could potentially displace up to 12GW of offshore or 21GW of onshore wind capacity and raise the prospect of the UK not meeting its renewable energy obligations.

To summarise: Irrespective of whether UK shale gas substitutes for coal, renewables or imported gas, the industry's latest reserve estimates for just one licence area could account for up to 15% of the UK's emissions budget through to 2050. Therefore, emissions from a fully developed UK shale gas industry would likely be very substantial in their own right. If the UK Government is to respect its obligations under both the Copenhagen Accord and Low Carbon Transition Plan, shale gas offers no meaningful potential as even a transition fuel. Moreover, any significant and early development of the industry is likely to prove either economically unwise or risk jeopardising the UK's international reputation on climate change. Against such a quantifiable and stark evaluation, it is difficult to conclude other than the UK needs to invest in very low carbon energy supply if it is to both abide by its international obligations *and* support economically sustainable technologies.