



Department
of Energy &
Climate Change

The Government's response to the MacKay-Stone report:

Potential greenhouse gas emissions associated
with shale gas extraction and use

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The Government's response

In September the Government welcomed the report by Professor David MacKay FRS, DECC Chief Scientific Advisor, and Dr Timothy Stone CBE, the former Senior Advisor to the Secretary of State for Energy and Climate Change, assessing the potential greenhouse gas (GHG) emissions from extraction of shale gas in the UK and the compatibility of such emissions with the UK's legislated climate change targets.

The Government's support for shale gas development in the UK is part of five equal and overarching objectives we have for energy and climate change.

- Deliver secure energy on the way to a low carbon energy future
- Drive ambitious action on climate change at home and abroad
- Save energy with the Green Deal and other policies and support vulnerable consumers
- Manage our energy legacy responsibly and cost effectively
- Promote UK growth

Our approach is to explore what benefits and investment shale gas and oil may bring. We cannot yet tell how much UK shale gas and oil might be commercially and technically recoverable. But it potentially offers a secure energy source with investment and jobs in the UK, given we expect to import increasingly large amounts of more gas and oil in the next few decades, as North Sea oil production falls and before full decarbonisation is complete.

However, we will only allow development to proceed where it does not come at the cost of the environment, climate or safety, which is why we have been looking carefully at the evidence base. We commissioned independent experts to review the evidence on the seismic risks, and in 2012 we introduced new controls based on their advice. Also in that year, the Royal Society and the Royal Academy of Engineering independently looked at the risks from shale gas, and concluded that it could be managed effectively in the UK as long as operational best practices are implemented and enforced through regulation.

Public Health England's report into the **health** impacts of shale gas and oil, evaluated available evidence on issues including air quality, radon gas, naturally occurring radioactive materials, water contamination and waste water. They concluded that "the risks to public health from exposure to emissions from shale gas extraction are low if operations are properly run and regulated."

Professor MacKay and Dr Stone's report is a similarly important consideration of an area of the evidence base on the potential **climate** impact of UK shale gas production. It concluded that with the right safeguards in place the net effect on GHG emissions from shale gas production in the UK will be relatively small. Indeed emissions from the production and transport of UK shale gas would likely be **lower** than imported Liquefied Natural Gas, which shale gas would likely replace. To ensure global cumulative GHG emissions to the atmosphere do not increase, worldwide shale gas production needs to be accompanied by additional international emissions-reduction efforts, including a global deal on emissions reductions and additional effort to develop low-carbon technologies such as carbon capture and storage.

Over the next two decades or more, gas in the power sector will support our ability to reduce carbon emissions, because it will help replace coal generated electricity while we continue to develop low carbon alternatives for electricity. There will be a continued need for gas for domestic use as alternatives are developed and deployed for renewable heating.

The authors of the report were also clear that without global climate policies, new fossil fuel exploration is likely to lead to an increase in cumulative GHG emissions and therefore climate change. The UK accounts for less than 1.5% of global emissions, so keeping average global temperature rise below 2°C requires global collective action. The most effective way to ensure the required level of action is through the United Nations Framework Convention on Climate Change (UNFCCC).

This is why the UK is working with countries across the world to achieve in 2015 an agreement to address climate change that is ambitious, legally-binding, and applicable to all. At the climate talks in Warsaw last year, the world agreed a timetable and work plan for this process.

The UK has also been leading the way in Europe in calling for urgent agreement of an EU 2030 Framework for climate and energy policy that includes an ambitious greenhouse gas target of at least 40%, rising to 50% in the context of a global deal. In March 2013, the UK helped found the Green Growth Group, a group of 14 like-minded EU Ministers, to champion the economic and strategic case for EU climate ambition. In March 2014, this group released a joint statement calling for the EU to agree a domestic greenhouse gas emissions target for 2030 of at least 40%.

Beyond the formal negotiations the UK is engaging bilaterally with big emitters such as the US, China and other emerging economies, to share expertise on developing and implementing domestic energy and climate change policies, achieve significant levels of carbon abatement and highlight that a shift to low carbon is in countries' best interests. China has launched five of their seven planned pilot carbon emissions trading schemes, with UK contributions acknowledged in three of the biggest (Beijing, Shenzhen and Guangdong); and UK funding, together with partner companies such as Truscot, has been instrumental in assisting the Shanghai Stock Exchange design a carbon efficiency index. The Government will continue to take advantage of such opportunities to make the case that the shift to low carbon can be good for prosperity, security and growth.

The UK is also providing £3.87 billion through the International Climate Fund between 2011 and 2016 to reduce poverty by helping developing countries adapt to the impacts of climate change, move to low carbon growth trajectories, and to address deforestation.

Projects supported by the UK include the Clean Technology Fund (CTF) to support the demonstration, deployment and transfer to low-carbon technology in developing countries; and Green Africa Power (GAP) which aims to stimulate private sector investment in renewable power generation in Africa.

The Government sees shale gas as an indigenous gas supply that can boost the economy and our security of supply whilst reducing our carbon emissions. By accepting and acting on the recommendations of this report, we can ensure shale gas production helps us to reduce our carbon emissions.

Recommendations

The report by Professor David MacKay FRS and Dr Timothy Stone CBE made 8 recommendations. The Government accepts them all.

- a) **In managing fugitive, vented or flared methane throughout the exploration, preproduction and production of shale gas, operators should adopt the principle of reducing emissions to as low a level as reasonably practicable (ALARP). In particular, “reduced emissions completions” (REC) or “green completions” should be adopted at all stages following exploration. Government should discuss with regulators appropriate mandatory requirements to be applied at each stage to ensure that the best technology is implemented in all cases.**

We accept this recommendation in full. We are committed to adopting green completions alongside the development of production facilities.

We will seek to build on existing regulatory mechanisms to minimise waste gases, including carbon dioxide and methane. Venting and flaring are regulated by DECC under licence conditions or under powers in the Energy Act 1976, and these mean in practice that operators must use green completion techniques. For all oil and gas activities, onshore and offshore, DECC requires that venting should be kept to the minimum that is technically possible. Routine venting is never permitted, but it is not possible to prohibit venting entirely, as in particular operational circumstances it may be necessary for safety reasons. However, the preferred alternative, where gas has to be released because there is no economic use for it, is that the gas should be flared to reduce its contribution to global warming emissions. In respect of future appraisal or production activities, DECC’s established policy is that flaring should be reduced to the economic minimum. Our regulation on venting and flaring in conventional oil and gas are amongst the strictest and most effective in the world and we commit to maintaining that standard.

The Environment Agency’s draft technical guidance for onshore oil and gas exploratory operations makes clear that operators should apply a hierarchy of controls to ensure waste gas is first prevented, then minimised and finally rendered harmless. The guidance goes on to make clear that operators should initially consider installing an engine to burn the gas and recover the energy. If this is not possible then a flare may be used. Operators must be able to show that their activities, including flaring during exploration, do not lead to emissions at levels higher than those set out in their environmental permits.

These controls will remain in place during exploration stage, where the use of green completions techniques is often not technically or economically feasible. But as MacKay-Stone makes clear, there are significant gains to be made using green completions in production.

The shale gas and oil industry has already recognised that the use of green completions in shale gas production is key to ensuring that emissions from shale gas sites are kept to a minimum and environmental protection ensured. It has committed to use these techniques wherever possible and to agree a common understanding with respect to terminology with Government and appropriate environmental regulators.

The recommendation suggests that industry should commit to keeping these 'As Low As Reasonably Practicable' (ALARP), which is a term generally used in health and safety to minimise risks. As waste gases are primarily regulated through environmental legislation, we intend to require the use of Best Available Techniques (BAT) instead. This means the industry committing to using BAT, which is based on considering how environmental pollution from a specific activity should be prevented, minimised or rendered harmless and considers what techniques that are both practical and cost effective. It puts the emphasis on industry wide application of the techniques, rather than site specific justification. The BAT approach is widely accepted across environmental regulation of all sectors.

Furthermore, while industry has committed to use these techniques, the forthcoming technical guidance from the Environment Agency will make clear that green completions or reduced emissions completions are a requirement of environmental permits for production.

The Environment Agency considers that 'green completions' are BAT for production facilities. Making green completions part of BAT will mean that producers will be required to use new technologies that will help limit or stop emissions as and when they are available. This means that technological advancement that helps the environment will be pursued and encouraged.

The Government, working with the Environment Agency to influence the forthcoming review of the European Commission's 'Best Available Technique Document' (BREF) for mining waste to ensure that reduced emissions completions are included as BAT for emissions control in European legislative instruments. This would ensure that mining waste permits at the production phase must use BAT. This would mean that shale gas across Europe will be held to the same high standard in limiting emissions from shale gas and oil developments.

- b) Shale gas exploration and production in the UK should be accompanied by careful monitoring and inspection of GHG emissions relating to all aspects of exploration, pre-production and production, at least until any particular production technique is well understood and documented in the context of UK usage (see Research, below).**
- c) Thereafter operators should monitor their sites to: (1) ensure early warning of unexpected leakages; and (2) obtain emissions estimates for regulators and government.**

The Government accepts these recommendations in full. The Government agrees that while shale gas is developing there is justification for careful monitoring and inspection of GHG emissions. The report is a significant step forward in establishing the range of emissions we might expect in the UK's regulatory context. Since the release of the MacKay-Stone report, the University of Texas at Austin produced a detailed study involving the monitoring methane emissions from various stages of shale production. It found that emissions from fracking are lower than previously thought. However we will not be able to conclude firmly that shale gas operations will not lead to damaging levels of GHG emissions without inspection and monitoring.

The Government will therefore be pursuing a programme of research that will monitor methane emissions (methane accounts for the vast majority of produced gas) from all exploratory sites in the next two years relating to exploration, pre-production and production of shale oil and gas. More detail on the research programme is covered in the response to recommendations g and h below.

These recommendations have been welcomed by industry who have already committed to monitoring work being undertaken on their sites and have conducted their own monitoring of existing sites. The UK Onshore Operators Group charter states that; 'Fugitive emissions levels will be constantly monitored at all stages of development and the data made available in line with best practice and regulatory reporting requirements'.

- d) Shale gas production in the UK should be accompanied by research into development of more effective extraction techniques, such as improved REC and self-healing cements, which minimise wider environmental impacts including whole-life-cycle GHG emissions.**
- e) Government and industry should actively pursue new techniques to minimise GHG emissions associated with exploration, pre-production and production of shale gas and also reduce the impact on local environment and infrastructure.**

The Government accepts these recommendations in full. Embracing new technologies and innovations goes hand-in-hand with the fight against climate change in all areas of energy development, shale gas included. Encouraging these technologies and innovations is not just good for the environment but good for our economy.

In 2013, the Technology Strategy Board (TSB) commissioned an independent review "UK business opportunities for innovation in the exploration, extraction and utilisation of shale gas" to establish how innovation could play a role in the safe and responsible exploitation of shale gas, and the areas where UK businesses might benefit most. The review indicated that there are clear innovation opportunities for UK business in a number of technology areas related to shale gas, which build on the UK's existing capabilities across a number of sectors.

In light of this review DECC and the TSB are launching a competition to invest up to £2m to encourage the development of innovative technologies for the safe and responsible exploitation of the UK's shale gas resources. Project proposals for this competition will focus on innovation in environmental management or other innovations that could have a major beneficial impact on the sector. We believe this will foster new innovations, such as self-healing cement. The criteria will be set to explicitly include projects aimed at reducing emissions, including through developing new green completion technologies and minimising emissions through site logistics, cutting down vehicle journeys and water usage.

Projects must be business-led, and may involve either a single company or collaboration with other businesses or research organisations. Business partners can attract up to 65% public funding (75% for SMEs), and we expect total project costs to be in the range of £50k to £150k. Projects should last from six to 12 months. Research organisations can apply but cannot lead a project. We are particularly interested in attracting a site developer willing to act as a 'test bed' for innovative technology in this area.

f) The shale gas industry should research methods to minimise water demand and vehicle movements, so as to reduce greenhouse gas emissions and the impact on local infrastructure.

The Government accepts this recommendation in full. There are many reasons to put an emphasis on reducing vehicle movements and reducing the demand for water. A recent projection in the Strategic Environmental Assessment for the 14th licencing round suggested that shale gas production would require be between 14-51 vehicles per day, per well pad during exploration and production stage. Up to 50% of these could come from the transfer of water to and from sites. Using piped water can significantly reduce the number of vehicle movements. Operators will have to assess the impact as part of an Environmental Impact Assessment and planning authorities can put conditions on vehicle movements, for example limiting them to certain routes and times of the day.

Industry is already considering how they can reduce the movement, and there are clear cost-reduction imperatives to do so. As part of the industry's community engagement charter, companies have committed to minimise disruption for communities, including traffic impact.

In November 2013, UKOOG and Water UK (who represent the major water supply companies in the UK) signed a Memorandum of Understanding which ensures their respective members will cooperate throughout the shale gas exploration and extraction process. A key aim of the agreement is to give the public greater confidence and reassurance that everything will be done to minimise the effects on water resources and the environment.

The Researching Fracking in Europe (ReFINE) group, led by Professor Richard Davies of Durham University, is currently researching the impact of increased traffic on an area. The group is funded by a large range of bodies including industry. Models will be used to predict congestion, emissions, noise pollution, infrastructure degradation and personal safety risks. There is further research in this area on both sides of the Atlantic. We expect that further projects may be supported under DECC/TSB funding, and will monitor research to continue improving our understanding.

g) There should be a detailed scientific research programme of methane measurement, aimed at better understanding and characterising sources and quantities of methane emissions associated with shale gas operations.

Government accepts this recommendation in full and has agreed to pursue the recommendation for a detailed scientific research programme to monitor methane emissions relating to exploration, pre-production and production, to increase the evidence base and inform regulatory monitoring. This is in addition to the industry commitment to monitor fugitive emissions outlined above. The research would aim to obtain estimates of the sources and quantity of emissions, as well as enabling the early warning of unexpected leaks and assessing uncertainty in the estimates.

To establish reliable estimates it is necessary to carry out a pilot study to establish the techniques and monitoring mechanisms. DECC and the Environment Agency is conducting an air quality survey to monitor the emissions, including methane, at a conventional oil site. This will inform the development of the longer term detailed research. This will, in turn, inform the long-term monitoring requirements across all three phases of production.

At the pilot stage, emissions will be monitored at point sources, as well as assessing whole-site emissions estimates, at both natural gas and oil extraction sites. Whole-site analysis is important to ensure sources of emissions are not missed, for example, from flow-back storage tanks. After the pilot research we will extend that emissions monitoring to the transmission and distribution system, where estimates are currently based on limited measurements and may warrant further verification.

The Government take this programme forward with appropriate funding. We are exploring possible research collaborations to adopt an efficient approach and ensure that we take on board the latest techniques, such as:

- the National Physical Laboratory (NPL), who are at the outset of a two-year EU-funded methane emissions monitoring research project involving National Grid and Cuadrilla as project partners; and
- the Natural Environment Research Council (NERC), who are running a GHG emissions monitoring programme that could potentially be utilised to gather relevant emissions data for DECC.

h) This research programme should be independent and managed jointly between government and industry. The research should aim, for example, to reduce uncertainty associated with estimates of local methane emissions from shale gas operations and also to guide the optimisation of regulatory monitoring. The research could also provide information on the effectiveness of operators' actions to minimise methane emissions.

Government accepts this recommendation in full. We will establish a programme board for the programme of research that includes industry, academics, environmental groups and regulators. The programme board would be responsible for improving the evidence base with the aim of reducing uncertainty associated with estimates of local methane emissions from shale gas operations and to input into regulatory monitoring, in a transparent manner. In the meantime, the pilot study will be managed by the Environment Agency and DECC will collaborate with the pilot.

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