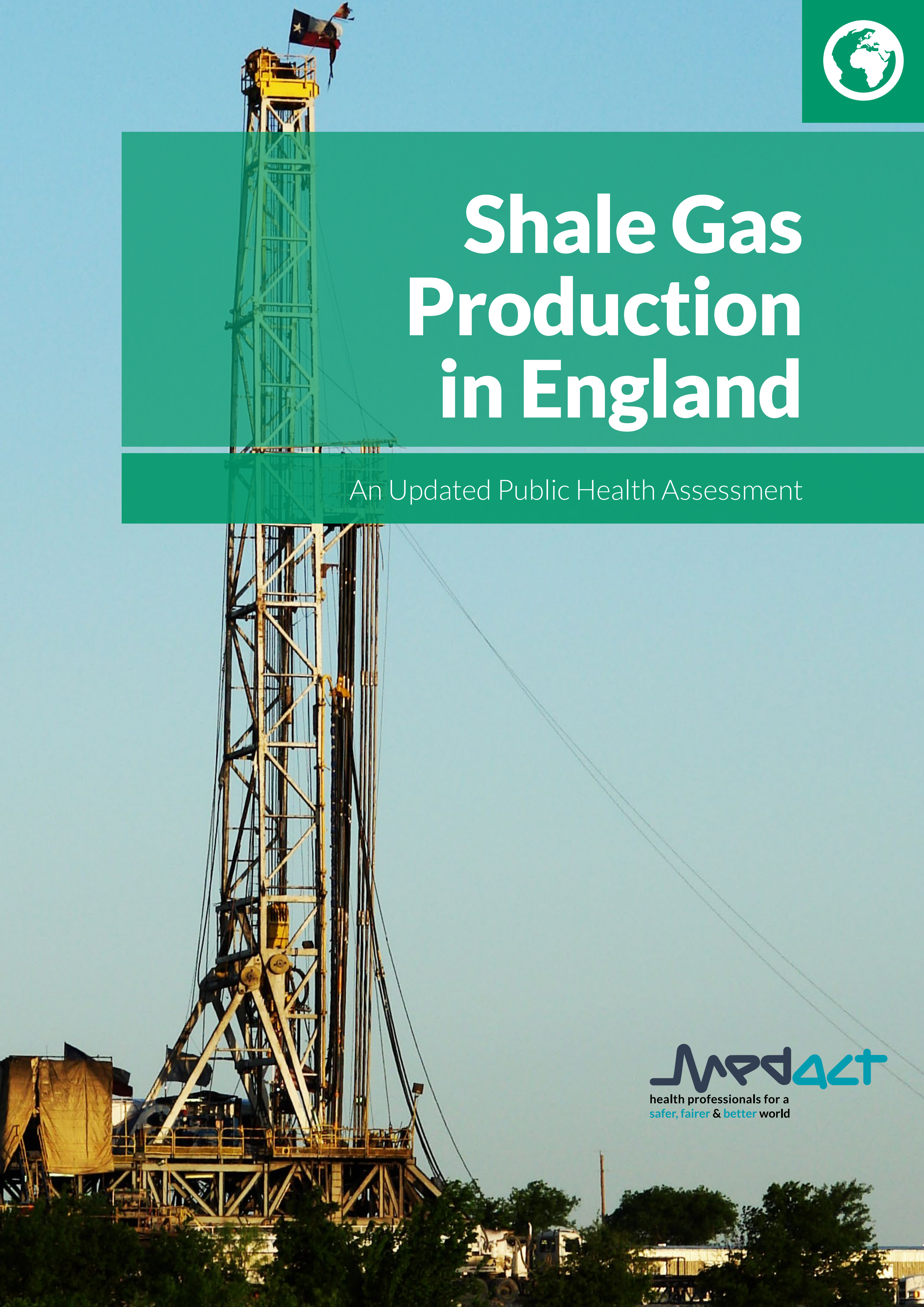
Shale Gas Production in England

An Updated Public Health Assessment



Medact

health professionals for a safer, fairer & better world

About Medact

Authors

David McCoy, Alice Munro.

Acknowledgements

This report, including any mistakes, are the sole responsibility of the authors. However, this report could not have been written without building on the work and expertise of many people who we acknowledge in an accompanying set of detailed notes.

Declaration of interests

Medact has received no dedicated funding to produce this report, although we gratefully acknowledge the financial support of the Sainsbury Family Charitable Trust to our Energy and Health programme. We declare no conflict of interest with regard to any of the issues discussed in this report.

Medact educates, analyses and campaigns for global health on issues related to conflict, poverty and the environment. We aim to mobilise the health community to support policy change and shift public attitudes. Medact is now over 20 years old, and our remit has grown to cover four distinct but interconnected programme areas:

Peace and Security

Climate and Ecology

Economic Justice

Health and Human Rights

Medact was formed by health professionals who sought to harness their expertise, mandate and ethical principles to raise awareness and speak out on health issues. Our members continue to be the cornerstone of Medact's activities through their active involvement in research and advocacy. Medact's members provide the bulk of our funding, which enables us to conduct independent research.

Medact is the UK affiliate of the Nobel Peace Prize winning organization International Physicians for the Prevention of Nuclear War (IPPNW).

health professionals for a
safer, fairer & better world

Published by
Medact
The Grayston Centre, 28 Charles Square,
London N1 6HT, United Kingdom

T +44 (0)20 7324 4739
F +44 (0)20 7324 4734
E office@medact.org

www.medact.org

Registered charity 1081097 Company reg no 2267125

Contents

Introduction

In April 2015, Medact published a review of the potential health impacts of shale gas production (SGP), including the process of high volume, hydraulic fracturing (HVHF). The report noted that:

- Significant health hazards are unavoidably associated with SGP and present real risks to the health and wellbeing of surrounding, local communities.
- The precise level of risk to health cannot be determined with certainty because: a) there is incomplete knowledge about the toxicity of a number of potential pollutants; b) SGP is an industrial process for which there are limited data and incomplete understanding; and c) the level of risk and impact on health depends on a range of context-specific geological, geographic, social, demographic, environmental and economic variables, including the number and density of wellpads and boreholes, and the size, composition and proximity of surrounding communities.
- The operating practices of shale gas companies, including how they treat and dispose of waste, and the adequacy and effectiveness of the regulatory system, are key variables in determining the safety of SGP.
- The regulatory framework for SGP in the UK was incomplete, unclear and potentially inadequate; and the capacity of regulators was being eroded by budget and staff cuts.

For these reasons, Medact recommended that any development of SGP be halted until a proper and comprehensive health and environmental impact assessment is undertaken. Such an assessment should: a) account for all the potential risks to physical and mental health, including the cumulative and compound effects of different types of hazard; b) be tailored to the specific geological, economic, environmental and social characteristics of the areas targeted for fracking; c) include an examination of the potential effects of SGP *at scale*; d) estimate the cost and affordability of an adequate regulatory system; and e) be conducted by a body that is independent of the oil and gas industry.

Medact also assessed the argument that shale gas is a relatively 'clean' fossil fuel that would aid the UK's transition towards a decarbonised energy system and concluded that these claims do not withstand scrutiny. As a result Medact argued that the government should abandon its plans to develop a shale gas industry on the grounds that global warming constitutes an unacceptable threat to global health.

Since then, Medact has continued to monitor the literature on SGP, and produced a detailed and fully referenced set of notes about the relationship between SGP and health. The analysis is over a hundred pages long and available on the Medact website. This document forms the scientific basis for this shorter and more accessible report.

Our view that the UK should abandon its policy to encourage SGP remains unchanged

We note that an industry-funded Task Force on Shale Gas, chaired by Chris Smith (former Chair of the Environment Agency and former Secretary of State for Culture, Media and Sport), produced a set of reports last year which concluded that SGP in the UK would be safe (to both human and environmental health), economically beneficial and important for the UK's energy security. Having reviewed the reports we reject their conclusions, and explain why.

A balanced assessment of risk and benefit

Introduction

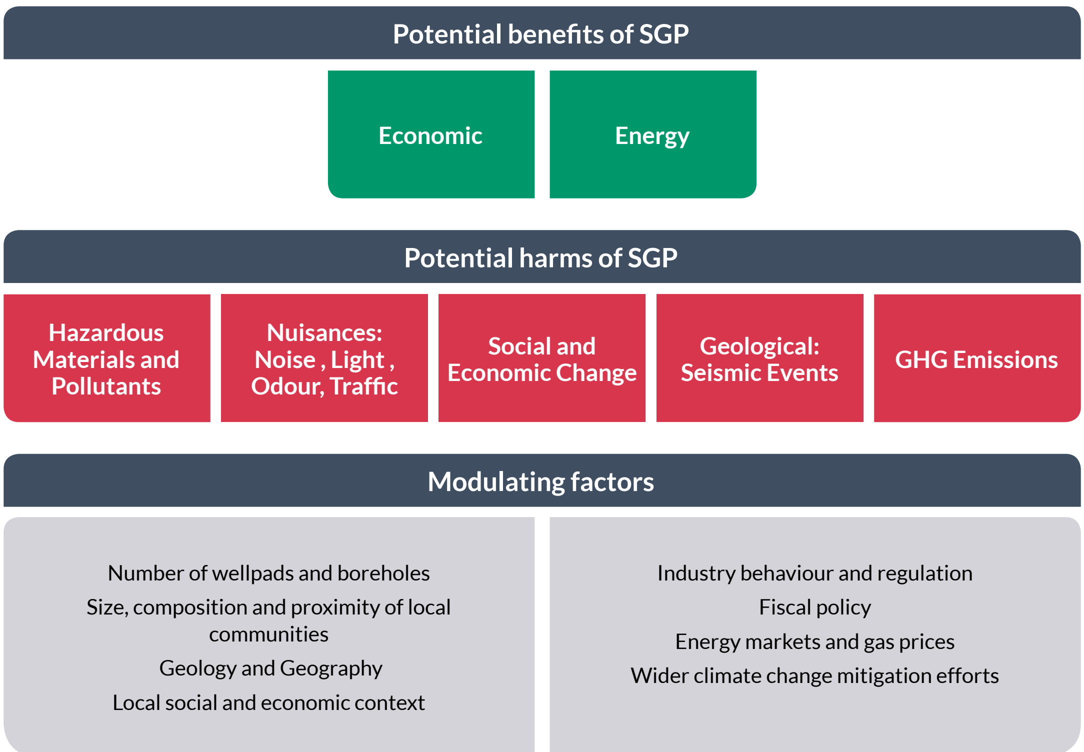
An assessment of the potential health impact of SGP has to be balanced and consider both the potential harms and benefits of SGP.

Shale gas operations are undeniably associated with a range of health hazards and *will* cause pollution and environmental damage. However, the question is whether these negative effects are acceptable in exchange for the benefits produced by shale gas. In answering this question, one must also consider the uneven distribution of harm and benefit across society (including between current and future generations).

In our detailed notes, we have used a framework (see Figure 1) that incorporates two sets of benefits. First, those related to energy itself, which has been a crucial ingredient of the remarkable improvements in human health witnessed over the past 250 years. Second, the potential economic benefits in terms of revenue, job creation and local investment.

Our framework also describes five sets of potential harms: 1) exposure to hazardous materials and pollutants; 2) exposure to so-called 'nuisances' such as noise, light pollution, odour and traffic congestion; 3) social and economic effects that may have an adverse impact on health and wellbeing; 4) seismic (earthquake) activity; and 5) the release of greenhouse gases (GHGs) and the effects of global warming and climate change.

Figure 1: Typology of Risks and Benefits Associated with SGP



Context and specifics matter

In assessing the potential harms and benefits of SGP, it has to be recognised that any potential future outcomes are dependent on a range of modulating factors that are context-specific (Figure 1).

Clearly, the scale and intensity of SGP, and the size, composition and proximity of local communities, will have a considerable bearing on the level of risk and impact on health. Similarly, the nature of local communities and pre-existing economic activities will determine the extent to which the social, cultural and economic disruption caused by SGP will impact negatively on local communities.

The specific geological features of the shale formations and their overlying strata, as well as geographic variables such as the local climate and topography, and the nature of the local ecosystem and road network, are also important in determining the type and degree of risk associated with SGP.

The adequacy and effectiveness of regulation and the ethical standards and operating practices of shale gas operators (including the adoption of new engineering technologies and safety improvements) are also important in determining levels of safety.

The economic benefits of SGP and their distribution across society are dependent on various factors including future gas prices; the tax and subsidy regime applied to the shale gas industry; the employment practices of shale gas operators; and the adequacy and effectiveness of a sanctions regime in the event of accidents, malpractice or negligence.

For these reasons, there is no such thing as a standard fracking operation and one cannot derive a generalisable measure of the harms and benefits associated with SGP. While it is important to learn from experiences of SGP in other settings, especially the United States, lessons must be applied carefully to the specificities of the UK context.

Assessment of research and evidence

Although SGP is a relatively new industrial activity, the number of rigorous studies of health and environmental impact is surprisingly low given that it has been operating on such a large scale in North America. Furthermore, sound research has been compromised by an over-reliance on data collected by the industry and often hindered by the use of non-disclosure agreements that have concealed information from public scrutiny. It is also notable that a significant amount of academic literature has been produced with oil and gas industry sponsorship or support.

Key points

It is clear that hazardous pollutants, with risks to both the environment and people, are produced across all stages of SGP including wellpad construction; drilling and hydraulic fracturing; gas extraction, treatment, storage and transportation; waste management; and after wells have been sealed and abandoned.

Pollutants include methane; volatile organic compounds (VOCs) such as formaldehyde, benzene, toluene, ethylbenzene and xylene; particulate matter (PM); oxides of nitrogen; hydrogen sulphide; silica; heavy metals such as lead, selenium, chromium and cadmium; and normally-occurring radioactive material (NORM).

There are many documented cases of air, surface water and groundwater pollution arising from SGP. The type, source and degree of pollution varies from one study to another, and from one site to another, for the reasons given above. There are also studies that show no association between significant levels of pollution, negative health effects and shale gas activity.

Several studies have documented evidence of population exposure to potentially harmful pollutants, while a smaller number of studies have shown an association between exposure to hazards and actual negative health effects.

Although it is not possible to quantify the health and environmental risk of SGP, there is clearly a potential for negative health impacts.

Of particular note are: a) the risk of adverse reproductive outcomes due to exposure to endocrine-disrupting chemicals which can be potent even at relatively low levels; b) the risk of respiratory effects resulting from ozone and smog formation, which may affect communities living at a distance from oil and gas extraction sites; and c) stress, anxiety, mistrust, fear and other psycho-emotional effects arising from nuisance impacts, as well as actual and perceived social and economic disruption.

The risk of groundwater pollution remains an issue of debate and concern. There are documented cases of groundwater pollution from the US, with the main source of risk coming from failures of well integrity and spillages of toxic fluid above ground. There is growing evidence of stray gas migration associated with SGP, although HVHF itself does not appear to pose a significant direct threat to aquifers.

The cost and capacity to safely treat and dispose of wastewater is a significant issue in the literature, and the availability of treatment facilities appears to be an issue of particular concern in England.

Well integrity failures rates are described in our detailed notes and may indicate an area of risk, particularly given concerns about the heavily faulted nature of the geology here compared to the US.

Seismic activity, a concern that has been accentuated by the experience at Preese Hall, is not thought to pose a direct threat to human health or property. However, seismicity may pose an additional risk factor for loss of well integrity, environmental pollution and release of fugitive emissions.

The degree and distribution of potential economic benefits remains unclear; and the lack of a comprehensive and independent social and economic impact assessment of SGP in England is deeply concerning, particularly given uncertainty about the commercial viability of SGP and evidence from the US that has shown how claims about of local economic benefits arising from SGP have tended to have been exaggerated.

Regulation and safe operating practices

Proponents of shale gas argue that SGP can be conducted safely because the UK has a strong regulatory system, and because shale companies are committed to 'best available techniques'.

In our first report, we argued that the regulatory framework for shale gas was inadequate, incomplete and unclear. Although it is not possible to fully determine minimum regulatory requirements and safety stands until there has been some experience of shale gas exploration in the UK, we remain concerned about: a) gaps in the regulatory framework; b) an over-reliance on self-monitoring by the industry; and c) large staff and budget cuts that have impacted the Environment Agency, Health and Safety Executive, and local government planning and public health departments.

Past efforts by the government to push for deregulation of the onshore oil and gas sector in Europe, coupled with the recent referendum result on the European Union, provide additional reasons for concern.

While some positive steps have been taken towards the establishment of some baseline data, concerns about the affordability and adequacy of regulation are legitimate and require attention.

Conclusions

Assessments of the immediate health and environmental threats posed by SGP must be viewed from the perspective of full scale commercial exploitation of shale gas.

The cumulative and synergistic risks of chemical, physical and psychosocial stressors of multiple wellpads and boreholes across a relatively densely populated and economically active, rural landscape will pose a health and environmental threat, particularly if regulation is inadequate and if tight profit margins cause companies to take shortcuts and minimise costs.

It is however important to recognise the uncertainty about the degree of risk and not to exaggerate the threat posed by SGP. Society presently tolerates a number of industrial and commercial practices that are considerably more harmful to human health and the environment. It is also important to note that nuclear, solar and wind energy produce their own set of negative social, health and environmental impacts.

Nonetheless, one can conclude that SGP *will* produce risks and some harms. It is therefore important that regulation would be able to keep the level of risk to an acceptable level, and that the benefits of SGP outweigh the harms. This is particularly important for local communities who will bear the brunt of the immediate risks and harms associated with SGP.

Presently, the absence of an independent social, health and economic impact assessment of SGP at scale is a glaring omission. Given the availability of alternative sources of energy, these are grounds for placing an indefinite moratorium on SGP (a position adopted by many jurisdictions across the world) until such time that there is greater clarity and certainty about the relative harms and benefits of shale gas.

However, this presupposes the viability and safety of shale gas as a source of energy. The validity of this presupposition is discussed in the next section.

The viability and safety of shale gas as a source of energy

The biggest threat posed by SGP to health is through its contribution to global warming and climate change. Shale gas not only produces carbon dioxide upon combustion, but is also an extremely potent GHG in its own right.

Proponents of shale gas argue that it produces a smaller carbon footprint per unit of energy compared to coal and oil, and will therefore help tackle climate change by displacing coal and oil from our energy mix. They also argue that shale gas is an important 'transition fuel' because renewable energy is not adequately advanced, nor affordable.

Carbon budgets

The average global land and sea surface temperature has risen by about 1°C since pre-industrial times. Because of lags in the response of the climate system, the world is already committed to even further warming.

The primary cause of global warming is the release of GHG emissions, about 70% of which is linked to the burning of fossil fuel. Agriculture, deforestation and cement use are also important sources.

Although scientifically challenging, the IPCC has constructed various (complex and multi-variable) risk models that relate GHG emissions to future temperature rise. A key output has been the production of global 'carbon budgets'. For example, to have a better than 66% chance of limiting global warming to 2°C, cumulative GHG emissions from 2011 onwards must be limited to around 1,000 (630–1180) $GtCO_2e$.

The IPCC's calculations are optimistic because they assume early peaks in global emissions and the future viability of 'negative emission technologies' (that would remove CO2 from the atmosphere).

Based on optimistic future scenarios about deforestation and cement processes, whilst accepting a more than 66% chance of limiting warming to 2°C, the 'carbon budget' for energy would be between 490-640 $GtCO_2e$ for the period 2016 to 2100. This would require reductions in energy-related emissions of *at least* 10% per annum from 2025, transitioning rapidly towards zero by 2050.

However, current GHG emissions trends are not reassuring. In 2010, annual global GHG emissions were about 49 $GtCO_2e$. Since then, emissions have actually been rising and are on track to reach 53-59 $GtCO_2e$ in 2030. At this rate, the global 'carbon budget' could be depleted before 2030.

The Paris Agreement (December 2015) has been heralded as a critical turning point in addressing the threat of global warming. However, the actual pledges made by individual countries to reduce GHG emissions do not yet match the ambition to limit warming to 2°C, never mind pursuing efforts to limit warming to 1.5°C. Even if countries deliver their current pledges, the predicted level of global warming would be between 2.8oC and 4oC.

The gap between climate science and the actual policies and plans to reduce GHG emissions is therefore considerable, reflecting both a reluctance to abandon our dependence on fossil fuels and unsustainable consumption patterns, as well as a belief that future technologies will be capable of sequestering GHGs from the atmosphere.

UK carbon budgets

The UK's statutory target is to reduce GHG emissions to 80% of 1990 levels. While this sounds ambitious, there are reasons why this target may be considered inadequate.

First, the target is based on the optimistic models and scenarios of the IPCC. Second, it accepts a dangerous level of risk for exceeding 2°C. Third, it effectively represents an unfair share of the global carbon budget, making little allowance for historical responsibility for GHG emissions, or the superior financial and technical capability of the UK relative to most other countries. Fourth, GHG emissions are calculated on a 'territorial' basis and do not account for GHGs that are emitted elsewhere but embedded in goods and services that are consumed in the UK.

In addition to this, the proposed trajectory for emissions reductions is spread across the period up to 2050 rather than being front-loaded. This runs counter to the advice of climate scientists to frontload emissions reductions so as to delay climate disruption, reduce the costs of abatement and lengthen the window of opportunity for the development and deployment of new technologies.

But even if one were to accept the statutory targets as adequate, there are concerns about our ability to meet them. According to DECC, although projections indicate continued reductions of GHG emissions, achieving the proposed targets for 2027 and beyond "will be much more challenging". For example, while primary energy demand is projected to fall 11% over the next 10 years, demand may start to increase because further improvements in energy efficiency may be insufficient to offset the impact of economic and population growth.

A key issue is the carbon intensity of energy production. Notably, by 2030, the mean carbon intensity for electricity generation would need to be below 100gCO2/kWh, and probably as low as 50gCO2/kWh (compared to 450gCO2/kWh in 2014 and 200-250gCO2/kWh expected by 2020).

This opens up questions about whether gas can play a significant role in helping the UK stay within its carbon budget after 2030. Even if we were to build new and efficient combine cycle gas turbines (CCGT), and even if we were able to deploy carbon capture and storage (CCS) technologies, it is becoming increasingly apparent that gas can only have a marginal and rapidly declining role in generating electricity after 2030.

Claims that shale gas will displace coal are clearly bogus given that the substitution of coal by gas has already mostly occurred and that coal is expected to be completely phased out of power generation by 2025. Rather, shale gas needs to be compared with other potential sources of electricity and heating including biogas, conventional gas, biomass and renewables.

Proponents of shale gas place a great deal of hope in carbon capture and storage (see later). Presently, the affordability, safety and feasibility of widely deploying CCS is questionable. However, it is worth noting that *even with CCS*, there may be limited cost-effective scope for gas use in power generation beyond 2030, because new gas-fired power stations would need to operate on relatively low load factors that would not be economically viable. This runs the risk of a new 'dash-for-gas' leading to a carbon lock-in, stranded assets, or failure to meet our carbon targets.

The global warming potential of shale gas

The global warming potential of shale gas depends on a number of variables: i) whether the gas actually reduces the use of coal and oil; ii) whether the gas is liquefied and transported before use (both liquefaction and transportation required energy); iii) the relative efficiencies of coal and gas power stations; v) the affordability, viability and safety of CCS; v) the amount of fugitive emissions released directly into the atmosphere; and vi) the time horizon over which the global warming potential of methane is assessed.

Shale gas also risks delaying the deployment of renewable energy and could lead to greater amounts of warming than would have occurred otherwise. Importantly, an estimated 50% of *existing* global gas reserves is deemed 'unburnable', raising doubts about the rationality and economic viability of developing SGP in the UK.

It is important to note that while shale gas displaced the use of coal in the US, it led to US coal being exported and burnt elsewhere. As a result, GHG emissions from the combustion of fossil fuels generated from within the US actually rose by about 10%.

Fugitive emissions are another critical issue. Fugitive emissions are gases (mainly methane) that are unintentionally lost to the atmosphere during the process of gas extraction, collection, processing and transportation. Fugitive emissions can also be released into the atmosphere through generalised seepage from below the ground, even after wells have been abandoned.

Some degree of fugitive emissions in oil and gas operations is unavoidable, and generally higher with unconventional natural gas compared to conventional gas extraction. In general, national inventories of oil and gas operations in the US have under-estimated the amount of fugitive emissions.

Scientific measurements of the amount and rate of fugitive emissions in SGP vary across the scientific literature. Studies have shown that emission rates can vary from area to area, and from well to well; and that a small number of 'super emitters' contribute to a disproportionately large percentage of fugitive emissions. Importantly, it is difficult to detect fugitive emissions, and 'super-emitters' are hard to identify.

Recent studies have indicated an alarming rise in global methane concentrations, including a 30% increase in atmospheric methane concentrations in the US over the past decade.

The cause of this global trend is believed to be a combination of increased biogenic methane emissions from tropical wetlands and agriculture, as well as the growth of oil and gas production. It is argued that the 20% increase in O&G production (including a nine fold increase in SGP) from 2002 to 2014 is a likely cause for the rise in methane concentrations in the US.

While the use of Reduced Emission Completions (REC) equipment can help to reduce levels of fugitive emissions during certain phases of production, the jury is still out as to whether the full life cycle of shale gas production and consumption is safe from the perspective of methane emissions and global warming.

Conclusion

One of the key arguments in support of SGP is that shale gas will help the UK meet its climate commitments. However, there appears to be little hard evidence supporting this claim. The risks associated with fugitive emissions, the inability to rely upon CCS as a safe, effective and affordable technology coupled, and the likelihood of shale gas hindering the development and deployment of renewable energy all point to SGP being more likely to aggravate global warming. The next section examines the risk posed by global warming.

Global warming and health

The health threats posed by global warming are increasingly recognised by the UK and international health community. According to the Director General of the World Health Organisation, climate change is one of the greatest challenges of our time.

The impacts of global warming and climate change have been noted and assessed by the Inter-governmental Panel on Climate Change (IPCC) and their impact on health studied by the public health community. For example, two Commissions on Climate Change and Global Health, convened by University College London and the Lancet (one of the world's leading medical journals) have drawn attention to both the threats of global warming, as well as the interventions required to mitigate and adapt to climate change.

The health effects of climate change can be mediated directly through, for example, heatwaves, extreme weather events and sea level rise; or indirectly through, for example, declining food production, increasing levels of conflict and violence, and forced migration.

GHGs are themselves also a direct cause of poor health and environmental damage: for example, air pollution is a major cause of premature mortality and chronic respiratory and cardiovascular disease, while high atmospheric concentrations of carbon dioxide are essentially poisoning the world's oceans through acidification.

There are already observed impacts of climate change on health globally. These include the effects of extreme high temperatures, floods, drought and salination of freshwater sources. Scientists are also certain that climate change is bleaching coral reefs worldwide; affecting river flows; forcing plant and animal species to move towards the poles and to higher elevations around the world; and negatively impacting on the productivity of key crops such as wheat and maize. Here in the UK, recent experiences of extreme weather, flooding and sea level rise can be attributed in part to global warming.

Certain parts of the world will initially suffer disproportionately from the effects of climate change. Eventually however, the interconnected and global nature of the climate system, ecosystems and human society mean that all parts of the world will be affected. Regions that may be less affected by the direct effects of climate change (e.g. extreme weather and sea level rise), will be affected indirectly through the effects of economic and social disruption in those regions that are more directly affected.

There is some uncertainty in the understanding of the earth's future climate system and how further global warming will impact on weather patterns, biodiversity, food production and water stress. This has led some people to adopt a blasé approach to climate change. However, there is a greater risk that unforeseen interactions and tipping points may produce rapid and irreversible accelerations in warming with catastrophic consequences.

According to the second Lancet-UCL Commission on Climate Change and Health, climate change could be *"sufficient to trigger a discontinuity in the long-term progression of humanity"* and that on the basis of current emission trajectories, *"temperature rises in the next 85 years may be incompatible with an organised global community".*

Proponents of SGP, including the industry-funded Task Force on Shale Gas, who argue that shale gas should be developed in order to reduce our reliance on gas imports and improve our energy security may fail to recognise that the effects and consequences of global warming cannot be prevented or mitigated through an outdated and narrow notion of national security. Global warming is a planetary phenomenon that has to be viewed through the lens of global human security.

In this sense, the debate about shale gas cannot be isolated from wider debates about the future of human development in a carbon-constrained and ecologically fragile world.

Alternatives to shale gas

The implications of global warming are clear: we need to rapidly develop and deploy a decarbonised energy system. Three aspects of decarbonisation are crucial: energy efficiency, energy conservation, and a rapid shift to very low or zero-carbon electricity.

In terms of practical implications, this entails the expansion of renewable energy (RE); increased electrification of end-use sectors; take-up of ultra-low emission vehicles and low-carbon heat (e.g. heat networks and heat pumps); improved home insulation; reduced agriculture emissions (by changing farming practices, reducing food waste and changing diets); and reduced aviation emissions.

Moving towards a low carbon world without shale gas *is* possible. Renewable energy is clearly one important ingredient in doing so.

Renewable Energy

The industry-funded Shale Gas Task Force has argued that we should embrace "a long term evolutionary approach" towards renewable energy, rather than "a short term revolution". The reasons they give for this slow approach include: a) inadequate grid infrastructure for absorbing wind, tidal and wave energy; b) public disapproval of bigger onshore transmission pylons; c) investors having limited funds; d) renewable energy being economically unviable; e) the intermittency of RE; f) RE technology being under-developed and socially unacceptable.

These arguments, designed to justify shale gas exploitation in the UK, are not valid.

Although low-carbon energy options are relatively inflexible or intermittent, the Committee on Climate Change (CCC) has argued that it will be possible *"to ensure security of supply in a decarbonised system with high levels of intermittent and inflexible generation"*. Two studies produced for the CCC indicate that the UK could generate over 80% of electricity demand from renewables without jeopardising security of supply, through the use of storage, interconnectors and demand side management. Other studies from the US demonstrate the possibility of cost-effectively moving towards an economy driven totally by renewable energy sources (largely solar and wind), within the next 15-35 years using technologies that are already commercially available.

Although the contribution of renewables to total energy mix in the UK has grown in recent years, and there are estimates that renewables will supply more than 40% of UK electricity by 2030, this does not represent an adequate degree of commitment or ambition. As noted by the Lancet-UCL Commission on Climate Change and Health, transition to a low-carbon infrastructure *"requires challenging the deeply entrenched use of fossil fuels"*.

While there are economic and technological challenges in expanding renewable energy, many more practical steps could be taken by the government to accelerate the development of renewable energy. Corrective taxation that internalises the full costs of GHG emissions and air pollution could reduce demand for fossil fuel and raise additional revenue for RE development. Hundreds of billions of dollars of public subsidies for the extraction and consumption of fossil fuels can be removed. Feed-in tariffs to encourage renewable energy production can be reinstated.

In terms of energy efficiency, regulation and standards can be pushed further and harder. Examples include placing a cap on GHG emissions from vehicles per kilometre driven, or on energy consumption of new buildings per unit of floor area. The list could go on.

Basically, the argument that we must develop shale gas in the UK for the purpose of energy security is without sound foundation.

UK energy security can be achieved through a combination of renewable power generation, improved energy efficiency and reduced overall energy consumption. But perhaps more importantly, this combined approach is safer in terms of avoiding catastrophic climate change.

Carbon capture and storage and technological fixes

As noted earlier, the models used by the IPCC to calculate global carbon budgets for avoiding different global warming thresholds tend towards being optimistic. In particular, they rest on some assumptions about new technologies being developed to mitigate climate change. This includes carbon capture and storage (CCS) which involves: 1) the separation of CO_2 from a gas stream; 2) CO_2 compression and transport (via pipeline or shipping); and 3) CO_2 storage in a suitable geological site (e.g. saline aquifers and depleted oil and gas reservoirs).

CCS could enable countries to continue to include fossil fuels in their energy mix for longer. One of the big hopes for the future is the combination of bioenergy and CCS (BECCS) which could even result in the generation of *negative* emissions.

However, the affordability, effectiveness and feasibility of CCS deployment is uncertain, and its impact before 2050 is likely to be modest. Worldwide, there is only one full-scale installation of CCS (in a coal-power plant) and the number of large-scale projects that are in either an 'identify', 'evaluate', 'define', 'execute' or 'operate' stage has actually declined in number since 2012. In the UK, the recent withdrawal of a £1 billion ring-fenced capital budget for CCS development has also thrown the viability of CCS in the near to medium term future into question.

Given the risk and threat of climate change, it seems prudent to develop an energy policy that does not assume any significant role for CCS before 2050.

A similar attitude towards other 'technological fixes' for continued fossil fuel use, including climate and geo-engineering approaches, would also be prudent. While these may have theoretical potential, they carry large risks.

In our view, a combination of renewable energy, improved efficiency and reduced overall energy consumption remains the safest approach moving forward.

The benefits

A further point that needs highlighting is that a set of social, ecological and health dividends could arise from our transition towards a low or zero net carbon world.

Links between climate mitigation practices and technologies and improved health and wellbeing include: a) improvement of crop yields from the mitigation of climate pollutants such as methane, black carbon, hydrofluorocarbons, and tropospheric ozone; b) avoidance of respiratory and cardio-vascular disease from reduced air pollution, increased levels of active travel (eg, walking and cycling) and improved home energy performance; c) expanded employment opportunities from low-carbon technology industries; d) reduced risks of antibiotic resistance and improved animal welfare from reductions in meat production and consumption; and e) the protection of ecosystems and local communities from the physical effects of fossil fuel extraction.

A world that consumes energy without warming up the planet would not be a poorer world.

Social and political change

While a health and environmental impact assessment of shale gas development in the UK must incorporate a rigorous and scientific study of data and information, it also has to be assessed from a social and political perspective, especially given the limitations of science and our knowledge.

The journey that we take to avoid catastrophic climate change is one that will be shaped not just by future developments in technology and the changes that occur with the climate and planet, but also by social and political preferences and choices.

The recent expansion of coal use across the world, which reversed the general trend of shifting towards less carbon intensive and less polluting fossil fuels through most of the 20th century, exemplifies a profound failure of politics and policy. The fact that global GHG emissions are still *rising* demonstrates just how much our institutions are built around narrow, short-term horizons; and how much our model of human development is centred around unsustainable economic growth and material consumption.

But there are other reasons why effective action on climate change has not been taken. Climate science is complex and involves a degree of uncertainty which creates room for equivocation and misunderstanding, and the effects of global warming, sea level rise and ocean acidification are psychologically distant in temporal, social and geographic terms for many people. And finally, as noted by the Lancet-UCL Commission, *"the active promotion of misinformation, motivated by either ideology or vested economic interests"* has blocked appropriate change.

It is vital therefore that in considering the arguments about shale gas in the UK that we also examine the social and political lenses through which we assess the evidence.

Conclusion

This report calls on the UK government to abandon its policy to encourage SGP in the UK.

The report, and its conclusion, is based on a wide reading of literature from different disciplines, covering multiple subject areas. A fully referenced set of notes drawn from this literature is available from the Medact website.

Some academics and public bodies hold the view that shale gas is safe, beneficial and in the public interest.

However, in our view, proponents of shale gas have tended to under-estimate the health and environmental risks, whilst over-estimating its local economic benefits. In fact there are significant hazards associated with SGP which may produce substantial risks to both human health and the environment.

While it *may* be feasible to commercially extract shale gas in ways that are relatively safe, it will be impossible to completely avoid harm, or eliminate all risk. Indeed, the social impact of SGP is already causing harm within certain communities in England.

While it is not possible to determine the level of risk with any precision, there are a number of factors which could increase the level of risk beyond an acceptable level. These include: the high population density of areas targeted for shale gas extraction; the present social and economic value of areas being targeted for shale gas extraction; the faulted nature of the local geology; the erosion of regulatory capacity amongst key public bodies; and the uncertain commercial viability of shale gas which may result in unsafe operating practices.

At the same time, this report recognises the importance of energy production to health, and notes that the actual physical health risks associated with SGP are less than those associated with some industrial and commercial practices that are accepted by society.

But the biggest health threat posed by SGP is the release of GHG emissions and its contribution to global warming. The risk of fugitive emissions and the limited global 'carbon budget' that remains available, suggest that shale gas cannot play a useful role in the UK's future energy mix.

Our report highlights the fact that global warming poses a potentially catastrophic threat. Given the recent and alarming trend of rising atmospheric methane concentrations, as well as the disturbing changes we are seeing with the world's climate and weather patterns, encouraging SGP would not just be unsafe, but also irresponsible.

The fact that shale gas will not displace coal as an energy source in the UK and will instead hinder the development and deployment of renewable energy technologies are additional reasons for opposing SGP in the UK at this point in time.

Furthermore, there are alternatives to shale gas that would be safer and better.

Although carbon, capture and storage (CCS) offers a theoretical possibility for reducing the GHG footprint of shale gas, there appears to be little prospect of this happening in the near future, not least because the government itself has withdrawn its own support from the development of CCS.

As a wealthy nation with a skilled workforce and a world-leading renewable energy resource base, choosing to develop a new fossil fuel industry would not only stop us meeting our national targets to reduce GHG emissions, but also damage the UK's international reputation and undermine the delicate negotiations being undertaken to strengthen international resolve to prevent runaway global warming and climate collapse.

In May this year, the province of New Brunswick in Canada, decided to *indefinitely* extend a temporary moratorium on hydraulic fracturing having set five pre-conditions for the oil and gas industry to meet. According to the Energy Minister, "after careful consideration, it is clear to us that the industry has not met the conditions. Additionally, the global market for natural gas has seen a precipitous drop in prices, which makes it further unlikely that industry will invest the necessary efforts to address the conditions in the short or medium term."

Three of the conditions that had been set were: i) a "social license" (i.e. public trust that they would be kept safe) to explore and exploit shale gas; ii) clear and credible information about the impacts of fracking on public health, the environment and water, allowing the government to develop a country-leading regulatory regime with sufficient enforcement capabilities; and iii) a plan that mitigates the impacts on public infrastructure and addresses issues such as waste water disposal. These conditions would also not be met by oil and gas companies here in the UK.

Germany has also recently joined the many jurisdictions that have decided to prohibit shale gas production. Doing the same in England would therefore not constitute a radical decision. If anything, prohibiting development of an industry that has doubtful economic viability, is risky to local communities, and runs counter to the direction of the necessary energy transition, should be regarded as a reasoned and sensible decision.

Selected readings

Anderson, K and Bows, A. Beyond 'dangerous' climate change: emission scenarios for a new world. *Philos Trans A Math Phys.* Eng Sci. 1934; 2011: 20–44

Budinis, Krevor, MacDowell et al, 2016. Can Technology unlock 'unburnable' carbon? London: Sustainable Gas Institute

Clarke L, Jiang K, Akimoto K et al, 2014. Assessing transformation pathways. In Edenhofer, Pichs-Madruga, Sokona (Eds.) Climate change 2014: Mitigation of climate change contribution of Working Group III to the Fifth Assessment Report of the IPCC. Cambridge University Press; 2014

Climate Action Tracker, 2015. Paris Agreement: near-term actions do not match long term purpose – but stage is set to ramp up climate action. http://climateactiontracker.org/assets/publications/briefing_papers/CAT_COP21_Paris_Agreement_statement.pdf

Committee on Climate Change, 2015. The fifth carbon budget: the next step towards a low carbon economy.

McCoy D and Saunders P, 2015. Health and Fracking: Impact and Opportunity Costs. London: Medact.

McCoy D, Saunders P and Munro A, 2016. Shale Gas: Risk and benefit to Health. Notes from the Literature. London: Medact.

McGlade C, Pye S, Watson J, Bradshaw M and Ekins P, 2016. The future role of natural gas in the UK. London: UK Energy Research Centre.

McGlade C and Ekins P, 2015. The geographical distribution of fossil fuels unused when limiting global warming to 2°C. Nature 517: 187—190. doi:10.1038/nature14016

Passut C, 2016. New Brunswick to Continue Fracking Moratorium Indefinitely. http://www.naturalgasintel.com/articles/106649-article-headline

Turner et al, 2016. *A large increase in U.S. methane emissions over the past decade inferred from satellite data and surface observations*, Turner et al., Geophysical Research Letters

(preprint), 2016 – http://onlinelibrary.wiley.com/doi/10.1002/2016GL067987/pdf

Watts N, Adger WN, Agnolucci P et al, 2015. Health and climate change: policy responses to protect public health. The Lancet, 386 (10006): 1861–1914.

health professionals for a
safer, fairer & better world

The Grayston Centre, 28 Charles Square, London N1 6HT, United Kingdom

T +44 (0)20 7324 4739
F +44 (0)20 7324 4734
E office@medact.org

www.medact.org

Registered charity 1081097 Company reg no 2267125