What level and volume of drilling is likely to be required to support commercial extraction of shale gas through hydraulic fracturing in the UK?

Friends of the Earth

Commercial extraction of UK shale gas is, at this point in time, far from guaranteed. Despite over five years having passed since the temporary moratorium on fracking was lifted, we have still not had a single test frack. It is as yet unclear how productive UK shale gas wells will be, and far from certain that gas can be produced in a way that is commercially viable. With this in mind what we say relates to the volume of drilling required to support a commercial industry, if indeed one is possible at all.

Shale gas extraction is, by its nature, a distributed industry. Unlike other centralised fossil fuel extraction methods such as deep pit or open cast coal mining, shale gas developments are individually far less productive and although smaller require a much greater number of extraction sites to have any significant impact on energy supplies. The shale gas industry must spread over large areas, rather than develop a handful of large sites.

The slow progress of the industry in the UK to date has made consideration of the cumulative impacts of a full-scale commercial industry difficult. To help with this consideration, Friends of the Earth commissioned a report from Professor Calvin Jones of Cardiff University to consider the potential scale of a UK shale gas industry. Professor Jones is one of the leading UK academics on energy and has produced reports for the Welsh Government on this issue.

In his report *The Implications of Fracking in UK Gas Import Substitution* (2018), Professor Jones makes projections for the number wells and well sites required to significantly replace UK gas imports over a fifteen year period.

The volume of gas required for import substitution was derived from the most up to date projections for gas imports from the Department for Business, Energy and Industrial Strategy and the National Grid. The report estimates the number of wells required to replace both 50% and 100% of UK gas imports over a 15 year period, 2021 – 2035.

As the true well productivity of UK shale gas is as yet unknown, Professor Jones puts forward three scenarios – a central scenario; an optimistic scenario in which well productivity is at the high end of estimations; and a low well productivity scenario. Unless stated otherwise I will refer to the central scenario throughout.

To give a sense of UK shale gas well productivity in relation to imports, under the central productivity scenario, one well over its circa 15 year lifetime would produce approximately the same amount of gas as a single typical liquid natural gas (LNG) tanker. In the low productivity scenario, four shale gas wells would be required to replace one tanker of imported LNG.

Using the central estimate of well productivity, Professor Jones calculates that replacing half of UK gas imports from 2021-2035 would require an estimated 6,100 wells – this equates to more than one new well every day for the 15 year period. In the optimistic scenario Professor Jones estimates that 4,090 wells would be required. In the low productivity scenario, the number of wells required is estimated to rise to 16,550, or 3 new wells per day.

For the UK to reach full self-sufficiency in our gas supplies, replacing 100% of projected imports over the 15 year period, the number of wells required under each scenario is doubled.

Productivity Scenario	Well productivity (BCM)	Wells required - 50% import substitution	Wells required - 100% import substitution
Low	0.021	16,550	33,100
Central	0.057	6,100	12,190
Optimistic	0.085	4,090	8,180

Campaign for Protection of Rural England

We initially refer to the most up-to-date piece of research on this question, that of Professor Calvin Jones of the Cardiff Business School.

We understand that Professor Jones will also be giving evidence, so we will focus on our interpretation of the implications of his findings rather than the findings per se.

We are particularly concerned at the scale of land take that upwards of about 6,000 wells would imply. Planning constraints in terms of protecting residential amenity will tend to mean locations in more remote rural areas are favoured, often in Green Belt and areas of countryside valued for their tranquillity and recreational use. This countryside provides vital 'breathing space' for both local communities and visitors alike and should not, in our view, be turned into an industrial testing site.

If the number of wells were to start to reach the upper estimates that Professor Jones indicates would be required to offset gas imports significantly, encroachment will also be likely into the settings of NPs and AONBs which are already under increasing pressure from marginal inappropriate development.

CPRE Cheshire, estimating 'ballpark' maximum potential resource, state that Peel Holdings, a major land-owner and developer, has described a scenario of 1,000-4,000 wells across shale bearing areas in NW England and INEOS has claimed to have 400 land deals in place for Cheshire.

INEOS is proposing up to 12 wells per site which indicates a potential 4,800 wells, making an indicative total of about 8,000 wells in NW England. The US Energy Information Administration reviewed BGS data in 2015 and estimated 26 Tcf (trillion cubic feet) of technically recoverable shale gas for the UK.

Using well productivity assumptions in Professor Jones' report, this gives estimates of between 8,500-35,000 wells.

In addition to the drill sites, in terms of further impacts on the rural environment, there would be significant additional plant, infrastructure and traffic required to process and transport the gas, water and other materials required. The developments will also require substantial facilities for treatment and disposal of contaminated waste. Each well produces substantial quantities (tens of thousands of tonnes) of solid and liquid waste. Scaling this up means very substantial waste outputs and associated HGV movements. Currently there are insufficient facilities to deal with this quantum of waste.

We would also point out that even at a lower level of well development in England, commensurate with the aim of displacing a significant proportion of imported natural gas, the timescales for development and levels of carbon released would likely to be inconsistent with scale of carbon.

Frack Free United

There are a variety of estimates on the level of drilling that would be needed to achieve this. What is certain is that it will require a major expansion of the onshore oil and gas industry, which drilled 1,303 wells between 1967 and 2017 and I snow expected to drill thousands more between now and the 2030s. This massive expansion of drilling is not appropriate at a time when we should be looking for alternatives to fossil fuels, action on climate change and working to improve air quality. Whether the higher or lower estimates of the amount of drilling required are correct, shale gas development is clearly the wrong kind of energy at the wrong time.

Calvin Jones, of Cardiff Business School produced a study on behalf of Friends of the Earth concluding that an estimated 6,100 wells would be needed to replace half of UK gas imports over the 2021-2035 period.

UKOOG estimated in 2017 it would need 400 well pads to achieve this level of import substitution.

In their 2014 report, *Getting Ready for UK Shale*, EY estimated that 4,000 horizontal wells would be drilled by 2032.

Andy Aplin, of Durham University, estimated in 2014 that perhaps 5,000 well pads would be needed to fully develop the Bowland Shale.

In 2016, Ineos released an advert seeking a seismic survey contractor which showed a production scenario of up to 30 well pads in a 10km x 10km licence area. The company later rowed back from this, but the advert should still be seen as indicative of the potential scale of the industry.

An important study by Sarah Clancy, of Durham University and others, looked at the spatial constraints on well pad density caused by the presence of water courses and existing buildings, roads and railways in the Bowland Shale. It concluded an average of 26 well pads could fit into a 10kmx10km licence area and that this average would lead to a total of 3,302 well pads. In this scenario, production would be limited to 26% of previous estimates of the recoverable resource.

Gundi Royle, oil and gas industry analyst, on behalf of Frack Free Ryedale

The UK consumed 1.4Tr Btu in 2015. Assuming that shale gas could assume a 50% share over time, the UK would need 18-20,000 wells. The only region in the world which is producing shale gas on that scale is the US. To make a meaningful contribution to the UK energy balance as is claimed by the proponents of shale gas exploration, the deduction is that wells will be drilled in their hundreds per year, rather than their dozens.

The Appalachia region of the US is the foremost gas producing region with the Utica and Marcellus basins. There are presently a total of 10,500 wells with some 90 to 120 drilling rigs operating on average.

Appalachia Drilling – cumulative shale gas wells: 10,500

Source shaleprofile.com and Eia.gov/petroleum/drilling/

So many wells are needed because shale gas wells decline at an average rate of 60% per annum in the Marcellus and Appalachia shale basins. This requires constant drilling to maintain and grow production. In the US, landowners are compensated for noise, pollution and interruption with wellhead royalties of up to 20%.

Oil and Gas Authority

The purpose of exploration activity, particularly drilling and testing, is to identify commercially-viable resources of oil and gas. Without such information, which is often specific to a relatively small geographic area, it is not possible to make accurate forecasts of the resulting development activity.

Consequently, the OGA will not make an assessment of future potential activity for a particular area or for the contribution to the UK energy mix until more is known from exploration. Important parameters are the flow rates that can be expected per well and the predictions for these rates over time. Further, commerciality is strongly dependent on the technology that can be deployed and the experience from North America is, for example, that operations are becoming more efficient and that fewer wells are needed to develop a given volume of gas. For any licence it is only when the performance of wells, the number required for a development and their cost is known that an accurate prediction of activity and the resulting reserves can be made.

The Strategic Environmental Assessment (SEA) prepared for the 14th Onshore Licensing Round in 2013/14 did present some illustrative scenarios for the number of exploration wells per licence and the ultimate, cumulative, scale of development activity based on the

geological and engineering at that time. The report did not make predictions of the overall contribution of the 14th Round to UK energy security.

The assessment was made before the creation of the OGA when oil and gas licensing was a function within the then Department of Energy and Climate Change. Amec were commissioned to carry out the assessment.

The outcome of the 14th Onshore Oil and Gas Licensing Round was the offer of 159 onshore blocks incorporated into 93 onshore licences. This was within range of scenarios set out in the SEA although exploration drilling has not yet reached the level of the "low activity" scenario.

What would full-scale commercial fracking actually look like in the UK on an area-by-area basis?

Friends of the Earth

Because Professor Jones's report is based on volumes of gas required for import substitution, it does not estimate *where* these wells be located.

He estimates that in the UK wells will, on average, be spaced 6 wells to a pad. Note that this is a higher number of wells per pad than the average currently in the USA, but it has been used due to UKOOG and others' suggestions that UK geology may enable a higher number of wells per pad. Therefore, the 6,100 wells required to replace 50% of imports in the central scenario would be spread across approximately 1,020 well pads, or individual fracking sites.

In such a scenario, the total land take of the fracking industry would be significant. Professor Jones calculates the necessary land for the 1,020 well pads to be 3,560 hectares to replace 50% of gas imports over 15 years. That is equivalent to over 4,900 football pitches. Replacing 100% of imports is estimated to require almost 10,000 football pitches of land to be given over to the industry.

Productivity Scenario	Ha per pad	Pads	Total Ha (50% import substitution)	Total Ha (100% import substitution)
Low	3.5	2,760	9,650	19,310
Central	3.5	1,020	3,560	7,110
Optimistic	3.5	680	2,380	4,770

In reality, this estimate of land take is likely to largely *underestimate* the total amount of land required by the industry, as it is calculated based solely on the footprint of the well pads. It does not take into account the required land for access roads to sites, or for pipelines, etc.

The area of directly affected land also grossly *under-represents* the total area of land affected by the developments. It is not, of course, one single open cast coal mine but over 1,000 individual sites spread out over a much larger area and likely connected in a network by pipelines and roads, spreading the visual impacts much further than just the footprints of the well pads themselves.

Research shows that fracking requires a lot of heavy traffic, often through rural locations. With regard to cumulative traffic impacts, academics have estimated that for a 6 well pad in production phase up to 6,500 HGV movements are required. Therefore, in a scenario where

there could be 1,000 such pads, the total traffic volume necessary could be up to 6.5 million HGV movements. This is to say nothing about the vehicle movements needed in other stages of development, which can be equally as vehicle intensive.

Currently the UK has 19,487 km^2 under PEDL licences for onshore oil and gas exploration (17,820 of which is in England. The most recent, 14th Onshore licensing round shows a spread of licenses across England and Wales for exploratory drilling, but with a concentration in central England, the North East and North West. However, devolved UK governments have (by various means) made it clear fracking is currently unwelcome in Scotland, Wales and Northern Ireland. In the current context therefore, all fracking developments will need to take place in England, significantly increasing the density of wells necessary for a, say, 6,000 well scenario.

To give some idea of the density of development that areas targeted by the industry could see, we can look to some of the industry's own claims. INEOS, the large petrochemicals company, has claimed that it aspires to build 10-15 fracking pads in each 10km by 10km area of their licences. If just 9 fracking pads where to be spaced perfectly evenly across a 10km by 10km licence block, the distance between well pads would be 3.3km. If you were living in, working in or visiting the area, you could never be more than 2.4km from a fracking site.

Looking at the areas covered by the current approximately 200 onshore oil and gas exploration licenses, there is a concentration around the Bowland Shale play, thought to be the UK's richest shale geology. This would suggest that the majority of shale gas development in the UK would take place in central and northern England. If the industry's current activities are a guide, development looks likely to focus on Lancashire and the North West, North Yorkshire, and South Yorkshire and the East Midlands – at least in the early stages of the industry.

The PEDL licenses in the South of England are being utilised predominantly for oil exploration, which although having some technological differences to shale gas fracking also has many similarities. Tight oil exploration requires drilling activities, large numbers of HGV movements and is, like fracking for shale gas, a distributed industry, with multiple sites needed across any reserves. It should be noted that due to this exploration being for oil they will not have an impact on UK gas imports and any wells are therefore additional to all of Professor Jones's estimates in his report.

Campaign for Protection of Rural England

We are clear that to reach large-scale output (commercial maturity of indigenous supply) would require significant land take in an already crowded rural landscape, which would likely give rise to serious cumulative impacts. Land use planning constraints (not all of them absolute for minerals, e.g. Green Belt) and designations for nature conservation and cultural heritage protection would tend to 'hem' shale gas development much closer to rural communities than is desirable in terms of protection of amenity and health.

The scale of well development in any given area would be dictated initially by planning consents and thereafter by production requirements and availability of plant and other resources. There would be a mixture of visual, traffic, ecological, environmental, noise/nuisance and tranquillity impacts associated variously with site establishment/construction, initial drilling, production and allied off-site movements of materials, equipment, water, gas etc. These impacts would be significant over long periods (5-10 years and maybe more), would likely be contiguous across wide areas of local countryside, giving rise to inter-visibility and significant cumulative impacts.

We would also include within cumulative impact, in the broader sense, the concept of and potential for 'sequential impact'. Here repeating patterns of built development (e.g. wind

turbines), experienced through sequentially visited visual catchments ('viewsheds') gives rise to negative perceptions of tranquillity and remoteness. Thus a variety of landscapes seen during a journey become homogenised by recurring visual intrusion.

Frack Free United

With the release of the new Written Ministerial Statement on shale gas, there is the threat of a one-size-fits-all approach of unrestricted drilling and fracking in all shale gas areas. The government is pressuring local authorities to permit shale gas planning applications, without giving them the detailed assessment they need. The ability of local authorities to control shale gas is being undermined by the WMS.

The government says British regulation will avoid the US experience being replicated here, but there is no reason to believe this. A precautionary approach requires the US experience to be considered.

Aaron Tustin et al of John Hopkins University found that unconventional gas development in Pennsylvania was linked to chronic rhinosinusitis and migraine.

Joan Casey et al of John Hopkins University found that unconventional gas development was linked to increased indoor radon levels.

Sara Rasmussen et al of John Hopkins University found that unconventional gas development was linked to hospitalisation related to asthma

Lisa McKenzie et al, of the Colorado School of Public Health found links between birth defects and gas development.

Helmig et al, of the University of Colorado found dangerous levels of VOCs and ozone associated with unconventional gas development in Utah.

Jessica Gilman et al showed elevated levels of ozone precursors in Boulder Colorado and showed through analysis of their composition that these were to a large extent caused by the nearby gas field.

The Public Health England report says that research in the US shows dangerous levels of air pollution in unconventional gas fields in the US but says these are due to particular topographical and meteorological conditions. This is unacceptable. The precautionary principle requires proponents of shale gas to demonstrate that there will not be dangerous levels of air pollution, instead of having the government make vague assumptions about this important topic.

Gundi Royle, oil and gas industry analyst, on behalf of Frack Free Ryedale

In the UK, no data on recoverable resources nor productivity rates has yet been collected. Therefore only an analogy with the US operations can be made.

Shale well gas production typically declines by 60-70% per annum. Taking into account US densities, the potential number of pads can be calculated as follows, based on the example of Ineos, which holds about 300,000 gross acres under licence.

Wells are typically drilled from a central pad. Each pad can contain between 12 and 14 wells. A typical site is 5 acres.

The reach of the horizontal wells means that a pad can reach between 640 and 850 acres.

Assuming a pad with 12 wells with 2.5Tr Btu recovery each, 1 pad would recover in 24 months 30 Tr Btu or 1.5% of the annual gas demand of the UK.

As wells production rates decline by 50 to 75% in the first 18 months, a continued supply of pads will be needed. In the US, pads are continuously constructed as evidence by the density of the pads on aerial photos.

Number of pads and wells depending on well density, reach or catchment area per pad in the licence area:

Ineos participates about 300,000 gross acres		% of licence area used for pads		
		75%	50%	25%
@ 640 acres reach per pad	No of pads	347	232	116
@ 850 acres reach per pad	No of pads	262	174	87
Number of wells				
@ 12 per pad	No	4,168	2,779	1,389
@ 24 per pad	No	6,277	4,184	2,092

Shale drilling and fracking operations are very traffic intensive. Materials and fluids have to be brought on and carried off site continuously. A typical US site has about 180 truck movements per day during fracking. Taking into account that pads are typically fracked in batches, some 10,000 truck movements are not unusual during a two-month fracking operation.

What is the potential impact on individual communities located near full-scale commercial development?

Friends of the Earth

Friends of the Earth has been working with the community in Kirby Misperton in Ryedale, North Yorkshire, a location targeted for fracking by Third Energy. While equipment was being brought on to the site in preparation for fracking, the local community reported suffering severe impacts. The Rt Rev Graham Cray, a Bishop who retired to the village, reports "traffic, noxious smells and a divided community. Some local businesses have shut down and people in the village can't sell their houses."

Kirby Misperton also provides as example of the impact of heavy industrial traffic on a small rural community. When bringing the drilling rig to site the HGV transporting it was too large to turn the bend on the main road, closing down the road for many hours. The grade II listed bridge in the village was also grounded by an HGV that could not clear it, causing damage.

It should be noted that that Kirby Misperton is not yet at production stage, and the site is for one single small vertical well, with no horizontals. These impacts would have to be replicated thousands of times for fracking to have any significant impact on our gas supply.

In Lancashire the local community's opposition to fracking has been sustained for many years. The cost to the local authority of policing Cuadrilla's Preston New Road site has been estimated at £7m. This of course has implications for other services within that local authority. This, again, is a single site (two wells) and before fracking has even started.

In central England fracking firm INEOS have been conducting seismic surveys – the first step towards fracking – to assess shale gas resources. Communities in Nottinghamshire have seen the company attempt to bring this process into some of their most treasured places. INEOS have signed an agreement permitting them to conduct seismic surveys within Sherwood Forest and the Birklands SSSI. After being refused access by the National Trust to their property at Clumber Park, Nottinghamshire, INEOS are now taking the National Trust to court to force access.

Campaign for Protection of Rural England

Our experience in many areas of England where permission has either been given, or is being sought, suggests that there will be a multiplicity of significant environmental or planning-related impacts (spanning water quality/water shortage, seismicity, traffic, cost of repairs/upgrades to highways, loss of amenity/tranquillity, planning blight) which cannot be mitigated to the satisfaction of those communities that will be affected locally. There is also widespread concern that planning conditions and/or other steps required for regulatory compliance will not be met or monitored in a satisfactory manner.

In addition, adverse effects on other parts of the economy including agriculture, recreation and tourism are likely. We also detect social stress and damage to community confidence in governance from the loss of local democracy and agency. This could worsen with proposed changes to the decision-making (planning) regime for England.

Frack Free United

The main impact of shale gas on local communities are damage to air quality, noise, large increases in traffic and threats to water quality. However, it should be remembered that shale gas development does not only harm those nearby. We are all put at risk by climate change, which can only be worsened by shale gas. There may also be region-wide impacts on important industries, such as farming and tourism.

At Preese Hall, the first gas well to be fracked in the UK, the fracking in 2011 caused earthquakes with a magnitude of 1.3 and 1.5. While these are not large earthquakes, it is important to note that the well casing was damaged.

At West Newton A in 2014, there was a serious environmental incident in which residents complained of a foul odour and feeling ill for several days. The Environment Agency found that there were multiple breaches of the Environmental Permit and that cold venting was taking place.

At Kirby Misperton the noise limits established in the planning permission have been exceeded despite the presence of a large acoustic barrier. This leaves open the question of how would a development of multiple well pads or multiple wells on one pad fare when it comes to noise.

A planning application for gas drilling in Ellesmere Port included flaring in a built up area near an AQMA.

The Traffic Management Plan for Cuadrilla's well pad at Preston New Road includes 90 two way traffic movements over a period of 12-18 months.

Seismic surveys are another problem caused by the exploratory stage. Residents are disturbed by the use of explosives and thumper trucks while landowners can be threatened with compulsion through the courts if they try to refuse access for seismic surveys. Ineos is seeking a court order to compel the National Trust to allow seismic surveys on its land at Clumber Park in Nottinghamshire.

It should be noted that shale wealth funds are not statutory and it is questionable how much influence local residents would have on the way this money is spent. However, some of the consequences of shale gas development, such as the threat it poses to air and water quality, cannot be compensated for by contributions to good causes.

Gundi Royle, oil and gas industry analyst, on behalf of Frack Free Ryedale

Shale drilling, by its nature of rapid decline in well productivity, demands industrial-scale drilling. This entails intensive and continuous operations around the drill pads.

Transport: Drilling equipment, water and frack materials will be transported to and from the site, as will flow back water after the frack.

Ineos participates about 300,000 gross acres		**% of licence area used for pads**		
		75%	**50%**	**25%**
@ 640 acres reach per pad	No of pads	347	232	116
@ 850 acres reach per pad	No of pads	262	174	87
Number of wells				
@ 12 per pad	No	4,168	2,779	1,389
@ 24 per pad	No	6,277	4,184	2,092
Tuck movements per pad pa				
Pad of 12 wells	No	65,700		
Water use				
Per well	m3	36,340		
Per pad 12 wells	m3	436,079		
Asumming drilling of 30 pads pa	m3	13,082,377		
Average UK house hold annual consuption	m3	165		

Based on US operations in the Marcellus
Sopurce for water: Scientific American july 2015

Water: The average fracked well requires 36,000 m3 of water. The returning waste water is brine and chemical contaminated therefore cannot be discharged into rivers. Based on the Ineos example and using US figures, each pad could consume 13 million m3 of water. This water has to be brought to site or freshwater bores have to be drilled to make it available.

Production infrastructure: This includes gathering pipelines and inspection gas treatment stations, road access to pads, waste water treatment plants. They will have to be removed and the land restored after pads are exhausted.

Can current planning policy and practice realistically support the level of extraction needed for full-scale commercial fracking in the UK to help provide energy self-sufficiency?

Friends of the Earth

This is complicated question without a single simple answer. Planning policy and planning practice need to be taken in turn.

With regards to planning policy – based on Professor Jones's research – full energy self-sufficiency would require, in the central scenario, 12,200 fracking wells. It is hard if not impossible to envisage a situation in which, given the points we have raised, development of this magnitude would not conflict with local and national planning policies designed to protect the countryside and landscape character, ecology, amenity and others.

Starting up a new fossil fuel industry in the UK at a point in time where we know we need to keep the majority of known fossil fuel reserves (and UK shale gas is additional to these known reserves) in the ground is, in Friends of the Earth's view, impossible to do within planning policies designed to address climate change and reduce reliance on fossil fuels.

In Professor Jones's central well productivity scenario, it is estimated that 7,100 hectares of land would be required for full self-sufficiency. While there is likely enough land available in England, whether there is enough land located outside of protected areas (National Parks, areas of outstanding natural beauty, water source protections zones, Natura 2000 sites and sites of special scientific interest) without introducing unacceptable cumulative visual and landscape, traffic, water resource, waste production, and climate change impacts remains to be seen.

With regard to the question of whether current planning practice can support the level of extraction, it cannot. There is already national shortage of town planners. Local government faces funding pressures, therefore minerals and local planning authorities struggle to recruit and retain sufficiently qualified, skilled and experienced planning staff. Minerals/hydrocarbons is a specialised sector within town planning and in turn requires input from related professions (ecology, engineering, etc). The cumulative implications of needing to provide the correct level of planning consideration for the multiple planning stages of each of the over 12,000 wells necessary for self-sufficiency are vast, and not currently within the realms of possibility for current planning practice.

Campaign for Protection of Rural England

The simple answer is no, especially in a situation where local (mineral) planning authorities are under-resourced. This would especially be the case if extraction was scaled up to the degree necessary to displace offshore/imported natural gas and LNG with indigenously sourced gas, even assuming this is possible or desirable.

However, CPRE is clear this does not provide a sufficient rationale for significant changes to the current planning regime, as the Government has signalled in the recent Written Statement by Mr Clark (SoS, BEICS: HCWS690, 17 May 2018). It is neither appropriate, given the scale and significance of impacts caused by exploratory drilling, nor in terms of the precedent of local decision-making, to allow such development to fall within permitted development. Nor would it be right, in terms of the need to ensure local communities are fully involved in planning decisions, to move the locus of decision-making for shale production to the NSIP regime.

As we have stated to the recent HCLG Select Committee inquiry into the planning regulation of fracking, other steps to assist mineral planning authorities (MPAs) in their decision-making (such as enhanced guidance; better co-ordination with other regulators; additional resources) would be of more assistance.

The US Energy Information Administration's estimates of 26 Tcf of technically recoverable shale gas in the UK would provide 7 years of supply at current levels of use. Thus full scale commercial fracking in the UK can only make a limited contribution to national energy needs. As such its impact on self-sufficiency is limited and is likely to be much less as INEOS, which is the largest current developer, has stated that it wants the gas mainly as feedstock for its chemical plants (to produce plastic).

Frack Free United

The problem is not that the planning system fails to give adequate support to shale gas. The government has heavily titled planning policy in favour of shale gas. The problem is that planning policy contradicts itself, seeking to promote shale gas, while at the same time protect landscape, air quality, water quality, wildlife and the climate. The only way to resolve this inconsistency is to ban shale gas development and fracking so that the UK can fulfil its duty to protect the environment.

Planning policy is contradictory. On the one hand it supports shale gas development. On the other hand, it protects the climate, landscape, air quality, water quality and wildlife. None of these other goals are compatible with full-scale commercial fracking. The only way to achieve consistency is to ban fracking and unconventional hydrocarbons developments. The two Written Ministerial Statements of 2015 and 2018 support the development of shale gas on economic grounds, but they have not made this case effectively. No cost benefit analysis or cost effectiveness analysis comparing shale gas with other energy sources is used to support these statements.

Gundi Royle, oil and gas industry analyst, on behalf of Frack Free Ryedale

Shale drilling is a major investment. A 1,000 well development is likely to cost (including infrastructure) more than £1 billion.

The industrial scale of operations is likely to leave hundreds of pads with well production equipment behind.

In the US, the pads continue to produce negligible volumes to delay the cost of plugging and abandoning the wells.

The case of orphan wells are on the rise. The High Country News Wyoming reported on 16 January 2018:

> *In Wyoming, the problem reached epidemic proportions. In 2014, under Republican Gov. Matt Mead, the state implemented an aggressive strategy to identify and plug orphan wells. To hedge against future busts, the state also significantly hiked the bonds companies must put up before drilling…. Wyoming has since reclaimed 1,700 sites on state and private lands, using taxes and royalties paid by industry to chip away at the backlog caused by the spike in orphaned wells and insufficient bond funds.* ***But it has also identified nearly 4,600 more orphaned wells — and that's just on state and private lands.***

The Huffington Post reported on 3 February 2018:

"Bankruptcies like that of Sequoia has left some 2,300 wells, 200 facilities and 700 pipeline segments to be dealt with at an estimated cost of US$650m."

As a consequence, bond payments demanded to guarantee that abandoned or railed wells are safely capped are now on the increase in the US.

Regulation in the UK has to include bonds to ensure adequate remediation.

Roseacre Awareness Group

We firmly believe in the principles of localism and that communities should be empowered to make their own choices about what is right, or not, for their community. This should done via a democratic planning process with locally-elected officials' input having a significant role.

We believe national guidance should look at the wider picture, such as number of sites required nationally, well density, separation distances, buffer zones, waste management storage and treatment, water usage, well integrity, well abandonment, financial viability and other matters of national importance including that of public health.

We believe the government should fund more extensive research, by independent bodies, into the economic benefits of shale gas and the potential environmental risks to air, ground water, soil and public health considering recent scientific evidence and not rely on industry bodies.

Does the planning system dealing effectively with cumulative impacts at the current time and whether the apparent separation of exploration and development in the NPPF remains appropriate

Friends of the Earth

The Planning Practice Guidance for minerals divides or "salami slices" fracking into three distinct phases: exploration, appraisal and production. This makes the assessment of cumulative impacts of the different phases difficult from a planning point of view. Under current guidance you cannot assume that if 3 applications are submitted all 3 will reach production stage. For the same reason, you can't suggest that an additional exploration well in an area with 2 production wells will introduce significant cumulative effects as it may not pass the exploration stage. If exploration is successful and an application to appraise the well or go into production is submitted, the site is at this point already an industrial site and therefore given different consideration to if production was considered at the beginning of the process.

This "salami slicing" holds back consideration of cumulative impacts especially linked to i) highway capacity/safety, ii) waste capacity, iii) visual and landscape impact, iv) water resource usage. Based on recent cases it appears that *some consideration* of cumulative visual impacts is being taken into account, however less tangible cumulative issues of traffic, waste and water supply are likely to be harder to judge, especially between neighbouring authorities:

a) Traffic impacts are a case in point, with highways authorities usually considering impacts within their geographical area only;
b) Waste processing facilities for fracking waste are usually considered as matters for the permitting regime. However there are clear planning implications if sufficient cumulative waste capacity is not available and there is nowhere for the waste to go.
c) Determination of adequate water resource for a number of fracking applications will likely be very difficult, especially for neighbouring authorities that don't currently communicate on this matter and/or see it as a permitting issue. For water resources, planning tends to focus on plan-making, rather than assessing if adequate resource will be available due to receipt of multiple fracking applications.

The above has largely related to shale gas *production*, however exploration is itself a form of development, often including drilling rigs, HGVs and heavy equipment. It is worth having in mind the scale of *exploration* development needed before any of the scenarios discussed above and found in Professor Jones's report could ever be realised.

Campaign for Protection of Rural England

Dealing with cumulative impact (CI) in the strict sense (i.e. the aggregate effect of similar nearby developments), the ultimate answer is that it is too early to tell because of the limited numbers of applications so far. Most local planning policies do include safeguards against negative aspects of cumulative development and currently there has been no serious failure in their operation, to our knowledge (principally as they have not been tested by multiple, contiguous applications). Some councils require developers to provide wider plans for 'roll out' – to assess the likely local overall impact of developing an oil or gas field (see for example Rotherham MBC's emerging Policies SP 53 and SP547). However, these did not come into play in recent Council decisions on exploratory drilling in the borough.

In a wider sense, multiple applications for exploration and development at Ellesmere Port and Ince Marshes in Cheshire took inadequate account for both stages simultaneously and

were approved by officers under delegated powers. Without significant additional resourcing for planning authorities and other bodies, regulatory oversight could deteriorate further as more applications come forward for exploratory drilling and progress to flow testing and development. One of the cumulative impacts of this progression will be the increasing burden of (effective) monitoring and enforcement of conditions which are currently being ignored.

The spectre of exploration becoming permitted development also has implications in relation to cumulative development as it may then evade policy compliance. Exploratory drilling has so far been determined (by MHCLG) not to be EIA development but European case law on EIA (which is extensive and complex) suggests that in some cases EIA would be appropriate when conducted on a wide scale and therefore triggering thresholds due to cumulative impact.

Finally we certainly believe that exploration, appraisal and extraction should be separated (see draft revised NPPF para.204b). There is already definitional and operational (monitoring) difficulty in respect of some appraisal/stimulation techniques within exploration that fall below the statutory definition of fracking yet may have environmental impacts and this needs further regulatory attention and monitoring accompanied by enhanced requirements for methodological and operational transparency on the part of operators.

Kit Bennett, Frack Free United

The planning system is currently actively avoiding proper consideration of the cumulative impacts of shale gas development. This can be seen in the recent Written Ministerial Statement, which places great weight on promoting shale gas, with little consideration of its impacts and in Planning Practice Guidance, which prevents proper consideration of the whole life cycle impact of oil and gas development when applications for exploratory wells are made.

The attempts of North Yorkshire Minerals and Waste Joint Plan (MWJP) to address cumulative impact may be undermined by the new Written Ministerial Statement.

The industry opposed language in the explanatory text of the MWJP that suggests more than 10 well pads in a licence area are too many, but this level of development would cause a substantial cumulative impact.

The Planning Inspector at the Harthill enquiry dismissed the issue of cumulative impact with regard to two other proposed well pads in the region at Woodsetts and Marsh Lane. It is now unclear how many well pads need to be in the area before cumulative impact is considered.

The separation of exploration, appraisal and production in the planning system limits the ability to control cumulative impact. This is because the impact of later stages cannot be taken into account at planning applications. This is despite the fact that it is clear the goal of the industry is widespread and intensive development.

Gundi Royle, oil and gas industry analyst, on behalf of Frack Free Ryedale

Shale operations deal with a lot of hazardous materials and violations are frequent. In Appalachia, 4,000 violations have been recorded since 2009 and fines totalled US$6.1m. Operators consider the fines as a cost of being in business.

Unsafe transport, disposal and treatment of waste and waste water represent 40% of violations.

To frame regulation properly, potential problems need to be identified and regulation framed accordingly. Adopting US regulation is inappropriate as US population density, farming/stock keeping and tourism bear no resemblance to the situation of the UK.

Barbara Richardson, Roseacre Awareness Group

RAG is concerned that there is no quantitative data on what full-scale commercial scale would look like or what infrastructure would be required to support it, including waste management, pipelines and compressor stations.

Local authority plans do not consider the impacts of full-scale production fracking, and associated infrastructure, or the potential impacts on existing sectors such as agriculture and tourism and their supply chains (Fylde Economic Development Strategy).

Yet fracking threatens to industrialise our countryside (already under threat from housing developments) at a time when green spaces are essential for health, leisure and biodiversity.

Most sites are likely to be in rural areas with inadequate infrastructure to support an industry of this widespread nature.

Over 17,000 HGV movements are required per exploratory site (more for production sites) using narrow country lanes, drilling round the clock and fracking six days a week. Millions of gallons of fresh water are required, producing tonnes of waste (drilling muds, flow back fluids) to be dealt with at waste treatment centres and many other impacts

The UK is far more densely populated, and geologically more complex and heavily faulted, than the wide-open spaces of the US and Australia and the impacts will be far greater

Planning policies do not allow cumulative impacts to be taken account. At present, exploratory shale gas sites are assessed only on a site by site basis. The cumulative impacts, such as traffic, waste treatment, water resources can be felt further afield affecting more than one local authority.

Sites are also defined as a ‘temporary’ development. But once a site is developed it is no longer a greenfield site.

Roseacre Awareness Group is concerned that proposed changes to the National Planning Policy Framework and proposals on permitted developments/Nationally-significant infrastructure projects will take away local decision making.

There are no national policies, legislation or restrictions on the number of sites in a given area, such as minimum separation distances or buffer zones. There is no assessment of the overall impacts on climate change targets and emissions generated by a new fossil fuel industry.

Account needs to be taken of the UK’s complex and highly-faulted geology, as well as the cumulative health impacts on people in affected areas, loss of habitats, effect on property prices and house sales.

We have seen a loss of democracy and localism. Communities are not listened to and have become disenchanted with the local democratic process.

There is no social licence for fracking. There is growing unrest and opposition and mounting police costs.

Oil and Gas Authority

In its submission to the APPG, the Oil and Gas Authority said issues of planning policy and its ability to deal with cumulative impacts were:

"matters for the Ministry of Housing, Communities and Local Government and the relevant Minerals Planning Authorities and not something which the OGA would be able to comment on. The Communities and Local Government Select Committee is currently conducting an Inquiry into Planning Guidance on Fracking – to which the OGA, among other regulators and stakeholders, has provided oral evidence."

UK Onshore Oil and Gas

DrillOrDrop asked for a copy of the submission by the industry body, UK Onshore Oil and Gas. This document will be updated if we receive it.