Acid stimulation: fracking by stealth continues despite the moratorium in England

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A B S T R A C T

The UK government's policy of support for shale gas extraction ended in November 2019 with the imposition of a moratorium on fracking (hydraulic fracturing) in England, and an admission that the policies to manage induced seismicity were insufficient. However, ambiguities remain regarding its scope, despite attempts at clarification. The concept of fracking to improve hydrocarbon production has evolved from defining a specific engineering process, using high volumes of water, to encompass other 'unconventional' methods to achieve the same end. We resolve the various definitions in a scientific, technical, regulatory and legislative context, robustly define unconventional extraction methods (circumventing the need to identify and quantify the various technologies available), and advocate the precautionary principle in drafting and interpreting regulations. Policy should be driven by the engineering of the bulk physical characteristics of the target rock, rather than by the current definitions based on injected fluid volume. To meet climate change concerns, the moratorium should be converted into a ban. In the interim, we argue that, in order to comply with the government's policy of ensuring safe and sustainable operations, the moratorium should be extended to all well stimulation treatments for unconventional hydrocarbon extraction, including acid stimulation.

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1. Introduction

Hydraulic fracturing and acid stimulation are both forms of hydrocarbon well stimulation. Although there has been discussion about the controls and regulations that should apply to fracking, the debate has tended to focus on one form of fracturing for shale gas, namely high-volume hydraulic fracturing (HVHF) using large volumes of fluid, normally water.

In recent years, there has been a proliferation of oil and gas developments targeting unconventional rock formations under the guise of conventional development, raising concerns in affected communities that commercial extraction may require the use of acid stimulation treatments. Acid enhances the productivity of oil and gas wells by increasing the permeability of the target rock. There are a variety of acid stimulation techniques, which are described below. There has been far less focus on the use of acid, as opposed to HVHF, as a means of enhancing oil and gas production. Acid stimulation is not clearly defined in law or regulation, making it challenging to establish where it might be taking place, and to monitor its use.

Acid stimulation techniques involve similar environmental risks to those posed by HVHF, but many of the legal and regulatory constraints that apply to fracking do not apply to acid stimulation, because the definition of fracking in the legal framework is restricted to HVHF. Acid stimulation, generally using only small volumes of water, therefore escapes such control.

In November 2019 a moratorium was introduced in England, in a dramatic U-turn in the government's policy on fracking. However, the scope of the moratorium is far from clear, and some ministers have suggested that it excludes lower volume hydraulic fracturing and other forms of stimulation such as with acid.

We examine firstly the definitions of the processes and the risks they entail. We then address the role of key regulators and authorities, in particular the Oil and Gas Authority (OGA), the Environment Agency (EA), the Health and Safety Executive (HSE) and planning authorities, and examine the legal and regulatory position surrounding the use of both HVHF and of acid stimulation in England, with a view to identifying the loopholes and ambiguities that exist, and which make the current government policy on fracking inadequate.

Our analysis is a fuller, updated policy discussion of a previous briefing paper on acidisation[1]; it also updates the review by Hawkins,[2] but with particular emphasis on acidisation, which she does not mention.

2. Definition of unconventional hydrocarbon resources

A conventional oil or gas resource is hosted in a well-defined finite volume of rock called the *reservoir*; the resource can be extracted without needing to alter the bulk rock properties. The oil or gas will have been formed elsewhere in a *source* rock, and will have migrated over geological time to become trapped in the reservoir. But in unconventional extraction a source rock is physically altered to *become* the reservoir. Sources of the various and often conflicting definitions of 'unconventional' are discussed in Appendix A1. In summary, the

[1] Brockham Oil Watch 2019. *Open letter to the Government asks for a ban on all forms of fracking.* https://brockhamoilwatch.org/2019/11/02/open-letter-to-th e-government-asks-for-a-ban-on-all-forms-of-fracking/.

[2] Hawkins, J. 2015. Fracking: minding the gaps. *Environmental Law Review*, 17, 8–21. https://journals.sagepub.com/doi/pdf/10.1177/1461452914563217.

fundamental defining characteristic of an unconventional resource is that 'stimulation' is required, and the fundamental aspect of the stimulation is that the bulk physical properties of the rock, mainly its permeability, are irreversibly altered in such a way as to make the oil or gas flow. The best-known method of achieving this end is by fracking, but acidisation (or acid stimulation) also comes under this heading.

3. Acid stimulation

3.1. Definitions

Acid stimulation (also known as acidisation or acidising) is the use of acid to enhance the permeability of oil and gas bearing rock to increase production from wells that target unconventional formations. It is, or should be, distinct from acid treatments to remove damage at the wellbore. A PetroWiki web page[3] states that *"*[t]*hese are two distinct and different purposes, the field applications and results of which are often merged or confused"*.

An acid wash is a standard conventional wellbore maintenance technique, not a well stimulation technique, which uses dilute acid to remove scale and other deposits blocking the well and pipes, and immediately around the wellbore. The purpose of this technique is to clean the well and equipment, as opposed to targeting the surrounding rock formation.

There are two kinds of acid stimulation:

1. Matrix acidisation (also known as 'matrix acidising', and can include 'acid squeeze'): a solution of diluted acid and other chemicals is injected into the rock to dissolve components of the rock to create channels for the oil and gas to flow. This process takes place at pressures below the fracture strength of the rock.

2. Acid fracturing (also known as 'fracture acidisation' or 'acid fracking'): the pumping of a solution of dilute acid and other chemicals at a pressure above the fracture strength of the rock to create new fractures within the rock, which penetrate much further into the formation, and to increase existing fractures by dissolving the rock or components of the rock.

Acid fracturing is a form of fracking, because the fluid pressure, whether water or acid, exceeds the fracture strength of the rock.

Matrix acidisation is a stimulation method, meaning that it irreversibly alters the rock permeability in such a way as to make oil or gas flow.

The EA also uses the term 'acid squeeze', which the industry generally avoids, and, indeed, does not define in its glossaries or online handbooks. However, we have found the term defined in one textbook[4] and one industry website.[5] In each case the term spans both acid wash and matrix acidisation. The former states:

> *It is common to inject a small volume of acid (acid squeeze) … to dissolve the fines and cement fragments around the wellbore. … Large acid squeezes are sometimes used in*

[3] PetroWiki, *Petroleum Exploration Handbook: Matrix Acidisi*ng, https://petrowiki.org/PEH:Matrix_Acidizing#Effects_of_Acidizing accessed 22 November 2020.
[4] R. O. Baker, H.W., Yarranton, H. W. and J. L. Jensen, J.L. *Practical reservoir engineering and characterization*. (Elsevier, 2015; ISBN: 978-0-12-801811-8).
[5] Trican Well Service, *Production enhancement*, https://www.tricanwellservice.com/coiled-tubing/production-enhancement, accessed 24 November 2020.

> *carbonate reservoirs to create deeper pathways for fluid flow and stimulate production above what even the undamaged well would be capable of.*

The latter states:

> *Matrix acidizing treatments are pumped below the fracture pressure of the formation. They can be an underbalanced acid wash to clean up the wellbore and perforation holes, or acid squeeze treatments designed to dissolve rock and create wormholes into the formation to increase permeability and production.*

Based on the above, the definition of an 'acid squeeze' is ambiguous and may amount to an acid wash or acid stimulation in the form of matrix acidisation.

This ambiguity persists in the oil service company, Schlumberger's, definition:

> *The careful application of pump pressure to force a treatment fluid or slurry into a planned treatment zone. In most cases, a squeeze treatment will be performed at downhole injection pressure below that of the formation fracture pressure.*[6]

3.2. Concerns around acid stimulation

Acid stimulation involves a variety of types of acid and other chemicals in greater concentrations than those used in other forms of hydraulic fracturing. While it is clear that many of these acids and other chemicals are potentially hazardous for the environment and human health, there are few studies examining the risks and impacts of acid stimulation.

The types of chemicals used and the potential hazards involved in acid stimulation are set out in more detail in a briefing by Friends of the Earth.[7] Indeed, many of the risks and concerns surrounding other forms of hydraulic fracturing are the same as for acid stimulation (including matrix acidisation and acid fracturing), namely: induced seismicity; air and noise pollution; groundwater contamination and industrialisation of the countryside.[8] Therefore, the use of acid stimulation techniques is inconsistent with the government's policy of ensuring safe and sustainable operations that cause minimal disturbance to those living and working nearby.

In addition, the climate change implications are equally as problematic for acid stimulation as for high volume hydraulic fracturing. They both involve the release of methane during the extraction process and the release of carbon dioxide during the combustion of the oil or gas extracted.

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[6] Schlumberger *Oilfield glossary: squeeze*, https://www.glossary.oilfield.slb.co m/en/Terms/s/squeeze.aspx, accessed 24 November 2020.

[7] Friends of the Earth 2018. *The acid test: The case for a ban on acid stimulation of oil and gas wells,* August 2018, https://cdn.friendsoftheearth.uk/sites/def ault/files/downloads/acidising-briefing_2.pdf, accessed 24 November 2020.

[8] *Ibid.*, page 6, citing Shonkoff et al, 2015, *Scientific Assessment of Hydraulic Fracturing in California: Ch 6, Potential impacts of well stimulation on human health in California*, CCST https://ccst.us/reports/well-stimulation-in-california/publications/. See also Abdulla, K. 2016. *Acidizing Oil Wells, a Sister-Technology to Hydraulic Fracturing: Risks, Chemicals, and Regulations*, https://escholarship.org/uc/item/6z9238sj, Fig. S1 & S2, p.42-43; and Abdullah et al., 2017, Toxicity of acidization fluids used in California oil exploration, *Toxicological & Environmental Chemistry* 99, 78-94, DOI: 10.1080/02772248.2016.1160285 http://dx.doi.org/10.1080/02772248.2016.1160285.

4. Legal definitions

4.1. Specific restrictions on high-volume hydraulic fracturing

Under s.4A of the Petroleum Act 1998 ('1998 Act'),[9] 'Associated Hydraulic Fracturing' is subject to various restrictions, including:

- A ban at a depth of less than 1000 m;
- A ban within protected groundwater source areas[10];
- A ban within other protected areas[11];
- Monitoring of baseline methane levels in the groundwater and ongoing methane emissions into the air[12];
- Establishment of a scheme to provide for financial benefits to the local area; and
- The prior consent of the Secretary of State.

The moratorium announced on November 2, 2019 applies to 'Associated Hydraulic Fracturing' by introducing a presumption against issuing Hydraulic Fracturing Consents.[13]

Neither acid stimulation, nor the different acid stimulation techniques, are defined in law. Furthermore, although acid fracturing takes place at pressures above the fracture strength of the rock formation, and acid stimulation techniques involve similar risks to hydraulic fracturing, neither acid fracturing nor matrix acidisation typically fall within the definition of hydraulic fracturing contained in the 1998 Act, and therefore are not subject to the same controls.

4.2. Volume-based definition of fracking

Under the 1998 Act, 'Associated Hydraulic Fracturing' is defined by reference to the volume of fluid involved. In particular, that the fracturing process:

> (i) *more than 1000 cubic metres of fluid at <u>each</u> stage, or expected stage, of the hydraulic fracturing, or*
>
> (ii) *more than 10,000 cubic metres of fluid in total.*[14] [emphasis added]

The definition at (i) above is poorly drafted. This is because, the use of the word "each" means that there could be an injection of 2400 cubic metres in (say) 4 stages, followed by a stage of 399 cubic metres. Thus the first criterion is not met, because one of the stages was less than 1000, and neither is the second criterion met because the total is 9999 cubic metres.

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[9] Inserted by s.50 of the Infrastructure Act 2015.
[10] Defined at reg.2 of The Onshore Hydraulic Fracturing (Protected Areas) Regulations 2016.
[11] Defined at reg.3 of The Onshore Hydraulic Fracturing (Protected Areas) Regulations 2016. Reg 3 includes National Parks, the Broads, areas of outstanding natural beauty and World Heritage sites.
[12] Monitoring is carried out by the Environment Agency under a waste management plan, issued as part of an environmental permit.
[13] *Government ends support for fracking* (Press release, 2 November 2019), https://www.gov.uk/government/news/government-ends-support-for-fracking?utm_source=da4034d2-092b-41fc-a5d1-34dda859a9bd&utm_medium=email&utm_campaign=govuk-notifications&utm_content=immediate accessed 24 November 2020. Written Statement of then Secretary of State for BEIS, 4 November 2019. https://questions-statements.parliament.uk/written-statements/detail/2019-11-04/HCWS68 accessed 3 December 2020.
[14] The Petroleum Act 1998, s.4B(1)(b).

The threshold figures of 10,000 and 1000 cubic metres (total and per stage, respectively) are based on the approach taken by the European Commission, which in turn was informed by a report which it had commissioned from a consortium of consulting firms. The source of the figures was uncovered by Kyla Mandel in a report for DeSmogUK[15] dated 27 February 2015. They originate in an AEA Technology report commissioned by the European Union.[16] Its authors intended to distinguish between the existing so-called conventional fracturing in vertical oil and gas wells, and the higher volume fracturing of horizontal unconventional gas wells. Based on the very limited numbers of fracking operations carried out by that date (2012) in Europe on horizontal wells, the authors concluded that "*in the European context, it appears that a definition of 1000 m^3* [cubic metres] *per stage would be a more appropriate working definition.*" This conclusion was set against, without much explanation, the definition of high volume hydraulic fracturing adopted in the state of New York, which put the threshold at only 1350 cubic metres cumulatively. It appears that by adopting such high volume thresholds, applicable mostly to deep shale gas wells, the definition failed to capture extraction processes from other unconventional resources such as shale oil, tight oil and tight gas.

The 10,000 and 1000 cubic metres volume thresholds are unrealistically high, because many HVHF operations around the world would not be defined as fracking if these figures are used. An objective, realistic upper limit for conventional well water use, taken from a USGS study[17] of a quarter of a million fracked wells of all types in the USA, would be more like 2000 and 2500 cubic metres in total per well, for oil and gas, respectively.[18] But such a purely volume-based definition of fracking is simplistic, whatever the threshold water volume figure.

In 2016, the Secretary of State issued regulations prohibiting the location of well pads used for hydraulic fracturing in 'protected areas', such as national parks.[19] These regulations do not refer to 'Associated Hydraulic Fracturing', but instead define "*Relevant Hydraulic Fracturing*" as:

> *hydraulic fracturing of shale or strata encased in shale which is carried out in connection with the use of a Well to search or bore for or get petroleum, and involves, or is expected to involve, the injection of—*
>
> (i) *more than 1000 cubic metres of fluid at <u>any</u> stage, or expected stage, of the hydraulic fracturing, or*
>
> (ii) *more than 10,000 cubic metres of fluid in total.* [emphasis added]

[15] https://www.desmog.co.uk/2015/02/26/definition-fracking-political-not-scientific.

[16] AEA Technology plc 2012. *Support to the identification of potential risks for the environment and human health arising from hydrocarbons operations involving hydraulic fracturing in Europe*, Report commissioned by the European Commission DG Environment Number 07.0307/ENV.C.1/2011/604781/ENV.F1, 10 August 2012, ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf

[17] Gallegos, T. J., Varela, B. A., Haines, S. S. and Engle, M. A. 2015. Hydraulic fracturing water use variability in the United States and potential environmental implications, *Water Resour. Res.* 51, 5839-5845 https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1002/2015WR017278.

[18] Smythe D. and Haszeldine S. 2017. Could fracking creep under the radar? *Nature* 393, 548, https://www.nature.com/articles/548393a.pdf?origin=ppub.

[19] The Petroleum Licensing (Exploration and Production (Landward Areas) (Amendment) (England and Wales) Regulations 2016 ("*the 2016 Regulations*").

So the problematic 'each' has been replaced by 'any', which dramatically expands the scope of the definition by including operations involving the injection of more than 1000 cubic meters of fluid in at least one stage.

On 29 November 2017, the Secretary of State issued a Direction to the Oil and Gas Authority (OGA) requiring all applications for Completion Work Approval[20] to be referred to the Secretary of State if the work involved hydraulic fracturing within the broader definition of fracturing, i.e. the 'Relevant Hydraulic Fracturing' definition contained in the 2016 Regulations.[21] The purpose of this was so that the Secretary of State could consider whether the conditions set out at s.4a of the 1998 Act were met.

In effect, therefore, the 2017 Direction appears to extend the requirements of the 1998 Act to hydraulic fracturing that involves the injection of 1000 cubic metres of fluid at any stage rather than at each stage of the fracturing process (or more than 10,000 cubic metres of fluid in total), at least once Completion Work Approval is applied for.[22]

However, the Associated Hydraulic Fracturing definition has not been amended. Consequently, there are now two conflicting definitions of fracking in the legislation.[23] It is unclear whether the 2019 moratorium extends to 'Relevant Hydraulic Fracturing' as well as Associated Hydraulic Fracturing.[24] In addition, there remain problematic issues even with this revised definition.

The history of the three shale wells fracked to date in the UK shows that it is possible that none of them would have met the definition of 'Associated' hydraulic fracturing, and only Preese Hall-1 met the definition of 'relevant' hydraulic fracturing. This is shown in Table 1 .[25] Preese Hall-1 was a vertical test well, whereas Preston New Road-1z and -2 (PNR-1 and PNR-2, respectively) were horizontal wells.

The maximum volume in any stage in both horizontal cases was only around 400 cubic metres. For instance, even if all 41 planned stages of PNR-1 had been fracked successfully without triggering the seismicity that forced a premature halt, it is likely that the total volume of water employed would have been only about 9000 cubic metres (41 stages times the average of 218 cubic metres per stage).

For both the horizontal wells the operator, Cuadrilla, sought Hydraulic Fracturing Consent from the Secretary of State because the expected volumes were much higher than those

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[20] According to the Oil and Gas Authority ("OGA"), "*Completion Work*" means work, by way of the installation of a casing or equipment or otherwise for the purpose of bringing the well into use as a Development Well.

[21] Directions to the Oil and Gas Authority in the exercise of its powers to grant completion work approval, November 2017, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/663909/171129_Direction_to_the_Oil_and_Gas_Authority.pdf.

[22] Although if the hydraulic fracturing proposed met the "*Relevant Hydraulic Fracturing*" definition and not the "*Associated Hydraulic Fracturing*", the requirement to meet the conditions set out at s.4a of the 1998 Act and obtain the consent of the Secretary of State, would not apply until Completion Work Approval was sought.

[23] Letter from BEIS 23 February 2018, https://www.whatdotheyknow.com/request/definition_of_hydraulic_fracturi_2#outgoing-714670.

[24] UK Parliament 'Written questions, answers and statements': fracking' tabled on 20 January 2020 https://questions-statements.parliament.uk/written-questions/detail/2020-01-20/5565.

[25] Table 1: There was no hydraulic fracture plan (HFP) or traffic light system (TLS) requirement in place in 2011. 'Main frack' refers to the principal frack at each stage, as opposed to preliminary mini-fracks. Seismicity monitoring in 2011 was much less sensitive than subsequently. M_L = local magnitude. At PNR-1 the first tremor was recorded at 4.48pm BST on 18 Oct 2018; the injection chart does not show precise timings. At PNR-2 the first tremor was recorded at 12.15 GMT on 15 Aug 2019; no injection pressure vs. time chart is available for this day.

achieved in the actual operations. It appears that, had Cuadrilla made more realistic assumptions, they may not have been required to obtain Hydraulic Fracturing Consents for either of the PNR wells.

In addition, even adopting the broader definition of "*relevant hydraulic fracturing*", the restrictions contained in the 1998 Act are unlikely to apply to acid stimulation. This is because both acid fracturing and matrix acidisation typically use less fluid than high-volume hydraulic fracturing and these stimulation techniques therefore fall outside both the "*associated*" and "*relevant*" hydraulic fracturing definitions contained in the 1998 Act and the 2016 Regulations, respectively.[26]

5. Role of the oil and Gas Authority

The Oil and Gas Authority **(**OGA) is a government company solely owned by the Secretary of State for Business, Energy and Industrial Strategy.[27] It is required to act so as to maximise the economic recovery of UK petroleum.[28]

The OGA has a twin role in relation to hydraulic fracturing activities. First, under the Petroleum Act 1998, the OGA grants licences to "*search and bore for and get*" petroleum.[29] These licences contain 'model clauses' set out in legislation.[30] Second, the OGA is tasked with managing the risks of induced seismic activity.

However, there is no definition of hydraulic fracturing that applies to either the OGA's licensing role or its management of seismic activity. In particular, the definition of 'Associated Hydraulic Fracturing' in the 1998 Act does not apply to the exercise of powers by the OGA generally, including in relation to the granting of licences. The only specific reference to fracturing in the model clauses refers to "*hydraulic fracturing*" without either defining its meaning, or how it relates to the publication of data contained in a Hydraulic Fracturing Operations Report, a report made once hydraulic fracturing has taken place.[31] Consequently, it is not clear which definition of hydraulic fracturing the OGA is required to use in the exercise of its functions. Indeed, the OGA guidance refers to 'fracking operations', 'hydraulic fracturing' and 'hydraulic stimulation' without defining what any of these terms mean, and whether or not they include acid stimulation.

The OGA sets out the applicable requirements in its guidance when hydraulic fracturing is proposed. The primary means for controlling and managing these operations is through:

- The agreement of a Hydraulic Fracture Plan (HFP)[32]; and

[26] Friends of the Earth 2018. *The acid test: The case for a ban on acid stimulation of oil and gas wells*, August 2018,, p.3 and note 12, https://cdn.friendsoftheearth.uk/sites/default/files/downloads/acidising-briefing_2.pdf, accessed 29 November 2020.
[27] Energy Act 2016.
[28] Petroleum Act 1998, ss.9A and 9B, inserted by the Infrastructure Act 2015.
[29] As amended by the Petroleum (Transfer of Functions) Regulations 2016.
[30] The Petroleum Licensing (Exploration and Production) (Landward Areas) Regulations 2014.
[31] The Petroleum Licensing (Exploration and Production) (Landward Areas) Regulations 2014, sched 2 (model clauses), para.32(e).
[32] Oil and Gas Authority 2018. *Consolidated Onshore Guidance*, June 2018, p.6, 24, 27, 30 and 31. https://www.ogauthority.co.uk/media/4959/29112017_consolidated-onshore-guidance-compendium_vfinal-002.pdf accessed 29 November 2020.

- The completion of a Hydraulic Fracturing Operations Report within 30 days of completion of hydraulic fracturing.[33]

For those operations that meet the 'Associated Hydraulic Fracturing' definition in the 1998 Act and the 'Relevant Hydraulic Fracturing' definition in the 2016 Regulations, the additional restrictions and Secretary of State consent listed in the previous section are also required.

5.1. HFP's and prevention of induced seismic activity

An HFP is important because it is one of the key ways in which the risks of fracturing operations can be assessed and monitored, including the risk of seismic activity, and any controls required to prevent or mitigate against these risks. An HFP is approved by the OGA and the Environment Agency (EA) once the Health and Safety Executive has had an opportunity to comment.[34]

OGA guidance suggests that an HFP will always be required for hydraulic fracturing, but that less information may be required if the activities do not meet the volume thresholds set out in the 1998 Act for 'Associated Hydraulic Fracturing':

> *If the proposed injection volumes fall below the BEIS associated hydraulic fracturing thresholds, the OGA may decide less information or monitoring is appropriate, but an HFP will always still be required.*[35] [emphasis added]

This leaves open the question as to what activities fall within this broader definition of hydraulic fracturing and whether they include acid stimulation activities. In evidence to the Committee on Housing, Communities and Local Government (HCLGC), in 2018, the OGA stated:

> *We use the Infrastructure Act definition as clarified by the Secretary of State last year to determine when a company needs to submit what we call a hydraulic fracture plan. If a plan does not meet the water-based tests that are set out in the legislation, we would not always require one. We reserve the right in guidance to require one should we think there are risks of seismic activity as a result of it. We would always require a hydraulic fracture plan when it meets the tests set out in the Infrastructure Act.*[36] [emphasis added]

Therefore, on the one hand OGA guidance suggests an HFP will always be required where hydraulic fracturing is proposed, albeit that the information or monitoring requirements in the HFP may be less if the Infrastructure Act definition is not met, and on the other hand, the OGA's evidence to the HCLGC suggests that an HFP is mandatory only where the Infrastructure Act definition is met, but in all other instances it is for the OGA to decide whether or not to request one.

The OGA guidance demonstrates, in an accompanying table, various circumstances that will and will not require an HFP. In particular, the table demonstrates that a 'completion acid wash' carried out at below fracture strength with hydrochloric acid at 15% without proppant but with flowback fluids will not require an HFP. In contrast, 'hydraulic fracture stimulation'

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[33] ibid. p.27 and 53.
[34] ibid. Section D.7.
[35] ibid. p.30.
[36] Housing, Communities and Local Government Committee 'Oral evidence:Planning guidance on fracking' HC 767, Q.123, http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/housing-communities-and-local-government-committee/planning-guidance-on-fracking/oral/82896.html.

carried out above the fracture strength, involving 'frac fluid', a proppant and various chemicals, with flowback fluids, will require an HFP.[37]

From this table it is not clear whether acid stimulation would require an HFP or not, because matrix acidisation is carried out at below fracture strength of the rock, and acid fracturing, although carried out at above fracture strength, does not usually involve the use of a proppant.

In its evidence to the HCLGC, the OGA explained that, as regards the risk of seismicity, it uses a 'volume-based test'. Consequently, if other substances are being injected of equal volume it will look carefully at this, including presumably by requiring an HFP.[38] However, in acid stimulation, the volumes of liquid involved are generally substantially less.

As a result, it appears that on the basis of the OGA's evidence to the HCLGC, the OGA would not require an HFP for acid stimulation in most instances, thereby removing a key mechanism for assessing and mitigating against the risks involved, including the risk of induced seismic activity.

One of the main ways in which the OGA mitigates against the risk of induced seismic activity is through "*the monitoring in advance of background seismic activity, a real time traffic light scheme during injection, and detailed operational precautions to be incorporated in an HFP.*"[39]

The OGA makes clear in its guidance that it is for the operator to propose a methodology and design as part of the HFP, which is then approved by the OGA. Consequently, if an HFP is not required, these controls on induced seismicity, including the traffic light monitoring system, do not apply.

It should be noted that the written ministerial statement of 4 November 2019 explaining the fracking moratorium stated that, because of the risk of induced seismicity, the OGA is at present unlikely to approve any HFPs.[40] Given that HFPs may be required in situations that fall outside of the "*associated*" and "*relevant*" hydraulic fracturing definitions, this ambiguity potentially expands the scope of the moratorium further,[41] to include, for example, the planned "*small-scale hydraulic fracturing activity*" at the Wressle oil site, which does require the submission of an HFP and approval by the OGA and the EA.[42] However, in light of the OGA's volume-based approach to fracking, it is doubtful whether the moratorium currently extends to acid stimulation. This is an important area for policy discussion, given the highly impactful nature of induced seismicity.

5.2. Reporting requirements – Hydraulic Fracturing Operations Report

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[37] Oil and Gas Authority 2018. *Consolidated Onshore Guidance*, June 2018, p.31.
[38] HCLGC, Oral evidence: *Planning guidance on fracking*, HC 767, Q.124-126, http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/housing-communities-and-local-government-committee/planning-guidance-on-fracking/oral/82896.html.
[39] OGA: Consolidated Onshore Guidance, June 2018, p.32.
[40] Written statement of 4 November 2019, Andrea Leadsom 'Energy policy update', https://questions-statements.parliament.uk/written-statements/detai l/2019-11-04/HCWS68.
[41] Although a more recent written statement casts some doubt on this approach: UK Parliament 'Written questions, answers and statements': fracking' tabled on 20 January 2020, https://questions-statements.parliament.uk/writte n-questions/detail/2020-01-20/5565.
[42] https://drillordrop.com/2020/09/28/egdon-plans-small-scale-fracking-instead-of-acidisation-at-wressle-oil-site/.

The other means for controlling and managing hydraulic fracturing is through reporting requirements, specifically a Hydraulic Fracturing Operations Report (HFOR).

OGA guidance states that a HFOR containing data in respect of "*the geology, operations or results associated with hydraulic fracturing of shale or other strata encased in shale*" must be submitted to the OGA within 30 days of completion of "*hydraulic fracturing*". Thereafter updated reports must be provided at 3 month intervals.

Once again, there is no definition of 'hydraulic fracturing' in this context. It seems likely that all companies required to submit an HFP will also be required to submit an HFOR, but it is not clear whether any activities that do not require an HFP must submit an HFOR. This requirement appears to be entirely at the discretion of the OGA.

A proper approach to interpretation of the OGA guidance, taking into account the precautionary principle, would be to include acid stimulation techniques within the definition of hydraulic fracturing thereby extending the requirements regarding HFPs and HFORs to acid stimulation activities.

6. Role of the Environment Agency

6.1. Responsibility

The environmental permitting regime overseen by the Environment Agency (EA) also lacks clarity as to how the different acid stimulation techniques are defined and regulated, resulting in broad discretion for the EA to determine whether exploration and production activities involving the use of acid should be exempted from the permitting regime, or will require specific groundwater permits.

Without specific definitions of the various types of acid stimulation and the regulation of each of these techniques set out in law, the use of acid in oil and gas exploration and production has primarily fallen to the EA to regulate through the environmental permitting system.

6.2. The Environmental Permitting Regulations

All onshore oil and gas activities, whether they involve hydraulic fracturing or not, are subject to an environmental permitting system, governed by the Environmental Permitting Regulations 2016 (EPR). The types of permits required depend on the site in question and the activities proposed. Hydraulic fracturing activities, like many other onshore oil and gas exploration and production activities, will at a minimum require a groundwater activity permit, a mining waste permit and a radioactive substances permit.

The use of acid in oil and gas activities is predominantly regulated by Schedule 22 of the EPR, which deals with 'Groundwater activities'. The EA is required to prevent the input of any hazardous substance to groundwater, and to limit the input of non-hazardous pollutants so as to prevent the pollution of groundwater.[43] In light of this objective, the EA can decide, among other things, whether to prohibit an activity,[44] issue a permit,[45] or grant an exemption for the activity on 'de minimis' grounds.[46]

[43] Schedule 22, para.6 of the EPR.
[44] Schedule 22, para.9.
[45] Schedule 22, para.7.
[46] Schedule 22, para.3(3)(b).

Schedule 22 does not contain specific definitions of activities and the controls required for those activities. Instead, the EA has broad discretion to determine whether the activity can take place and whether a permit is required based on the objective of preventing the pollution of groundwater.

6.3. Application and enforcement in practice

In response to increasing public concerns and questions about acid stimulation, the EA published a factsheet in January 2018 on the use of acid in oil and gas exploration, and how it regulates this activity.[47] Although the factsheet sets out the different acid stimulation techniques, it provides little clarity on where the boundaries between each activity lie. For example, there are no specific limits on the concentration of acid for an acid wash as compared to matrix acidisation or acid fracturing. Similarly, there is no distinction in the pressure used for an acid wash or matrix acidisation, or indeed, the extent to which the different procedures are likely to penetrate the rock formation.

The lack of clear distinctions between an acid wash and acid stimulation is significant, because activities deemed to be an acid wash are treated as 'de minimis' and are granted an exclusion from the permitting regime under paragraph 3(3)(b) of Schedule 22 of the EPR:

The regulator may determine that a discharge, or an activity that might lead to a discharge, is not a groundwater activity if the input of the pollutant is or would be of a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater.

In practice it is clear from the EA's own factsheet and from responses to information requests that the EA relies heavily on the operator's stated 'intention' in relation to the acid use to determine whether the procedure is an acid wash or acid stimulation, and therefore whether to issue a de minimis exclusion or to require a groundwater permit.

While other information may be sought by the EA - such as the type, volume, concentration and quantity of acid, details of other chemicals, waste disposal procedures and specifications of the well and the formation – it is not clear from the de minimis exclusions that have been granted where the distinctions between acid wash and acid stimulation lie, and whether sufficient restrictions or monitoring are in place to differentiate adequately between the two. This is because the EA does not differentiate between an acid wash and matrix acidisation in terms of a specific volume, concentration and frequency of acid used. For example, the de minimis exclusion granted for the wellsite in Brockham, Surrey:

- Contains no definitive restriction on the frequency of the acid use[48];
- Allows any pressure below formation fracture strength; and
- Allows acid at a concentration of up to 15%, whereas an acid wash only requires 7%.[49]

(The case history of Brockham is discussed in Appendix A2). The EA has stated that it assesses:

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[47] Environment Agency 2018. *Use of acid at oil and gas exploration and production sites*, January 2018 https://consult.environment-agency.gov.uk/onshore-oil-and-gas/onshore-oil-and-gas-regulation-information-page/supporting_documents/Acidisation FAQs January 2018.pdf.

[48] The de minimis proforma for the Brockham wellsite, dated 18 December 2018, states that the frequency will be "*typically annual, but more or less as conditions in the wells require*".

[49] This is despite the fact that the EA's factsheet suggests that an acid wash usually uses a concentration of acid at 7% (*Use of acid at oil and gas exploration and production sites*, Environment Agency, January 2018, p.2.).

> *each proposed type of acidisation activity on a site specific basis prior to deciding whether the activity is acceptable or not, and whether an environmental permit can be granted or whether an exclusion applies.*[50]

However, this merely highlights the exercise of discretion by the EA, without clarifying the basis upon which the EA demarcates between an acid wash and acid stimulation.

Once a 'de minimis' exclusion has been granted the operator is exempted from having to obtain a groundwater permit. Consequently, the level of information required by the EA for monitoring and enforcement purposes is significantly reduced. Based on information requests to the EA, it appears that once a de minimis has been issued, the EA does not:

- Require reports on the pumping pressure used;
- Require reports on the amounts of acid and chemicals used or frequency of use;
- Require notifications of when an acid wash takes place; and
- Monitor the acid treatment procedure itself.

The EA states that site inspections at an acid wash site:

> *should identify relatively small volumes of acid on site that would be consistent with use for the acid wash and the inspector would be able to review documents to show quantities of dilute acid brought onto site, and the volumes of any waste brought back to the surface*.[51]

Sites using stimulation are said to "*generally use higher volumes of dilute acid*", different equipment and higher volumes of returned waste fluids and have documentary evidence of such activities.[52]

Despite these assurances, given the blurred lines between acid wash and matrix acidisation and the limited controls in place where a de minimis exclusion has been granted, campaigners are understandably concerned that acid stimulation could be taking place under the guise of an acid wash.

The EA's factsheet also refers to the process called 'acid squeeze', describing it as squeezing acid into the rock to dissolve it and enhance or create new flow paths to enable the well to be more productive. But as with other forms of acid stimulation, the EA does not define it in terms of a specific volume, concentration and frequency of acid used.

Despite the fact that an acid squeeze is a form of stimulation, the EA granted an acid squeeze a 'de minimis' exclusion in 2019, thereby deeming it an operation which has negligible effect on the environment and exempting it from permitting requirements.[53]

6.4. Monitoring

Each drill site has a specific monitoring and reporting regime, which is agreed with the Environment Agency as part of the permitting process.

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[50] Environment Agency 2018. *Use of acid at oil and gas exploration and production sites*, (January 2018, p.4.).
[51] Response from the Environment Agency of 7 November 2018 following a freedom of information request.
[52] Response from the Environment Agency of 7 November 2018 following a freedom of information request.
[53] Environment Agency 2019. *EA permitting decision 6 August 2019, West Newton 'A' Well Site*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/825302/BB3001FT-V003_Decision_Document_FINAL.pdf.

For hydraulic fracturing operations that meet the definition set out in the 1998 Act,[54] there is an automatic requirement for baseline monitoring of methane in groundwater in the 12-month period before hydraulic fracturing begins, as well as for ongoing monitoring of emissions of methane into the air. Other monitoring is also likely to be required under the environmental permitting system (see, for example, the Preston New Road[55] and Kirby Misperton[56] sites).

For activities that do not fall within the 1998 Act definition, the monitoring and inspection regime is decided on a site-specific basis, and depends on the permits required. There is, however, no automatic legal requirement for baseline monitoring of methane in groundwater or ongoing methane emissions into the air. In addition, no groundwater monitoring (baseline or ongoing) is required for sites that have been granted a de minimis exclusion.[57]

6.5. Classification and treatment of fluids returned to surface

EA guidance refers to fluid that returns to the surface after HVHF as 'flowback'. Flowback that cannot be reused as injection fluid is classified as waste, and must be sent to a permitted waste facility plant for treatment or disposal. It cannot be re-injected underground for disposal.[58]

The EA's approach to flowback fluid is limited to HVHF, and therefore excludes acid stimulation activities. In response to an information request, the EA stated that fluids returned to the surface after an acid wash could legally be combined with produced water and injected into a permitted reinjection well.[59] It is not clear whether flowback fluids following acid stimulation can also be re-injected.

7. The Health and Safety Executive

This section examines the health and safety regime for onshore oil and gas exploration and production, which applies to all hydraulic fracturing operations, including acid stimulation activities.

The HSE is responsible for ensuring that companies adequately control risks to the health and safety of people, including workers, contractors and members of the public (see Appendix A3 for more on the HSE onshore oil and gas exploration and production regime). In the context of hydraulic fracturing the HSE focuses on safeguarding well integrity by:

> *ensuring wells are designed, constructed, operated, maintained, and ultimately abandoned to ensure that the flow of fluids in the well, whether fracking fluids or produced gas or water is controlled and stays within the well.*[60]

There are two distinctions where operations involve hydraulic fracturing.

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[54] Although, currently, the 2019 moratorium means fracking as defined in the 1998 Act, in practice, cannot take place.
[55] Environment Agency information page for Cuadrilla's Preston New Road Information on Cuadrilla's Preston New Road Site.
[56] Environment Agency information page for Third Energy's Kirby Misperton (KM8 well) site Third Energy - Kirby Misperton (KM8 well) information page.
[57] *EA: Onshore oil and gas sector guidance*, Feb 2019, p.13.7 https://www.gov.uk/guidance/onshore-oil-and-gas-sector-guidance.
[58] EA: Onshore oil and gas sector guidance, Feb 2019, p.11.2.
[59] Response from the Environment Agency of 20 April 2018 following a freedom of information request submitted by Brockham Oil Watch on 4 April 2018.
[60] Health and Safety Executive. *HSE's role in regulating onshore shale gas and hydraulic fracturing*, available at http://www.hse.gov.uk/shale-gas/about.htm.

First, the HSE and EA have agreed to take additional measures in relation to hydraulic fracturing sites, as set out in a 'working together agreement' between the HSE and the EA of November 2012.[61] Pursuant to this agreement, the HSE and EA jointly inspect hydraulic fracturing operations. In addition, for new or first-time shale gas operators, the HSE and the EA will:

- Meet and advise them of their duties under the relevant legislation;
- Conduct a joint inspection of the key operations, including:
  - Cementing and verification of cement;
  - Mini hydraulic fracture;
  - Bleed back;
  - Main hydraulic fracture.

These meetings and visits may include other licensing or statutory bodies. Any change to the process, such as hydraulic fracturing at shallow depth or change of fracturing media, may result in a review of the inspection schedule and may require permit modifications.[62]

This agreement does not specify what the EA and the HSE consider as 'hydraulic fracturing operations' and 'shale gas operators', and it is therefore not clear whether the HSE would consider acid stimulation activities to fall within the scope of the EA/HSE agreement.

Based on the precautionary principle, a proper approach to interpretation would be to include acid stimulation within the scope of hydraulic fracturing operations.

A more recent 'working together agreement' has been signed between the HSE, EA and the OGA.[63] This agreement sets out the purpose of the Shale Environmental Regulator Group (SERG), comprising these three regulators. The agreement contains no additional measures regarding hydraulic fracturing sites, but rather focuses on coordination. Confusingly, it contains no reference to hydraulic fracturing and instead focuses on 'shale gas exploration and production', 'shale gas operators' and 'shale gas sites'. Once again, these terms are not defined, but could be interpreted so as to include acid stimulation activities and operators.

Second, under the 1998 Act, the Secretary of State cannot consent to 'Associated Hydraulic Fracturing' unless 'appropriate arrangements have been made for the independent inspection of the integrity of the relevant well'.[64] This condition can be satisfied by the issue of a certificate from the HSE, confirming that it has:

- Received a well notification under regulation 6 of the Borehole Sites and Operations Regulations 1995,
- Received the information required by regulation 19 of the Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996, and

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[61] Health and Safety Executive 2012. *Working together to regulate unconventional oil and gas developments* November 2012 http://www.hse.gov.uk/aboutus/howwework/framework/aa/hse-ea-oil-gas-nov12.pdf.

[62] ibid.

[63] Environment Agency 2018. *Working Together Agreement as the Shale Environmental Regulator Group*, 19 September 2018, Working Together Agreement as the Shale Environmental Regulator Group This is a Working Together Agreement (WTA).

[64] Petroleum Act 1998, s.4A(3)(i) and condition 2 of Column 1, inserted by s.50 of the Infrastructure Act 2015.

- Visited the site of the relevant well.[65]

Given that these mirror the existing requirements for all onshore oil and gas, this condition does not appear to impose any additional constraints.

In oral evidence to the Committee on Housing, Communities and Local Government (HCLGC), the HSE clarified the distinction when activities fell within the 'Associated Hydraulic Fracturing' definition inserted in the 1998 Act by the Infrastructure Act:

> *The only area where it probably has some impact is that the Infrastructure Act requires us—because of the definition, I guess—to visit each shale gas site before fracking takes place and then let the Secretary of State at BEIS know that we have received notification of weekly reports from the operator. We would regulate those sites in exactly the same way whether the definition was there or not.*

When asked whether HSE staff would not visit a site if it did not meet the definition, the HSE clarified that it may or may not visit the site depending on its own risk assessment. In other words, in cases involving 'Associated hydraulic fracturing' the HSE *must* carry out a site visit.[66] But for all other oil and gas exploration and production sites, including sites involving acid stimulation, the HSE has the discretion as to whether to carry out a site visit, depending on its own risk assessment.

It is not known whether acid stimulation is considered sufficiently high risk by the HSE to warrant a site inspection prior to the start of operations.

8. The planning regime and acid stimulation

8.1. The scope of the planning regime

A further lack of clarity regarding acid stimulation is found in the definition of hydraulic fracturing in the planning regime.

Planning permission for hydraulic fracturing operations is normally granted by local authorities, acting as the Mineral Planning Authority (MPA), in accordance with the Minerals section of the National Planning Policy Guidance (NPPG). This states:

> *What is hydraulic fracturing?*
>
> *Hydraulic fracturing is the process of opening and/or extending existing narrow fractures or creating new ones (fractures are typically hairline in width) in gas or oil-bearing rock, which allows gas or oil to flow into wellbores to be captured*.[67]

This definition is far broader than both the definition of 'Associated Hydraulic Fracturing' in the 1998 Act and the definition of 'Relevant Hydraulic Fracturing' contained in the 2016 Regulations. It raises the possibility of hydraulic fracturing activities falling within the NPPG definition for planning purposes but outside of the restrictions contained in the 1998 Act.

The definition quoted above would include acid stimulation in all forms. However, the guidance continues (para.130):

> *How does the hydraulic fracturing process work?*

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[65] Petroleum Act 1998, s.4A, document 2 of Column 1.
[66] Although, currently, the 2019 moratorium means 'Associated Hydraulic Fracturing', in practice, cannot take place.
[67] NPPG, Annex A, Minerals, para.129 https://www.gov.uk/guidance/minerals.

> *During hydraulic fracturing, a mixture of water, sand and possibly some chemical additives is pumped under pressure down a borehole into the rock unit. The sand is used to prop the fractures open to increase gas extraction …*[68]

If this explanation of the fracturing process is taken to form part of the NPPG definition of hydraulic fracturing it would exclude most forms of acid stimulation Acid stimulation does not typically involve the use of sand but rather relies on the acid to create, widen or extend fractures in the rock.

On the other hand, para.130 of the NPPG could be read as describing one of the ways in which hydraulic fracturing is carried out, and not as part of the definition of hydraulic fracturing itself. This preferred approach to interpretation is supported by the fact that other forms of hydraulic fracturing that do not fit the precise description set out para.130, such as fracturing using liquefied gas, and which does not require the use of water or sand, are still considered by industry scientists to be forms of hydraulic fracturing.[69]

The lack of clarity concerning the NPPG definition raises two concerns:

1. Whether the NPPG definition of hydraulic fracturing includes acid stimulation, or represents another loophole by which acid stimulation avoids planning restrictions that apply to other forms of hydraulic fracturing; and

2. Whether MPA's are aware of the difference in the NPPG definition and the definition contained in the 1998 Act and 2016 Regulations, and the implications of this.

Some MPA's are aware of the fact that the NPPG definition of fracturing could include hydraulic fracturing, including acid stimulation, that is not HVHF. However, to the extent that this is the case, they appear to be avoiding examining the issue, and instead are relying on other regulatory authorities to alert them to any potential planning implications (see the case history in Appendix A2). This is problematic because of the different definitions found in the regulatory and planning regimes.

The government stated in a Written Ministerial Statement of May 2018 that it 'expected' MPA's to recognise the definition of 'Associated Hydraulic Fracturing' in the 1998 Act.[70] However, a subsequent legal challenge clarified that this was only an 'expectation' and MPA's could continue to rely on the broader definition set out in the NPPG.[71] The Government also informed the House of Commons Committee on Housing, Communities and Local Government (HCLGC) that it intended to amend the NPPG definition so that it mirrored the 1998 Act definition (introduced by the Infrastructure Act, 2015). However, in its report, 'Planning Guidance on Fracking', the HCLGC concluded that:

> *The Infrastructure Act 2015 definition of fracking does not reflect the technologies used on the ground nor the public understanding of fracking, leading to a lack of understanding among key stakeholders and significant concerns about loopholes in the current regulatory regime. We therefore believe that the Infrastructure Act 2015 definition is unsuitable in the planning context and recommend that it should not be*

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[68] Ibid., at para.130.
[69] Grundmann, S. R., Rodvelt, G. D., Dials, G. A., Allen, R. E. 1998. Cryogenic Nitrogen as a Hydraulic Fracturing Fluid in the Devonian Shale. Paper presented at the SPE (Society of Petroleum Engineers) Eastern Regional Meeting, 9-11 November 1998, Pittsburgh https://doi.org/10.2118/51067-MS.
[70] James Brokenshire 'Planning policy' HCWS689, 17 May 2018. https://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2018-05-17/HCWS689/.
[71] *R (o.a.o. Andrews) v SSBEIS and SSHCLG* (CO/3256/2018).

> *liquid or volume-based. While we welcome the Government's intention to unify the definitions of fracking used in the Infrastructure Act 2015 and the National Planning Practice Guidance due to the resultant lack of clarity and uncertainty in using multiple definitions, we are highly concerned at the Government's suggestion that the Infrastructure Act definition will replace the current definition in a revised National Planning Practice Guidance. We call on the Government to amend the Infrastructure Act definition to ensure public confidence that every development which artificially fractures rock is subject to the appropriate permitting and regulatory regime*.[72]

Amending the definition of hydraulic fracturing in the Infrastructure Act 2015 to 'the artificial fracturing of rock,' as suggested by the HCLGC, could include all acid stimulation activities. However, amending the definition to encompass all well stimulation treatments which may enhance the productivity of oil and gas wells by increasing the permeability of the target rock would avoid any ambiguity in this regard. Either amendment would reflect a major and welcome change in policy.

8.2. Environmental impact assessments

Prior to the grant of planning permission, the MPA must consider whether the proposal for oil or gas extraction requires an Environmental Impact Assessment (EIA).[73] The proposal will require an EIA if it is a development that falls within:

- Schedule 1; or
- Schedule 2 and is likely to have significant effects on the environment by virtue of factors such as its nature, size or location.

Schedule 1 developments include those involving the:

> *extraction of petroleum and natural gas for commercial purposes where the amount extracted exceeds 500 tonnes per day in the case of petroleum and 500,000 cubic metres per day in the case of gas*.[74]

Schedule 1 does not distinguish between the methods used for extraction and could therefore apply to the extraction of oil and gas by hydraulic fracturing or acid stimulation.

Relevant schedule 2 developments include deep drilling, where the area of the works exceeds 1 ha and "*surface industrial installations for the extraction of coal, petroleum, natural gas and ores, as well as bituminous shale*" in which the area of the surface development exceeds 0.5 ha.[75]

As with schedule 1, the wording of schedule 2 does not differentiate between acid stimulation and other well stimulation techniques, such as water-based hydraulic fracturing.

However, para.119 of the NPPG examines when an EIA is required for hydrocarbon extraction. Despite stating that all applications must be assessed on a case by case basis, and that the nature, size and location of the proposed development must be taken into account, the

[72] HCLGC, *Planning guidance on fracking*, 5 July 2018, para.19.
[73] The Town and Country Planning (Environmental Impact Assessment) Regulations 2017, reg.3.
[74] The Town and Country Planning (Environmental Impact Assessment) Regulations 2017, Schedule 1, para.14.
[75] The Town and Country Planning (Environmental Impact Assessment) Regulations 2017, Schedule 2, para.2(d) and (e).

NPPG also states that "*it is unlikely that an Environmental Impact Assessment will be required for exploratory drilling operations which do not involve hydraulic fracturing*".[76]

Consequently, there appears to be a presumption built into the NPPG that if the drilling operations involve hydraulic fracturing, then an EIA is required. On the other hand, drilling operations not involving hydraulic fracturing are presumed not to require an EIA. If MPA's interpret acid stimulation as falling outside the definition of hydraulic fracturing, planning authorities will be less likely to require an EIA.

8.3. Conventional and unconventional

Although the NPPG regime largely focuses on the process of extraction and whether or not hydraulic fracturing is involved, as opposed to the type of target geology, the distinction between conventional and unconventional resources does have some consequences in planning. According to the NPPG, great care is needed when considering applications for unconventional hydrocarbon developments in National Parks, the Broads and Areas of Outstanding Natural Beauty. Major developments should be refused, as should developments that would lead to substantial harm to or loss of a World Heritage Site, unless exceptional circumstances exist.[77]

The NPPG defines 'conventional hydrocarbons' as oil and gas where the reservoir is sandstone or limestone, and 'unconventional hydrocarbons' as oil and gas which "*comes from sources such as shale or coal seams which act as the reservoirs.*"[78] This is an overly simplistic definition that uses rock types to differentiate between conventional and unconventional resources without taking into account their permeability – the key rock property used by scientists to make the distinction - and ignoring gradations between end-member rock types. For example, geologists can and do differentiate between a muddy sandstone, a sandy limestone, or a sand-prone shale. The end-members themselves, for example, 100% pure limestone, are rather rare in nature. And, as described in Appendix A1, oil and gas can also be unconventional resources, when contained in low permeability ('tight') formations.

Elsewhere, the NPPG refers to reports published by the Department of Energy and Climate Change (DECC)[79] and the OGA, when prescribing how mineral planning authorities should plan for hydrocarbon extraction[80] and explaining the role of planning within the wider regulatory system.[81] The categorisation of conventional and unconventional resources laid out in these reports is at odds with the NPPG's simplistic definition.

For example, the DECC-commissioned 2014 report[82] on the Jurassic shales of the Weald Basin, produced to "*address the potential distribution and in-place resources of unconventional oil and gas contained in shales beneath the UK*", refers to "*interbedded*

[76] NPPG, Minerals, para.119, https://www.gov.uk/guidance/minerals#Environmental-Impact-Assessment.
[77] NPPG, Minerals, para.223, available at https://www.gov.uk/guidance/minerals.
[78] NPPG, Minerals, para.91.
[79] In July 2016, the department was disbanded and merged with the Department for Business, Innovation and Skills, to form the Department for Business, Energy and Industrial Strategy.
[80] NPPG, Minerals, para.105.
[81] NPPG, Minerals, para.109.
[82] Andrews, I. J. 2014. *The Jurassic shales of the Weald Basin: geology and shale oil and shale gas resource estimation.* (British Geological Survey for Department of Energy and Climate Change, London, UK, 2014), https://www.ogauthority.co.uk/media/2773/bgs_decc_jurassicwealdshale_study_2014_main_report.pdf.

limestones and shales", and compares them to "*a hybrid Bakken-type shale oil play*".[83] Bakken here refers to one of the US unconventional shale plays.

In another example, a regulatory roadmap published by DECC in December 20, 2015[84] refers to "*conventional oil and gas accumulations*" as those contained in permeable rocks, and "*unconventional hydrocarbon accumulations*" where "*the same rock layer acts as both source and reservoir rock.*" These definitions are scientifically accurate. Interestingly, this document's content is "*primarily for unconventional oil and gas operations*" because:

> *The oil and gas industry is well established in the UK, having focused on exploiting conventional oil and gas fields, both onshore and offshore. The industry is now in phase of exploration for unconventional oil and gas as a result of recent technological developments.*[85]

This implies that most, if not all new onshore oil and gas wells are unconventional hydrocarbon developments, requiring the use of stimulation that irreversibly alters the bulk physical properties of the rock, namely its permeability. Therefore, taking a precautionary approach, they should all be subject to the same stringent regulatory controls that apply to high volume hydraulic fracturing as defined in the Infrastructure Act 2015, including the 2019 moratorium.

9. Discussion

9.1. The importance of precise definitions

Fracking (in the general sense) is framed by its opponents as a novel and potentially dangerous technology, whereas government and industry claim, with examples, that the technology has been widely and safely used in the onshore UK sphere for many years.[86] But the latter claim depends upon what, precisely, is meant by 'fracking'.

The fossil fuel industry claims that fracking was invented in 1947, and has been used routinely ever since; evidently, to regard such a technique as unconventional would be oxymoronic. But this assertion - of the routine and safe history of 'conventional fracking' - elides the fact that such 'historical' (pre-2005) fracking comprises the use of low volumes of water, in contrast to HVHF defined in section 2 above.

Inaccurate definitions, which have been promoted not just by the industry, but also by some academics quoted in the press, can materially alter the debate by misleading the public as to the true nature of HVHF. The case history of the conventional giant Wytch Farm oil field, wrongly cited as unconventional, is discussed in Appendix A4.

9.2. A new robust definition of unconventional hydrocarbon exploitation

It is due to the lack of clear definitions around fracking and historical misinformation that there is a need for a new approach based on a single robust and quantified definition of

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[83] ibid. p. 33.

[84] Department of Energy and Climate Change 2015. *England: Onshore oil and gas exploration in the UK: regulation and best practice*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/503067/Onshore_UK_oil_and_gas_exploration_England_Dec15.pdf.

[85] ibid. p. 6. The recent technological developments are principally directional drilling, especially horizontally at depth, and fracking. It is unlikely that any economically exploitable conventional oil or gas fields in the onshore UK sector remain to be discovered.

[86] Hilson, C. 2015. Framing fracking: which frames are heard in English planning and environmental policy and practice?, *J. Environmental Law* 27, 177-202. https://doi.org/10.1093/jel/equ036.

unconventional hydrocarbon extraction. We propose the following definition, which focuses on increasing permeability, rather than on a specific extraction process:

> *All well stimulation treatments of oil and gas wells which increase the permeability of the target rock volume to higher than 0.1 millidarcies beyond a 1 m radius from the borehole.*

This new definition takes the scientifically accurate definitions (quoted in Section 8.4 above by DECC), of "*unconventional hydrocarbon accumulations*" where "*the same rock layer acts as both source and reservoir rock*", or, equivalently, the USGS definition of 'continuous petroleum accumulations' (Appendix A2), and targets the stimulation of the aforesaid accumulation. The specification of the whole rock volume excludes local activities such as localised well-cleaning, involving water or acid treatments both limited to the vicinity of the borehole, which are recognised as conventional practices.

This definition also circumvents the current confusion and obfuscation (summarised in Appendix A5) by going to the heart (the purpose) of the various stimulation processes, whether they involve HVHF or acidisation, or other methods such as gas and electrical energy injection that have either been tried in the past or could be tried in the future. It avoids the arguments about how much water is required to define a HVHF threshold. The inclusion of 'hydrocarbon' rules out massive rock stimulation used in other fields such as geothermal energy, water resources, or water disposal/re-injection.

10. Conclusion and policy implications

There is a lack of clarity over what amounts to hydraulic fracturing when it falls outside the definition of HVHF, and what regulatory and planning restrictions should apply in these circumstances.

This lack of clarity is true not only for acid stimulation, but also for other forms of hydraulic fracturing that do not use large volumes of fluid. One of the key issues is that regulatory and planning guidance is ambiguous, and that regulators have broad discretion to determine when restrictions and additional requirements are imposed, without reference to clear parameters.

The HCLGC identified loopholes in the current system, and recommended an amendment to the Infrastructure Act definition of hydraulic fracturing to include all development that artificially fractures rock. However, this recommendation, with which we broadly concur, has yet to be implemented. Until then, the current fracking moratorium remains inadequate, since it does not cover the wide spectrum of stimulation treatments that do not qualify as HVHF.

In November 2020, in a parliamentary discussion about a proposed clause to be added to the Environment Bill that would ban 'Associated Hydraulic Fracturing', Rebecca Pow MP, referring to the definition in the Infrastructure Act 2015, said that it "*sets the right balanc*e" between capturing hydraulic fracturing operations and not capturing techniques used by conventional oil and gas operations, or processes used to clean wells after drilling.[87]

In a written parliamentary question early in 2019, Dr David Drew MP asked the Secretary of State for BEIS whether the consent process for acidising is the same as for fracking. In

[87] Public Bill Committee Environment Bill New Clause 3 - Well consents for hydraulic fracturing: cessation of issue and termination, https://www.theyworkforyou.com/pbc/2019-21/Environment_Bill/20-0_2020-11-24a.639.0?s=fracking+or+shale+gas+or+shale+oil#g642.0.

response, Claire Perry MP stated "*Acidisation refers to a number of techniques used to clean wells to improve productivity*".[88]

These inaccurate statements highlight the concerns of many affected communities, who fear acid and other well stimulation that fall outside of the current volume-based definition, and their environmental consequences are not sufficiently understood by politicians and policymakers, and as a consequence, are not subject to appropriate regulation.

A precautionary approach to the extraction of hydrocarbons from unconventional wells would see the inclusion of acid stimulation techniques within the legal and regulatory framework that currently only applies to HVHF. Unfortunately, the UK government's approach to fracking to date, has been to adopt a so-called 'sound science' principle rather than a precautionary principle. Patterson and McLean explain the sound science approach in the fracking context[89] as "*based on a premise that no* [remedial] *action should be taken unless there is concrete proof that it* [the alleged threat] *will be detrimental*."

To urgently tackle climate change, and given the environmental impacts of the extraction and use of oil and gas trapped in unconventional formations, the government should introduce an immediate ban on all well stimulation for oil and gas exploration and production, including water-based hydraulic fracturing and acid stimulation. However, as an interim measure, the changes required to clarify and expand the scope of the current regime to adequately regulate all well stimulation are set out in Appendix A6.

By emphasising the fundamental concept of stimulation in unconventional hydrocarbon extraction, the uncertainties and inconsistencies of defining hydraulic fracturing ('fracking'), acidisation, and related processes can be avoided.

In conclusion, our definition and proposals for implementation will close the existing loophole in the current phase of hydrocarbon exploration and production in England, which targets mainly unconventional oil and gas (as acknowledged by DECC - see section 8.3 above), but which the operators are pursuing under the guise of conventional activities.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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CRediT author statement

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[88] Written question of 4 March 2019 https://www.parliament.uk/business/publications/written-questions-answers-statements/written-question/Commons/2019-03-04/227944/.

[89] Patterson, A., McLean, C. 2018. The regulation of risk: the case of fracking in the UK and the Netherlands, *Science and Public Policy* 45, 45-52, www.hpaf.co.uk/wp-content/uploads/2018/03/The-RegulationofRiskUKNetherlands.pdf.

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Table 1

Frack fluid volumes and earthquake triggering at the three UK HVHF wells.

Well	**Preese Hall 1**	**PNR 1**	**PNR 2**
Start date	2011/03/26	2018/10/15	2019/08/13
End date	2011/05/31	2018/12/17	2019/08/23
Percentage of stages fracked	n/a	36%	16%
Total fluid volume (cu. m)	8,399	3,869	2,485
Fluid used as percentage of fluid permitted	n/a	12%	7%
Average fluid volume of main frack (cu. m)	1,594	218	355
Maximum volume of main frack	2,245	417	432
Number of main fracks	5	17	7
Number of recorded induced tremors	2	56	134
Largest induced tremor (M_L)	2.3	1.5	2.9
Date of largest tremor	2011/04/01	2018/12/11	2019/08/26
Main fracking start date	2011/03/28	2018//10/16	2019/08/15
Recorded seismic event start	2011/04/01	2018/10/18	2019/08/15
Magnitude of first recorded events (M_L)	2.3	-0.2, -0.8, -0.3	-0.2
Total fluid volume injected before start of seismic events (cu. m)	4,308	483 - 876.5	2.5 - 305.9

Appendix

A1 Definition of unconventional hydrocarbon resources

Trapped oil or gas may be recovered to the surface by natural flow pressure up a borehole; however, steam or water may be injected to direct or encourage the flow. The wellbore and its immediate vicinity (within, say, a 1 m radius) may also be cleaned up, or 'washed', to remove mud or limescale. These are conventional processes. An operational or economic definition[90] of unconventional resources is: *one that cannot be produced at economic flow rates or that does not produce economic volumes of oil and gas without the assistance of massive stimulation treatments or special recovery processes and technologies.* The problem with the latter part of such a definition is that it evolves with time. A resource that may be considered unconventional now may not be so in the future, as technology evolves and becomes routine.

The US Geological Survey (USGS) may be regarded as an impartial authority. However, it does not explicitly define unconventional. Its publications, using concepts defined just before the advent of widespread high-volume fracking in the US,[91] prefer to speak of 'continuous petroleum accumulations'.

However, a consensual definition of 'unconventional' is to employ a permeability cut-off for the host (reservoir or source) rock. Permeability is a measure of the ability of a porous material to allow the passage of fluids through it. Because it varies over many orders of magnitude in rocks, the unit of measurement, the darcy (or millidarcy), is usually depicted logarithmically; 0.01, 0.1, 1, 10, 100, etc. So the difference between 0.1 and 0.2 millidarcies, for example, is geologically insignificant.

A low permeability (by consensus defined as less than 0.1 millidarcies) implies that the resource is unconventional, meaning that it requires special methods to extract the resource. Above that value, conventional methods suffice. Unconventional resources are also characterised by being widely distributed, with low energy density (i.e. in a low concentration) and ill-defined in volume. There are no discrete boundaries, in contrast to those bounding a conventional hydrocarbon reservoir.

To further complicate the issue, a geometrically conventional reservoir may host the hydrocarbons in low-permeability, or *tight* rocks, to use the industry jargon, such as limestone or sandstone, and not just shale. The resource is then considered unconventional.

PetroWiki is an information site run by the Society of Petroleum Engineers (SPE). The SPE has published hundreds of articles on unconventional methods. SPE publications comprise mostly grey literature, with scanty peer review; nevertheless, it is a leading source of information. PetroWiki has a Glossary section, within which there is, remarkably, no definition of stimulation. PetroWiki defines other terms as follows:

> *Acidising: use of a mineral acid (typically HCl or HCl/HF) or an organic acid (typically acetic or formic) to remove damage or stimulate the permeability of a formation.*

[90] PetroWiki. *Unconventional resources of oil and gas from a geologic perspective*, https://petrowiki.org/Unconventional_resources_of_oil_and_gas_from_a_geologic_perspective accessed 10 February 2020.
[91] For example, Schmoker, J. W. 2005. *U.S. Geological Survey assessment concepts for continuous petroleum accumulations*, U.S. Geological Survey Digital Data Series DDS–69–D.

Unconventional resources: Hydrocarbons from unconventional and more difficult to produce resources such as shale gas, shale oil, tight gas, and tight oil, coal seam gas/coalbed methane and hydrates.

Hydraulic fracture: A fracture created by hydraulic pressure - usually intentionally.

Acid fracture: To fracture stimulate a formation by injecting the acid over the parting pressure of the rock and using the acid to etch channels in the fracture face.

The American Petroleum Institute[92] (API) is a long-established trade association aimed at aggressively promoting the interests of the hydrocarbon industry in the USA and worldwide. It also sets technical standards; some units of measurement in the industry are simply referred to as API units. However, it does not have any objective definitions useful in the present context.

A2 The planning regime and acidisation: case history of Surrey County Council and Angus Energy

Surrey County Council (SCC), the MPA, granted planning permission to Angus Energy for oil appraisal activities in August 2018. Condition 1 of the planning permission prohibited 'hydraulic fracturing'.

Given concerns that Angus Energy might be engaging in acid stimulation techniques, SCC was asked how it was monitoring and enforcing planning Condition 1. In response, SCC stated that hydraulic fracturing would require OGA approval of an HFP, EA permits and BEIS consent, and that SCC would be informed of any such proposals via the OGA and EA. SCC also stated that hydraulic fracturing would involve 'major changes to the site infrastructure'. This response is inaccurate. Not all hydraulic fracturing requires OGA approval of an HFP, consent from BEIS and major site infrastructure changes.

SCC internal emails revealed that, although some planning officials thought it necessary to examine the proposed 'acid washes' in more detail, the overriding view was that, having determined that this was an 'acceptable use of the land', SCC 'should not get involved in the processes used on site'.

Further, in relation to the discrepancy between the definitions of hydraulic fracturing under the 1998 Act and the NPPG, and the consequences for enforcing the ban on hydraulic fracturing, SCC stated that no discussions had taken place and it was not in their 'remit to question differences in definitions of a process'.

This approach raises the question whether a planning condition to prohibit hydraulic fracturing is in effect meaningless, and whether it is lawful for planning authorities to rely on other regulators to alert them to breaches of planning laws when activities that fall outside the regulatory regime may fall within the planning regime.

[92] American Petroleum Institute https://www.api.org/.

A3 HSE - Onshore Oil and Gas Exploration and Production

In carrying out its work the HSE follows its general goal under the Health and Safety at Work Act 1974, as well as specific regulations that govern oil and gas extraction, including:

1. The Borehole Sites and Operations Regulations 1995 – these relate to the health and safety management of the site and require notification to the HSE in various circumstances, including prior to commencement of well construction, if there is a material change in operation and prior to abandonment (regulation 6).

2. The Offshore Installations and Wells (Design and Construction etc) Regulations 1996 – these apply to all onshore and offshore wells and are concerned with well integrity. They impose a requirement for weekly reports to be sent to the HSE (regulation 19).

3. The Reporting of Injuries Diseases and Dangerous Occurrences Regulations 1995 – these list a set of dangerous occurrences that an operator must report to the HSE to enable investigation of whether well integrity is impacted and to ensure improvements to operations.

Each of the above regulations apply to all onshore oil and gas exploration and production sites, regardless of whether the operations involve hydraulic fracturing, including acid stimulation, or not.

The HSE fulfils its role by conducting:

- assessments of well design prior to construction;
- monitoring well operations during construction, based on weekly operations reports submitted by operators; and
- meetings with operators prior to and during the operational phase, including site inspection.

Once again, this regime is not specific to hydraulic fracturing sites and would therefore apply to all onshore oil and gas exploration and production operations, including those using acid stimulation techniques.

A4 Misleading and inaccurate definitions of high volume hydraulic fracturing: the Wytch Farm oil field case history

Professor Peter Styles asserted in a presentation[93] to the South Downs National Park Authority in 2013 that more than 200 fracking jobs had been carried out to date in the UK. These included treatments of wells other than for hydrocarbons. He also failed to distinguish 'conventional fracking' from HVHF. Styles repeated his assertion in an article in *The Telegraph*[94] in 2013 about the Wytch Farm oilfield in Dorset, with the implication (by juxtaposition of quotations by the article's author, and not by Styles himself) that fracking had been carried out there. DECC responded to an FOI request. The Refracktion website (since taken down) made an FOI request to DECC and published the response. The reply

[93] Styles, P. 2013. Shale Gas *What is it, do we need it, how do we get it and what are the implications?* Presentation no longer available on the southdowns.gov.uk website, but a copy is available here: http://www.davidsmythe.org/fracking/Shale-Gas-Presentation-_Professor-Peter-Styles_Keele-University.pdf.

[94] Gray, L. 2013. The town where a form of 'fracking' is already happening, *The Telegraph* (London, 10 August 2013), https://www.telegraph.co.uk/news/earth/earthnews/10233955/The-town-where-a-form-of-fracking-is-already-happening.html. Paywalled; relevant text extract available here: http://www.davidsmythe.org/fracking/telegraph wytch farm 2013 extracts.pdf .

from Toni Harvey, senior geoscientist, onshore exploration and development, DECC, August 2013 was as follows:

> *DECC has records of some kind of the drilling of 2159 onshore wells … we believe that at least 200 did have hydraulic fracturing treatments of some kind, but we would emphasise that these non-shale fracs are not comparable, in the volumes of fluid employed, to Cuadrilla's operations at Preese Hall in 2011 – the non-shale fracs are much smaller.*

Table 1 shows the data for this well and the only other two wells in the UK that have subsequently been subjected to HVHF to date.

Wytch Farm is renowned for its 'extended reach' horizontal wells, running some 10 km out under Bournemouth Bay from the onshore wellsite at Poole harbour. Another academic, Dr James Verdon, claimed in 2013 that these wells had been fracked.[95] This is incorrect. The initial publication on the Wytch Farm oil field[96] makes no mention of hydraulic fracturing in the field, nor does the account of the subsequent field development.[97] Some extended reach wells were designed to inject water low down into the oil-bearing aquifer (a 'bottom waterflood') to help the oil flow above. This conventional process has no affinity to fracking of any sort. The reservoir rock at Wytch Farm, the Sherwood Sandstone Group, has very high permeability, so does not need fracking, and would, in any case, not be amenable to high-volume fracking.

Nevertheless, the *Telegraph* article went on to assert that 'water injection' or 'water flooding' is a form of fracking, despite having been obliged to add a later footnote admitting that this technique is not 'hydraulic fracking'. But the false and pernicious claims in the article have subsequently been widely reproduced and accepted, for example, by Chris Hilson,[98] Liverpool City Region[99] and Kevin Hollinrake MP.

Mr Hollinrake is a strong supporter of fracking and one-time Vice Chair of the All Party Parliamentary Group on Unconventional Oil and Gas. He wrote to his constituents in 2014, quoting the *Telegraph* article as follows:

> *You may be aware of the Wytch Farm site in Dorset where a form of fracking has been taking place for decades.*[100]

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[95] Verdon, J. 2013. *Shale gas and fracking Slideshow for Glastonbury lecture (2013)*. No longer available on the Bristol University website, but a screenshot of the relevant slide is available here: http://www.davidsmythe.org/fracking/screenshot verdon 2013 glastonbury talk slide 8.jpg.

[96] Colter, V. S., and Havard, D. J. 1981. The Wytch Farm oilfield, Dorset, in Illing, L. V. and Hobson, G. D. (eds) *Petroleum geology of the continental shelf of north-west Europe* (Heyden and Sons, London, 1981).

[97] Hogg, A. J., Evans, I. J., Harrison, P. F., Meling, T., Smith, G. S., Thompson, S. D., Watts G. F. T. 1999. 'Reservoir management of the Wytch Farm Oil Field, Dorset, UK: providing options for growth into later field life' in Fleet, A. J., Boldy, S. A. R. (eds) *Petroleum Geology of Northwest Europe: Proceedings of the 5th Conference* (Geological Society, London, 1999).

[98] op. cit.

[99] Liverpool City Region Local Enterprise Partnership 2015. *The potential for the Liverpool City Region economy to benefit from shale development*, in Agenda for meeting of 16 July 2015, https://www.liverpoollep.org/wp-content/uploads/2015/07/Strategic-Board-July-2015.pdf at p.37. This link is liable to expire in 2021; if so, the document is available here: http://www.davidsmythe.org/fracking/Liverpool LEP Strategic-Board-July-2015.pdf.

[100] http://www.husthwaitevillage.com/new_news_detail.php?id=407.

The shale gas company INEOS Shale has similarly claimed Wytch Farm as an example of fracking of horizontal wells in the UK.[101]

The Royal Society and Royal Society of Engineering report of 2012 into fracking commissioned by the government[102] also wrongly stated that the "*combination of hydraulic fracturing and directional drilling allowed the development of Wytch Farm field in Dorset in 1979.*" This error is reprehensible, given that four of the eight experts on the committee were solid earth scientists, and given also that the written submission to the committee by the joint Geological Society of London and the Petroleum Exploration Society of Great Britain explicitly described Wytch Farm as an example of *"'conventional' hydrocarbon extraction*". The error persists, having been cited by a House of Commons briefing paper[103] dated March 2020.

A5 Ambiguities in legal definitions

Many of the legal and regulatory constraints that apply to high volume hydraulic fracturing, including the 2019 moratorium, do not apply to acid stimulation or are ambiguous as to whether they apply. This is because of the issues detailed above. They can be summarised as follows:

- The controls introduced by s.50 of the Infrastructure Act 2015 and the 2016 Regulations governing protected areas only apply to fracturing involving large volumes of fluid.

- The Oil and Gas Authority, responsible for managing the risks of induced seismicity in particular by requiring a hydraulic fracture plan (HFP), do not clearly define when an HFP is required, and has given evidence to the Committee on Housing, Communities and Local Government that conflicts with its own guidance.

- The Environment Agency, which oversees the environmental permitting regime, has failed to clarify the boundaries between acid stimulation and well maintenance techniques, thereby risking acid stimulation taking place under the guise of maintenance techniques, with insufficient restrictions, reporting and monitoring in place to guard against this.

- Site inspections that are mandatory for high-volume fracturing are not required for other forms of well stimulation and the Health and Safety Executive's agreement with the EA for meetings and the inspection of "*hydraulic fracturing*" sites does not define what activities are included in this regime.

- Although the minerals section of the National Planning Policy Guidance contains a definition of hydraulic fracturing that is broader than the Infrastructure Act 2015, it lacks clarity and is still too narrow.

- The 2019 moratorium is unclear as to its precise scope but appears unlikely to extend to acid stimulation.

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[101] INEOS Shale 2017. *Wytch Farm* (Twitter, 26 May 2017), https://twitter.com/INEOS_Shale/status/868037366350479360. A screenshot is available here: http://www.davidsmythe.org/fracking/INEOS tweet wytch farm 26may17.jpg.

[102] Royal Society and Royal Academy of Engineering 2012. *Shale gas extraction in the UK: a review of hydraulic fracturing* (Royal Society, London, June 2012), royalsociety.org/policy/projects/shale-gas-extraction.

[103] Priestley, S. 2020. *Shale gas and fracking*, (Briefing paper no. CBP 6073, House of Commons Library, 31 March 2020) https://commonslibrary.parliament.uk/research-briefings/sn06073/.

A6 Recommended changes to the legal and regulatory framework

To urgently tackle climate change and given the environmental impacts of the extraction and use of oil and gas trapped in unconventional formations:

Ban all well stimulation, including water-based hydraulic fracturing and acid stimulation, for oil and gas exploration and production. In the interim to:

Amend the definition of 'Associated Hydraulic Fracturing' in the Petroleum Act 1998 to:

All well stimulation treatments of oil and gas wells which increase the permeability of the target rock volume to higher than 0.1 millidarcies beyond a 1 m radius from the borehole.

Require all regulators of the shale oil and gas exploration and production industry to apply this amended Petroleum Act 1998 definition consistently across the entire regulatory regime, to ensure that all prohibitions and restrictions, and monitoring and reporting requirements currently applicable to HVHF apply to all well stimulation treatments, including:

- The requirement to draw up a 'well-stimulation plan' (currently a hydraulic fracture plan); and
- The requirement for a traffic light monitoring system to monitor and manage induced seismicity.

For the purposes of environmental permitting and monitoring:

- Require the EA to use the definition set out in the amended Petroleum Act 1998 in order to distinguish between acid stimulation and acid wash;
- Require the submission of detailed injection charts to the EA for all injected fluids, including volumes of fluid pumped, injection depth, pressures, and timings; and
- Require the public disclosure of information of all chemicals and the amounts used in each acid stimulation treatment, including chemicals subject to the 'de minimis' exclusion.

Amend the Minerals NPPG to:

- Replace 'hydraulic fracturing' with 'well stimulation', including at para.129 and amend the definition at para.129 in line with the proposed Petroleum 1998 Act definition;
- Clarify that para.130 is only one form of well stimulation technique;
- Include at para.119 a presumption in favour of an EIA in all cases involving well stimulation; and
- Replace para.223 with a prohibition on all well stimulation in National Parks, the Broads, Areas of Outstanding Natural Beauty and World Heritage Sites.