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Briefing: Public Perceptions of Shale Gas Exploration in the UK: A Summary of Research (2012-2020)

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1. Summary

Understanding public perceptions of shale gas can inform energy policy-making, industry practice and societal debate on net zero emissions. In this benchmark review, we provide an overview of research findings on public perceptions of shale gas in the UK as reported primarily by a series of studies using survey methods between 2012-2020. We emphasise some caution in generating firm conclusions, given variation in how public perceptions are measured by different studies. Nevertheless, we offer five key findings. First, public *awareness* of shale gas increased between 2012-2014 but has remained stable since then. Second, public *support* for shale gas has decreased over time while public opposition has generally increased. Third, a substantial minority are consistently undecided about whether they support or oppose shale gas. Fourth, while research shows an unclear relationship between levels of awareness of shale gas and levels of support, the consensus amongst researchers is that providing additional information is only likely to sway the opinions of those who are currently undecided. Taken together, the research literature suggests an increasingly polarised societal context about shale gas that comprises three distinct groups: strong objectors, strong supporters and those without a firm opinion.

Reasons for support and objection to shale gas are talked about and discussed differently by different people, organizations and governments. The main points of argument relate to the economy, the environment, trust and justice. Induced seismicity and the subsequent potential for earthquake damage is one of the most prominent concerns about shale gas exploration in the UK, as is environmental degradation and climate change more broadly. People tend to view academics and the British Geological Society (BGS) as highly trusted on shale gas, while trust in government actors as it relates to shale gas is low and trust in industry actors is very low. Reflecting a polarised societal context, studies indicate that increasing public awareness of shale gas has not led to an increase in public support. Exploring public perceptions as they change over time helps to account for how different events and trends influence public opinion and provides a clearer picture of patterns than snapshot measurements do. This makes them valuable for informing public policy as well as tracking the influence public policy has on attitudes both initially and long-term.

Several key gaps in knowledge exist, including questions such as:

i. What frames are used by members of the public to conceptualise shale gas extraction?
ii. How do shale gas perceptions evolve over time in the same individuals and in response to societal events?
iii. How has the COVID-19 pandemic influenced shale gas perceptions and perceived risks?
iv. How do public perceptions relate to proximity to shale gas exploration sites?
v. What role is played by social media (e.g. Twitter) in shaping public support for shale gas?

We expect that as the Challenge 5 social science projects funded under the Unconventional Hydrocarbons in the UK Energy System programme conclude, the next two years will bring more clarity on perceptions of shale gas exploration in the UK and how they relate to these current circumstances.

2. Introduction

Gaining public support is a key aspect of implementing technologies geared toward accessing and extracting new energy resources (Devine-Wright 2011). Knowledge of how the public thinks about energy can inform policy-making as well as industry conduct and societal debate. Yet it is a formidably complex topic. As Walker (1995) identified several decades ago, 'the public' is not a single homogeneous group. Instead perceptions are likely to be diverse across society, associated with factors including age, gender, education, socio-economic status, political ideology, location of residence, and past experiences with energy development. Moreover, public perceptions are not static; they evolve over time in response to specific events. In this benchmark review, we summarise the available evidence on UK public perceptions of shale gas, as captured by research published over the last 8 years. We begin by discussing findings from studies about public awareness and knowledge of shale gas, how shale gas has been framed in public dialogue, and to what degree the public support or oppose shale gas exploration and why. In particular, we focus on the details of surveys aimed to gauge national-level acceptance and opinion of shale gas exploration. We note key methodological details, where appropriate, that help to understand divergent findings. In closing, we highlight knowledge gaps in research that remain to be addressed, and discuss the implications of these for policy development and future research.

3. Background Information

Shale gas extraction has been in commercial use in the United States over the last 15-20 years, but has seen little large-

scale success elsewhere. In England, efforts have been made in shale gas exploration following the awarding of Petroleum Exploration and Development Licenses (PEDLs) to different companies over the last ten years. To date, no extraction has been completed here, however exploration—while currently paused—has moved forward, albeit slowly.

Over time, and particularly in the United States, shale gas has become a controversial, politicized topic. The dominant narrative and subsequent resistance was to 'fracking,' which became a catch-all term for shale oil and gas development, and was often perceived as being used frequently by those who oppose shale gas development. Yet perhaps surprisingly, the Attitudes to Shale Gas in Space and Time (ASSIST) project, funded under the Unconventional Hydrocarbons in the UK Energy System programme, found that in 2019 the use of the word 'fracking' in a national survey did not lead to lower support for shale gas by comparison to use of the words 'shale gas extraction'. Understanding this nuance and how the meaning and connotations of words or labels emerge and evolve is important, as how an issue is talked about and framed can influence public perceptions about it (see Evensen et al. 2014).

Here we focus on the framing of this issue in the UK, and the degree to which members of the public are aware of, support or oppose shale gas exploration. Taken together with research on shale gas policy development and contestation (see Johnstone et al. 2017; Williams and Sovacool 2019; Whitton et al. 2017), we believe an understanding of framing, awareness and perception can lead to better UK policy decisions on energy infrastructure projects now and in the future. This will continue to be of relevance given the scale of development of energy infrastructure – both above ground and sub-surface – that will be required to meet the UK's net zero policy goals.

4. Public awareness of shale gas exploration in the UK

Studies have persistently attempted to gauge public awareness of shale gas, as well as to investigate whether levels of awareness relate to positive or negative perceptions. In the UK, the most extensive national survey has comprised the 33 waves of data collection of the Public Attitude Tracker (PAT) commissioned by the UK Department for Business, Energy and Industrial Strategy (BEIS), conducted on a quarterly basis since 2012. In addition, three other major national surveys have been undertaken over the last eight years which have studied this topic. Each has used slightly different question wordings and produced slightly different findings (see Boxes 1-3 below).

Box 1: Summary of national surveys measuring perceptions of shale gas extraction in the UK

Study	Sample Size	Sample Strategy	Project details and funding sources	Survey Date(s)
BEIS Public Attitude Tracker (PAT)	1,851	Face-to-face omnibus survey (cross-sectional)	UK Department for Business, Energy and Industrial Strategy	March 2020 (recurring quarterly across 33 waves since 2012)
Andersson-Hudson et al. 2016	3,8231	YouGov omnibus survey (cross-sectional2)	Led and funded by the University of Nottingham	Sept 9-11, 2014 (recurring 2012-20163)
Howell 2018	1,745	YouGov omnibus survey	Led by University of Edinburgh, funded by the Climate Change Consortium of Wales.	March 8-9, 2015 (one point in time)
ASSIST National Survey	2,777 (Wave 1) and 1,858 (Wave 2)	YouGov omnibus survey, (longitudinal with same participants over time)	Led by University of Exeter, part of the Unconventional Hydrocarbons in the UK Energy System, funded through the Economic & Social Research Council and the Natural Environment Research Council	April 2019 (Wave 1), July 2020 (Wave 2) and mid-2021 (Wave 3)

1 This is the sample size for the Sept. 9-11, 2014 survey.

2 Cross-sectional surveys collect data on the same questions from different people over time. Longitudinal surveys collect data on the same questions from the same people over time. Therefore, longitudinal data is considered more robust than cross-sectional data to show change over time.

3 This study appears to have collected data on a recurring basis at least once a year from 2012-2016. The published data from the study is from the 2014 survey, so we focus on this data in this review.

The UK Department for Business, Energy and Industrial Strategy (BEIS) Public Attitude Tracker (PAT) survey asked participants to self-report how much they know about shale gas (see Boxes 1 and 2). Results for 33 waves of data collection on a quarterly basis since 2012 show that **public awareness of shale gas increased between 2012 and 2014, yet has remained stable since then**. In June 2012, 42% of respondents reported being aware of hydraulic fracturing for shale gas. Just under two years later, by March 2014, self-reported awareness had increased to 75%. Since that time, reported public awareness has remained similar. In March 2020, 78% of respondents reported being aware of hydraulic fracturing for shale gas, which is in the typical range of awareness reported over the last 6 years (74-80%, see Box 2 and Chart 1). Further, the BEIS PAT found that increased awareness of shale gas exploration is associated with higher levels of opposition, not support (BEIS 2019).

Box 2: Summary of shale gas awareness questions and findings in UK national surveys

National Survey	Survey Date	Question(s)	Results
Andersson-Hudson et al. 2016	September 2014	This is a fossil fuel, found in sedimentary rock normally more than 1000m below ground. It is extracted using a technique known as hydraulic fracturing, or 'fracking'. Is this fossil fuel: a) Boromic gas, b) Coal, c) Xenon gas, d) Shale gas, e) Tar-sand oil, f) Don't know.	>75% of respondents correctly identified 'shale gas'
Howell 2018	March 2015	This is a fossil fuel, found in sedimentary rock normally more than 1000 m below ground. It is extracted using a technique known as hydraulic fracturing, or 'fracking'. Is this fossil fuel: a) Boromic gas, b) Coal, c) Xenon gas, d) Shale gas, e) Tar-sand oil, f) Don't know.	71% of respondents correctly identified 'shale gas'
ASSIST Wave 1	September 2019	Overall, how much have you read or heard about shale gas extraction? (Nothing at all, I have heard of it but know nothing about it, I know a little, I know a fair amount, I know a great deal)	85% of respondents reported having read or heard of shale gas, 63 % knew at least a little
BEIS PAT Wave 33	March 2020	Before today, how much, if anything, did you know about hydraulic fracturing for shale gas, otherwise known as 'fracking'?' ('Knew a lot about it', 'knew a little about it', 'aware of it but did not really know what it was', 'never heard of it').	78% of respondents reported being aware of shale gas
ASSIST Wave 2	July 2020	Overall, how much have you read or heard about shale gas extraction? (Nothing at all, I have heard of it but know nothing about it, I know a little, I know a fair amount, I know a great deal)	94% of respondents reported having read or heard of shale gas, 74% knew at least a little 4

The University of Nottingham tracker survey asked members of the public about their knowledge of shale gas as well as their support for it with data collected annually between March 2012 and October 2016 (Andersson-Hudson et al. 2016). The study was designed in part to determine whether the survey participants could distinguish shale gas from other energy sources (see Box 2). In the September 2014 survey, 75% of respondents were able to correctly identify shale gas, suggesting a basic understanding of what it is. While this rate of public awareness of shale gas is similar to the findings of the BEIS PAT, contrary to the BEIS PAT findings, the participants who were able to correctly identify shale gas were more supportive of exploration. This suggests that the relationship between awareness of shale gas and support or opposition may have changed over time. However, differences in the framing of these knowledge questions (see Box 1) for measuring knowledge of shale gas (that is, a self-assessment of knowledge [BEIS PAT] versus a factually-based definition question [University of Nottingham]), may have contributed to the different results and relationships between these variables in the surveys.

Relying on the same shale gas knowledge question as the Nottingham tracker survey, Howell (2018) found that 70.6% of respondents correctly identified shale gas, mirroring the patterns of the above surveys (see Box 2). In this study, while increased knowledge of shale gas meant survey takers were more likely to have an opinion, there was no indication that increased knowledge meant that respondents were more or less likely to support or oppose shale gas in the UK generally. Instead, more knowledgeable respondents were likely to hold views on both ends of the support/opposition spectrum (see more about this in the 'public support for shale gas' section below), supporting our interpretation of an increasingly

4 Caution needs to be used here, as respondents to this survey were the same ones who had taken the ASSIST Wave 1 survey on shale gas 14 months prior.

polarised societal context towards shale gas, a polarization that seems unlikely to be solved by providing additional information.

In April 2019, the ASSIST project conducted the first of three waves of a national longitudinal survey on public awareness and acceptance of shale gas exploration (see Boxes 1 and 2). The second wave of survey data was collected in July 2020. Importantly, this study differs from all previous national survey efforts as the same individuals participated in both survey waves. As such, it provides the most accurate data about changes in shale gas attitudes and awareness over time. With a question wording that is similar to the BEIS PAT, results for the April 2019 survey reveal that 63.3% had 'a little' or more self-reported knowledge of shale gas extraction. A further 21.7% indicated that they had 'heard of it but know nothing about it', and finally 15% reported knowing 'nothing at all' about it. When the awareness question was repeated in July 2020 with 65% of the respondents who participated in the 2019 survey, 63% indicated no change in awareness of shale gas; 12% reported being less aware in comparison to 2019 and 25% reporting being more aware. In July 2020, 74.1% responded that they knew at least a little about shale gas extraction, similar to the findings of other national survey efforts discussed above. The results support the trend revealed in other research that awareness levels have primarily remained the same over the last few years, with a slight increase in awareness of shale gas.

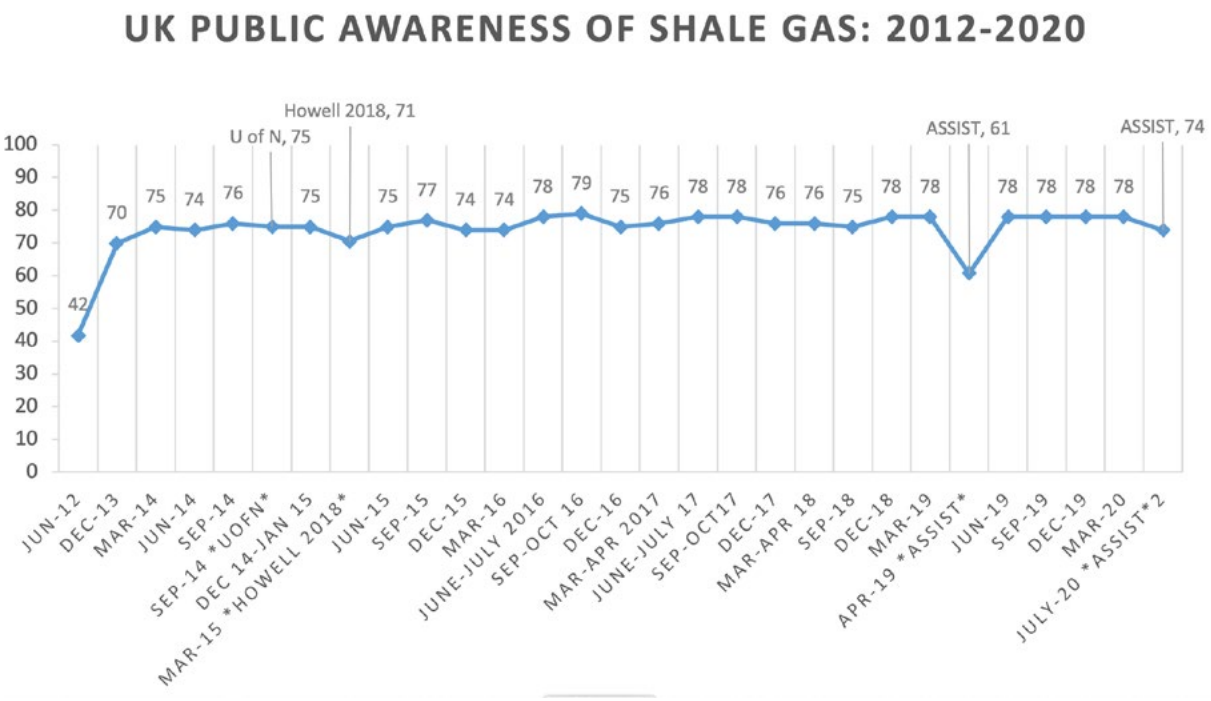
What we can conclude from these surveys is that **public awareness of shale gas was quite low in 2012, and since 2014 has been consistently high** (see Chart 1). However, the relationship between public awareness of shale gas exploration and public support or opposition to it remains unclear. The BEIS PAT (2019) reveals that opposition is higher amongst people with awareness of shale gas. Howell (2018) demonstrates that knowledge leads to more polarisation (both more support and more opposition); similarly, Andersson-Hudson et al. (2019) report that people with more awareness of shale gas have less nuanced, and more politically-motivated, views towards extraction. In the ASSIST 2019 survey, the association between public awareness and public support for shale gas was very weak.

Of the other studies that have investigated the relationship between knowledge about shale gas and support or opposition, one study (Whitmarsh et al. 2015) is noteworthy for using an experimental design to investigate whether gaining additional knowledge about shale gas might change public attitudes toward it. In this research, when respondents were provided additional information on the benefits of shale gas, support increased. Furthermore, this relationship was strongest for individuals who were ambivalent in their attitudes towards shale gas to begin with (similar to the finding on more nuanced views from people with less awareness, discussed above). Essentially, in this research additional information on shale gas increased support primarily for those who did not already have a strong opinion on shale gas to begin with.

Another indication of societal polarisation on shale gas comes from the 2019 ASSIST survey when participants were provided with information about the Treasury's Sovereign Wealth Fund (designed to provide financial benefits to shale gas communities) in order to test whether providing knowledge of the fund led to an increase in public support. Findings indicated that the majority of respondents (65%) did not change their opinion of shale gas. However, of those who did shift in opinion, 20% became less supportive and 15% became more supportive. This suggests that by and large being more informed about a specific potential benefit of shale gas does not lead to increased support for the practice. In short, those with strong objections to shale gas were more likely to view the fund as a bribe rather than a benefit.

Finally, it is worth noting that survey research on awareness of shale gas has not successfully gauged the depth of public knowledge of shale gas or how it could be increased. This is reflected in the BEIS PAT which shows that consistently only about half of UK survey respondents say they have any knowledge of the shale gas process or its effects, beyond just hearing of it in passing (BEIS 2019). Further, the primary ways that the public has become aware of shale gas at such high rates since 2014 remain unclear, though the ASSIST survey and other UKUH C5 projects are currently studying this topic.

Chart 1: Proportion of the public indicating awareness of shale gas extraction in the UK over time (with non-BEIS surveys highlighted)



5. Discourse and rhetoric from current research

Recognizing that there is considerable awareness of shale gas exploration in the UK, several important issues arise. First, how is shale gas exploration framed5 in the UK, and who is creating these frames? Second, how is language handled in research, both in the wording of survey instruments and the interpretation of findings? In terms of framing, Williams and Sovacool (2019) identify nine key frames on UK shale gas development from 2010-2018. This is important because some research has noted that the language and framing used to communicate about shale gas can affect public perceptions, even potentially increasing or decreasing support for it (McNally et al. 2018, Bond et al. 2019). Several years ago, the term 'fracking' was considered a pejorative way to describe shale gas exploration but evidence suggests that this has changed over time. In the ASSIST project, the 2019 national survey found that using the term 'fracking' made no difference to levels of public support for shale gas by comparison to using the term 'shale gas extraction'.

Discussions of shale gas in the UK tend to be made up of arguments by 'pro' and 'anti' shale gas camps using different, often conflicting frames to talk about the issue. Pro-shale gas discourse focuses rather narrowly on a few specific economic benefits (e.g. employment, economic growth) as well as energy independence and at times the debated benefit of reduced greenhouse gas emissions (see Greiner et al. 2018; Stamford 2020). In contrast, anti-shale rhetoric and framing picks up environmental risks alongside concerns about trust in pro-shale actors, fairness and inclusion in the decision-making process (procedural justice), the distribution of project costs and benefits (distributive justice), and local issues (including a lack of democratic opportunity for local decision making on shale gas exploration) (see Williams and Sovacool 2019). Researchers acknowledge the competing shale gas frames of economics versus the environment, similar to much discourse in the U.S. (Jacquet et al. 2018).

Neil et al. (2018) and Jones et al. (2013) argue that opposition and activist groups have used social media particularly effectively when spreading their messages about shale gas, even influencing mainstream mass media reporting (Neil et al. 2018). Although Rattle et al. (2020) are more subdued in their assessment of the effective use of social media for activism, they note its value in sharing information. Bomberg (2017a & 2017b) and Stephan (2017) draw attention to the incorporation of broadly focused concerns into anti-shale rhetoric as one factor supporting its success. For example, many authors cited

5 In this context, we refer to 'framing' as how shale gas exploration is conceptualized, discussed and written about. Questions tied to the framing of shale gas exploration include: What other issues are highlighted in connection with it? How is it worded or portrayed? What are the labels used for talking about the issue and where people stand on it?

a local focus in anti-shale discourse on justice issues, raising questions about residents' abilities to influence decision-making and whether they are being asked to shoulder too many risks with too few benefits (Bomberg 2017a; 2017b; Clough 2018; Cotton et al. 2014; Griffiths 2019; Szolucha 2018). Yet concerns about health, public safety, quality of life, wildlife, the environment and seismicity have been documented in UK data collected through the ASSIST project from local case study communities where shale gas projects are proposed. It remains unclear, despite the above, which frames resonate most strongly with the public (e.g., those put forward by government, industry, anti-shale non-profits, activists). However, there is evidence that early support for government framing was initially successful, and subsequent government approaches and decisions may have contributed to a decrease in public support (Williams et al. 2020) Jaspal and Nerlich (2014) suggest that different frames are used more frequently and are more effective across different media outlets. For example, they note that some newspapers tend to take pro-shale stances (The Times, The Telegraph) while others take anti-shale positions (The Guardian, The Independent). From the research we reviewed here, institutional actors involved in the conversation around shale gas exploration all engaged from a clearly pro- or anti-shale gas perspective—save for the Church of England which acknowledged concerns but did not suggest the practice be banned.

Yet other research has shown that the framing of shale gas in the UK has moved beyond an argument of economics and energy security vs. the environment and public health (see, for example Evensen and Stedman 2017). In the BEIS PAT, environmental reasons are frequently cited as the top reason that respondents both supported *and* objected to shale gas exploration (see Section 7 below). Other aspects of discourse that research has explored include: whether regulation is adequate (Pedersen 2015), fracking as a threat, particularly to green energy (Jaspal and Nerlich 2014), whether shale gas is a novel or established technology, and whether the focus of shale gas impacts should be at the local, national, or global scale (Hilson 2015). These aspects have been incorporated into the arguments of both the pro- and anti-shale factions, with pro-shale actors using the frames of adequate regulation, shale gas as greener than coal, positive economic impacts in the US, shale gas as an established technology, and the national scale as the appropriate level of analysis. Anti-shale actors framed shale gas exploration as lacking necessary regulation, a dirty fuel contributing to carbon emissions, having caused environmental contamination and health problems in the US, as a novel technology, and needing analysis of local and global impacts (Hilson 2015). Upham et al. (2015) discuss the heavy focus in newspaper reporting on how shale gas exploration and extraction is inconsistent with the UK Government's climate targets. Specific mention of the ways in which pro- and anti-shale actors dealt with the connection between shale gas and carbon emissions arose in multiple studies. Nyberg et al. (2017) found that arguments for the continued use of fossil fuels in the near term have greater resonance, whilst Bomberg (2017a) focuses on the strength of the anti-shale frame of the practice leading to fossil fuel 'lock in'. Hence, existing research on the environmental impacts of shale gas suggest more nuance is needed in framing and exploring the issues (see Stamford and Azapagic 2014).

In terms of the language used by researchers, even subtle differences can contribute to different understandings of an issue and different research results and outcomes. This has certainly been the case for studying public perceptions of shale gas in the UK. For example, as Howell (2018) explains, differences in responses between the University of Nottingham and BEIS PAT surveys can be attributed, at least in part, to differences in research design. These differences include: (1) how questions are worded (2) what response options are available (3) the degree to which the survey informs respondents about shale gas exploration as they are taking it and (4) language used to describe the practice (i.e. 'fracking,' shale gas, unconventional gas).

Researchers on shale gas exploration do not study it in a vacuum—they are at once both framers of the discussion while also subject to the dialogue and frameworks pursued by other organisations and the public. In particular, how language is used in the social sciences contributes to the social construction of how 'shale gas extraction' is conceptualized. Complexity in terms of who researchers include when studying "the public", how researchers describe shale gas exploration activities (shale gas, hydraulic fracturing, fracking, exploration, extraction) and what precise terminology researchers are using in their studies of public responses to the practice (perceptions, attitudes, discourse, rhetoric, meaning, acceptance, support, framing) not only muddy the waters concerning understanding of the issue, but likely have unintended influence on the subsequent research findings. This means that thinking critically about what terms are used and how is an essential part of research design and data collection, analysis and interpretation. It can present a dilemma for researchers studying the issue as a choice must be made between using scientifically correct terminology, such as 'induced seismicity' or using language that is more readily accessible to the public at large, such as 'earth tremor' or 'earthquake.' For example, while 'induced seismicity' might be seen as industry-friendly language, 'earthquake' connotes an approach more sympathetic to anti-fracking campaigners. Yet, use of the word 'fracking' to describe hydraulic fracturing and shale gas exploration more broadly, while thought to have negative connotations previously in the UK as well in the US, actually seems to have taken on a more neutral interpretation amongst the UK public. Being aware of how framing decisions and word choices might influence research findings and broader discussions of shale gas exploration differently across time and context is crucial for researchers (as well as policymakers) in terms of research design and interpretation and application of study findings.

6. Public support or objection to shale gas extraction in the UK

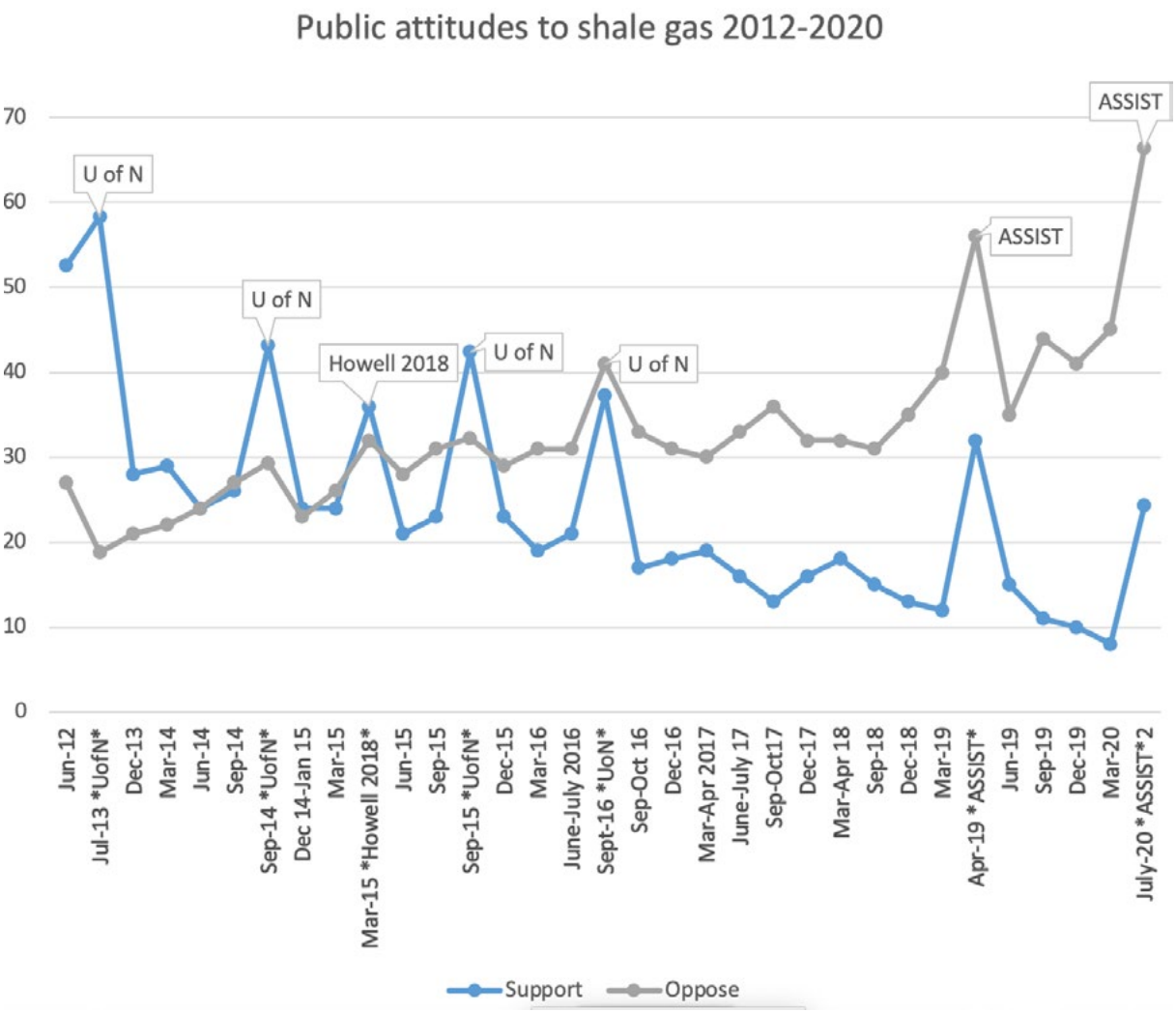
When considering how shale gas extraction is talked about in British society, other important questions arise. Where does public opinion on it fall? And has this changed over time? As with the data on public awareness described in Section 4, comparison of findings between studies is not straightforward due to different methods used. The studies differ in numerous ways: how questions are worded, how many response options are provided and how many questions were used. Generally, in survey research, use of multiple questions with multiple response options is considered more reliable than use of a single question with yes/no/don't know response options (De Leeuw et al. 2008). The ASSIST surveys are distinctive in using a combination of 7 separate questions to measure public support for shale gas, based on statistical analyses showing a high level of between-question correlation and hence validity (see Box 3).

In December 2013 the BEIS PAT began to include a direct question about public support for shale gas (see Box 3). At the time, there was more public support for shale gas exploration (28%) than opposition (21% see Chart 2). Yet by June 2014, this was no longer the case. **Opposition to shale gas exploration has increased steadily since 2014 while support has more or less steadily declined (see Chart 2)**. In the March 2020 BEIS PAT (wave 33), 45% of participants indicated opposition to fracking with support dropping to 8%. These numbers mark the highest degree of opposition and lowest degree of support recorded by the survey to date. **However, the percentage of respondents who do not support or oppose the practice remained the same at 45%, suggesting that many in the public do not have a strong opinion on the issue**, despite extensive media coverage of the issue.

Box 3: Summary of shale gas support and objection questions and findings in UK national surveys

National Survey	Question(s)	Survey Date	Results
Andersson-Hudson et al. 2016	Should shale gas extraction be allowed in the UK? (Yes, no, and I don't know)	Sept 2014	43% support, 29% oppose, 28% 'don't know'
Howell 2018	Would you say you are generally in favour or opposed to fracking for shale gas taking place (a) in Britain; (b) within 10 miles of your home? (Strongly in favour, In favour, Opposed, Strongly opposed, Don't know/ Not sure).	March 2015	32% oppose, 36% support
ASSIST Wave 1	(1) If the UK continues to use gas in the future to generate heat and electricity, to what extent do you support or oppose each of the following options for how we obtain that gas? Shale gas extraction ('fracking') in the UK (Strongly oppose, Moderately oppose, Slightly oppose, Slightly support, Moderately support, Strongly support, Don't know) (2) Please indicate the extent to which you support or oppose shale gas extraction in each region of shale gas licences. (Five UK regions coloured in on map, response options include: Strongly oppose, Moderately oppose, Slightly oppose, Slightly support, Moderately support, Strongly support, Don't know) (3) Irrespective of whether you live near any of the coloured areas , would you support or oppose shale gas extraction in your local area (i.e., within 3 miles of your home): (Coloured areas refers to regions in the previous question, response options include: Strongly oppose, Moderately oppose, Slightly oppose, Slightly support, Moderately support, Strongly support, Don't know).	April 2019	56% oppose, 32% support, 12% don't know
BEIS PAT Wave 33	From what you know, or have heard about, extracting shale gas to generate the UK's heat and electricity, do you support or oppose its use? ('Strongly support', 'Support', 'Neither support nor oppose', 'Oppose', 'Strongly oppose', 'Don't know/no opinion')	March 2020	45% oppose, 8% support, 45% neither support or oppose
ASSIST Wave 2	Same wording as ASSIST Wave 1 above	July 2020	66% oppose, 24% support, 29% don't know

Chart 2: Public support of shale gas exploration in the UK over time (with non-BEIS surveys highlighted)



Data from the University of Nottingham study (Andersson-Hudson et al. 2016) reflect much higher levels of support for shale gas exploration than the BEIS PAT, though it follows a similar trend over time as public support for shale gas has decreased and opposition has increased. Disparity in data between this and the BEIS PAT could be related to differences in what question was asked to gauge support, as well as the different response options (see Box 3). While individuals may not support shale gas per se, they may believe there is no legal reason it should not be allowed, hence leading to higher support when the question is framed as it is in the University of Nottingham survey.

In 2015, Howell (2018) found that 36% of respondents supported shale gas exploration, while 32% opposed it. In addition, the researchers evaluated participants' responses to positive and negative statements about shale gas (the same statements used in a May 2014 Opinium poll). Levels of support were strongly correlated to respondents' opinions on positive and negative statements related to fracking, that is, those who agreed with positive statements about shale gas exploration were likely to express support for shale gas and those who opposed shale gas were likely to agree with negative statements about it. Those less informed on the topic more frequently agreed with negative statements about shale gas, yet those who could correctly identify shale gas in the survey were not necessarily more likely to agree with positive statements about it. More knowledgeable respondents were more likely to hold more polarized views on both ends of the support/opposition spectrum. This finding aligns with other research that suggests initial scepticism about shale gas (Partridge et al. 2017; Thomas et al. 2017b; Williams et al. 2017) as well as the development of more negative beliefs about shale gas exploration when educated further on the topic (Evensen 2017). This survey also gauged whether support would differ if a project were proposed near a respondent's home (i.e. within 10 miles). Analysis indicated that shale gas received substantially less support when extraction was hypothetically situated near their local community. Despite the observed downward trend in public support for shale gas, there remains ambiguity regarding public attitudes

toward shale gas. However, the ASSIST project has reduced some of the unknowns, providing greater evidence for a decline in support for shale gas over time. As mentioned above, the ASSIST project collected data on public awareness of and support for shale gas using two waves of national survey data collected in April 2019 and July 2020. In addition to this survey relying on the same set of respondents, this study developed a more complex measure of shale gas support, based on a composite index of 7 different questions to create a more reliable measurement tool (see Box 3). Taking the average of these questions reduces measurement error and provides a more reliable measurement than relying on a single question or statement. With this measure, a much larger proportion of the survey sample could be categorized as either in support of or opposed to shale gas.

In 2019, 56% of participants opposed shale gas extraction, 32% supported it and 12% indicated 'don't know'. Support had further decreased in 2020 as only 24% supported shale gas, while 66% reporting being against. In addition, the number of participants reporting that they 'don't know' decreased in 2020 to 9%. These findings, which show more negative perceptions over time, must be understood within the context of two societal changes occurring between April 2019 and July 2020: (i) the moratorium on shale gas in England, which was justified by policymakers in terms of the difficulty of extracting shale gas in a safe and sustainable manner; and (ii) the COVID-19 pandemic, which has it's own implications for risk. Future analysis should take these events into consideration when examining changes in public risk perceptions of shale gas.

Finally, some research has focused on whether levels of public support and opposition to shale gas exploration varies sub-nationally by region, including in areas where shale gas exploration projects have been proposed. Whitmarsh et al. (2015) focused on regional samples, comparing residents between areas with and without prospects for extraction. This research revealed respondents in an area with potential for extraction (Lancashire) were more supportive than respondents in areas without viable shale resources. Given Howell (2018) found that respondents were less supportive of the (hypothetical) idea of exploration within 10 miles of their home, this seems surprising. Yet, in both 2019 and 2020 ASSIST surveys, no significant differences in shale gas support were found between different regions or countries of the UK. The limited nature of these data provide clues, but not a robust understanding of if and how public support for shale gas varies across regions in the UK.

When we take these findings altogether, it suggests that public support in the UK has been in, and continues to, decline - though there remains a significant minority who are undecided on the topic. So, while there appears to be deeper entrenchment and growing opposition to shale gas, there also remains some portion of the public that knows very little about it and has remained consistently uninformed and/or unengaged on the issue over the last eight years.

7. Explanations for support and objection to shale gas exploration in the UK

Since 2015 the BEIS PAT has asked respondents to explain why they support or oppose shale gas exploration. Those who support the practice have more or less consistently cited the need to use all available energy sources as the most frequent reason they support it. Yet the need to reduce our dependence on other fossil fuels and the need to reduce our dependency on other countries for UK energy supply have also been cited frequently since 2015 and both are trending upward. In March 2020, the concern for reducing dependence on other fossil fuels was cited almost as frequently as the need to use all energy options, while the desire to reduce foreign dependence has fluctuated throughout. Those who opposed shale gas extraction have consistently cited loss or destruction of the natural environment as their most frequent concern. However, since September 2018, the second most cited reason in the BEIS PAT has been risk of earthquakes. It is essential to keep in mind, however, that like previous research on public perceptions of shale gas (Evensen 2018), the potential social impacts of fracking were not provided as options they could select for why they opposed it.

In the ASSIST 2019 survey, 57% of respondents believed that it was either 'somewhat' or 'very likely' that seismicity from shale gas exploration could cause surface damage. There is, therefore, evidence to suggest that the perceived risks posed by shale gas exploration have increased over time, perhaps connected to the August 2019 seismic events at the Preston New Road site, associated media reporting and the UK government's narrative for the 2019 moratorium in England. Unsurprisingly, the ASSIST 2019 survey also found that 48% of respondents were opposed to any relaxing of the seismic threshold at which hydraulic fracturing by operators must stop, although some independent scientists, as well as industry operators, have complained that the level is set so low it hinders the ability for the shale gas industry to develop and grow. Taken as a whole, the reasons for supporting or opposing the practice emerging from this research suggest the public has environmental concerns about shale gas exploration, both in terms of how it might positively and negatively impact the environment and climate change. Interestingly, support for the practice was not primarily rooted in economic

reasons as other literature on discourse (see Howell 2018 and Section 5 above) has tended to find.

Across these surveys, we tend to see the same factors emerge repeatedly as associated with support and opposition: those who express support for shale gas are more likely to be male, to vote for the Conservative Party, to associate shale gas with clean energy, cheap energy, and energy security; those who express opposition have strong environmental values, associate shale gas with water contamination, earthquakes, and increased greenhouse gas emissions. Another factor that may influence support for shale gas is the degree to which people trust particular institutions and organizations, the information they produce, and the decisions that they make on the issue. Research in the United States has shown strong differences in the public's propensity to trust various institutional actors communicating about shale gas, suggesting value in obtaining UK-specific data on trust in relevant actors who share information. The ASSIST project found that only 12% of respondents trust industry groups. Government regulators were trusted at a much higher degree (42%), but were not as trusted as much as university scientists (59%) or the British Geological Survey (BGS) (61%). This suggests the public has very little faith in the shale gas industry, but also reflects that less than half of the public trust the government on this issue as well. Trust issues may very well be tied to concerns about fairness in the procedural and distributive sense described above.

Procedural concerns about the role afforded to the general public in decision making and distributive concerns about unequal exposure to risk across areas and populations have motivated opposition and activism (see Beebeejaun 2017; Harthorn et al. 2019; Szolucha 2018; Thomas et al. 2017a & 2018; Williams et al. 2017). A lack of trust in industry, government, and publicly available scientific information, alongside a questioning of the purported benefits of shale gas also contributed to public scepticism of the necessity for shale gas in the UK (Partridge et al. 2017 & 2019; Thomas et al. 2017a & 2018; Szolucha 2018; Williams et al. 2017).

8. Research gaps

This review highlights what we know about public perceptions of shale gas. Yet it also reveals that much remains that we do not know. We know almost nothing about how mass media, political commentary, industry positions, environmental and anti-shale group communication, and further access to information on the topic generally might affect public perspectives on shale gas development. We also understand little about the degree to which members of the public rely on these groups or other outlets to obtain information on shale gas. Initial findings from the 2019 ASSIST survey suggest that the primary reported sources for information on the topic were (in order) environmental non-governmental organizations (48%), local or national television (44%), citizen action groups (40%) and broadsheet newspapers (36%). Further research underway by the Unconventional Hydrocarbons in the UK Energy System programme Challenge 5 social science projects will continue to help us determine not only where people get their information, but how the framing of the information across these sources might impact public perceptions of shale gas exploration. Additional work could be useful in revealing communication and knowledge gaps on this topic and effective approaches to communicating about shale gas. For example, what role is played by social media (e.g. Twitter) in shaping public support for shale gas? As highlighted earlier, the substantial percentage of UK residents who are undecided or uncommitted on shale gas suggests both the value and potential effectiveness of additional communication - if coming from trusted sources and speaking to issues relevant to these audiences.

Beyond content-specific gaps in knowledge, the strong attention to public perceptions and societal discourse at the national UK level highlights the lack of knowledge about variations in perceptions of shale gas across space and scale. How do shale gas attitudes evolve over time in the same individuals and in response to societal events? The ASSIST surveys have begun to shed light on this with the same respondents (i.e. a panel design) reporting their perceptions of shale gas across a multi-year study. How do public attitudes relate to objective and subjective/psychological proximity to shale gas exploration sites? Further, how do findings on public perceptions compare across geographic scales? A few UK studies are situated in specific, locally-defined, geographic areas (Harthorn et al. 2019; Partridge et al. 2017, 2018 & 2019; Thomas et al. 2017a & 2018; Williams et al. 2017), but none of these compare across geographic scales (e.g., local, regional, national) within the UK. While some studies have compared the above data to research in the US (see Evensen et al. 2017; Stedman et al. 2016), a valuable direction for future inquiry in the UK would be a single study that systematically compares perceptions, knowledge, communication, rhetoric, and/or policy processes across local and national scales. Crucial questions in studying shale gas across scales include: How do the factors affecting support and opposition differ at each level? Which arguments and rhetorical devices are used at each scale; do they differ? Are the procedural and distributive justice concerns the same across geographic scales? To what degree do public attitudes connect to and influence public policy decisions about shale gas?

9. Conclusion: Implications for policy and future research

Over the last eight years, much has been learned about public perceptions of shale gas in the UK. Today, we see consistently high levels of awareness of shale gas exploration and a continued decline in public support since perceptions began to be tracked in 2012. Yet there is still a relatively large segment of society that has consistently remained undecided on the issue. There remains little evidence that opinions on shale gas vary across different geographical regions, though there is some evidence that individuals are less supportive of shale gas if it is proposed relatively close to their home. It remains unclear what the relationship is between awareness of shale gas and support or opposition to it, and the degree to which the framing of the issue influences public opinions of the practice also requires more research. What is clear is that society seems to be made up of three distinct and to some extent polarised groups – supporters, objectors and the undecided. Primary reported concerns for shale gas are induced seismicity and earthquake damage, yet broader environmental concerns such as degradation and climate change are also regularly expressed. As mentioned, research shows that environmental reasons are cited by both supporters and objectors to shale gas. Primary reasons for support include the need to use all energy sources, the reduction of dependence on other fossil fuels, and a reduction of dependence on other countries for the UK energy supply.

Research reveals public concern about fairness in decision-making. If, as some authors contend (Bomberg 2017a & 2017b; Stephan 2017; Williams and Sovacool 2019), the focus on procedural justice and local democracy has increased in shale gas discourse over time, this suggests more of a demand for meaningful local governance and community engagement. This seems particularly important given that that there remains a lack of evidence that increasing awareness of shale gas leads to increased support, nor has a focus on 'educating' the public (Thomas et al. 2017a) or highlighting economic incentives (Howell 2018; ASSIST 2019) generated more support for the practice. Given these have yet to be demonstrated as effective in the context of shale gas, looking forward to future energy projects policymakers and industry operators can respond to these research findings by creating spaces for information sharing and collaborative decision-making with the public, particularly those in potentially impacted communities. This may increase perceptions of trust and a sense of fairness and justice in decision-making. Furthermore, government and industry could strive to meet a community's standards for what constitutes sufficient reception and response to their legitimate concerns, drawing on frameworks of procedural justice and social acceptability (Andersson-Hudson et al. 2019; Batel et al. 2013; Hall 2014a & 2014b).

As new climate-friendly energy projects are needed to reach net zero emissions, appropriately involving the public and addressing their concerns will be essential for creating an energy system that faces less resistance. As such, it is critical that the government take public concerns into consideration when forging future energy policies—something the literature above suggests has been lacking in the context of shale gas. Rattle (2018) suggests that in cases of local resistance, power dynamics tend to continue to favour the national government, which does not incentivise sufficient public or community engagement. A re-thinking of these processes and practices from a fairness and justice framework is needed, and it must involve the government and other actors thinking more critically about who constitutes 'the public' and where efforts to incorporate public opinion should be focused in decision-making across different regions, from the local to national level, and/or across time. While more research can be undertaken to examine and verify the causal links between public perceptions and responses to shale gas extraction, existing research could be better integrated into public policy decisions for shale gas and future renewable energy projects.

Because actual shale gas extraction has been so slow to occur, strong factions and discourse coalitions have become entrenched. Nevertheless, with the 2019 English moratorium on shale gas in place, a potential shift in perceptions, relevant actors, and key topics of discussion in relation to shale gas could be imminent. This has relevance not only to the future role of gas in the UK energy system, but for climate emergency activism more generally and the narrative to 'keep fossil fuels in the ground'. Another policy development that will invariably impact perceptions of and discourse about shale gas, but in unpredictable ways, will be BREXIT and associated economic impacts. We still have very little concrete understanding of how public support for shale gas, along with other energy policies or energy market transactions, will be impacted by these developments and in what ways.

Finally, an open question is whether the COVID-19 pandemic influences public perceptions of shale gas. One key issue is whether risk perceptions associated with shale gas extraction change in response to risks posed by the pandemic. Another issue is whether shale gas is consistent with economic recovery strategies. Evidence from the UK Climate Change Citizens Assembly (2020) indicated that 79% of assembly members 'strongly agreed' or 'agreed' that, "Steps taken by the government to help the economy recover should be designed to help achieve net zero", including putting in place policies to limit or constrain investments in high-carbon industries. Since shale gas exploration and policy is situated within the contexts of larger societal events including BREXIT and COVID-19, it suggests we may see new

public perceptions about energy and shale gas exploration emerge across the period of 2020-2022. How exactly public perceptions will change will depend in part on the government and industry efforts moving forward from here, including the degree to which government and industry make efforts to meaningfully engage the public in decision-making processes. Research already underway is well positioned to track these movements and the subsequent outcomes for public support for shale gas.

About the Authors

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Patrick Devine-Wright is an environmental social scientist with a primary interest in social acceptance of energy transitions, community engagement and place attachment. With expertise spanning human geography and environmental psychology, he was cited in the top 1% of social science scholars globally by Web of Science in 2019 and 2020. He is an IPCC Lead Author on social aspects of climate change mitigation, member of the International Energy Agency's Task 28 on social acceptance of wind energy, Chair of the Devon Net Zero Task Force, sits on the National Advisory Group for EirGrid, the Irish electricity grid operator, and is a non-executive Director and former Chair of Exeter Community Energy.

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