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Seeing futures now: Emergent US and UK views on shale development, climate change and energy systems

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ABSTRACT

Shale development – extraction of oil and gas from shale rock formations using hydraulic fracturing or 'fracking' – has become a critical focus for energy debates in the US and UK. In both countries, potential industry expansion into new areas for shale extraction is expected to produce a wide range of environmental and social impacts and to change the configuration of future energy systems. To engage with emergent views on these complex, multi-scale issues, we held a series of day-long deliberation workshops (two in the US and two in the UK) designed and facilitated for diverse groups of people to discuss a range of possible consequences and meanings of shale development. Amid nuanced differences between and within national contexts, notable similarities in views were tracked across all four workshops. Concerns in common were not limited to specific risks such as water contamination. Participants also questioned whether shale development was compatible with their visions for and concerns about the longer-term future – including views on impacts and causes of climate change, societal dependency on fossil fuels, development of alternative energy technologies, the perceived short-term objectives of government and industry agencies, and obligations to act responsibly toward future generations. Extending prior qualitative research on shale development and on energy systems change, this research brings open-ended and cross-national public deliberation inquiry to bear on broader issues of climate change, responsibility, and ideas about how shale development might undermine or reinforce the energy systems that people consider important for the future.

1. Introduction

Fossil fuel extraction from shale rock using processes of hydraulic fracturing (or 'fracking') has increased significantly in recent years. This has created a range of measurable impacts at local, regional, national and global levels (Willow, 2014). The US has become the world's largest producer of oil and gas (EIA, 2015), and governments elsewhere, including the UK, support shale development within their energy policies. Widespread changes that shale development introduces affect energy systems, defined as the material and social infrastructures involved in energy generation, distribution and consumption. Since energy systems interact with industrial processes such as manufacturing and agriculture as well as with ecosystems, shale development also has consequences for global climate change (Levi, 2013). Energy systems underpin many technological arrangements, forms of social organization, and environmental practices in industrial economies (Miller et al., 2013) and so the actual and potential changes introduced by shale development are wide-ranging, as are public responses to them.

Surveys have broadly gauged changing levels of public support for and opposition to shale development in both the US (Clarke et al., 2012) and UK (O'Hara et al., 2014). However, these studies have not yet fully explored the concerns, values and imagined futures that influence views on shale development and energy systems more broadly (Demski et al., 2015). Addressing such gaps, the research presented here is based on a series of public deliberation workshops held in the US and UK – designed and facilitated for diverse groups of people to learn about and explore

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through open-ended group discussion a range of possible consequences and meanings of shale development that go beyond the tangible health, economic and environmental effects addressed in survey research. Much previous public participation research on environmental decision making has focused on local issues (Dietz, 2013), but climate change and energy system change operate across multiple temporal and geospatial scales and have similarly wide-ranging effects on social, economic and environmental relations (Ostrom, 2010; Jasanoff and Kim, 2013; Pidgeon et al., 2014). Through multi-sited, deliberative research we bring public deliberation techniques and inquiry with their special capacity to illuminate emergent views to bear on diverse views on these complex, multi-scale issues in locations with distinct histories, priorities and socioecological conditions.

The US and UK share important similarities and differences that contextualize this research. Miller et al. (2013) argue the broader social consequences of energy system change have been systematically underemphasized in US energy debates, including in reports from the Department of Energy (DOE, 2011) and the National Academies on *America's Energy Future* (e.g. NRC, 2008; NAS, 2009). Similar observations have been made of UK energy debates (Butler et al., 2013). Both countries have also historically shared comparable degrees of dependency on fossil fuels for electricity generation (DECC, 2016; EIA, 2016) and today face similar pressures to develop shale oil and gas reserves (Thomas et al., 2016). However, shale extraction in some US states is an established industry, while in the UK it is still at an exploratory stage (Hawkins, 2015). We suggest these variations make shale development a "liminal" case for deliberation and discuss the implications this has for deliberative research. Further critical differences between the two countries in science values (Gaskell et al., 2005), attitudes toward precaution about risks, climate change beliefs (Capstick et al., 2015), deliberative processes and risk controversy histories (Jasanoff, 2005; Pidgeon et al., 2009) provide a compelling basis for studying public deliberation across these different contexts.

Shale development has become an important case in which critical US and UK energy debates are played out, and scholars in both countries have identified the need for analyses of the social context and impacts of energy system change (Hess, 2013; Laird, 2013; Parkhill et al., 2013a; Pidgeon et al., 2014). Such analyses require research that considers shale development in national and global contexts without restricting focus to specific locations and localized impacts – as has been the focus of much qualitative work in the US (Thomas et al., 2016). In this paper, we ask how people in small public deliberation groups across multiple US and UK locations form or refine views on shale development and associated near- and long-term impacts when considered as part of larger energy systems. We examine these emergent views in the context of broader discussions on: tensions between immediate interests versus longer-term concerns (Groves, 2014); dependency on fossil fuels (Demski et al., 2015); and questions about individual, collective, industry, and governmental responsibilities for changing energy systems to address long-term societal needs (Leiss and Powell, 2004; Lorenzoni and Hulme, 2009). Our analysis thus extends the focus of qualitative research on shale development from specific perceived risks and benefits to broader issues of responsibility, climate change, and energy-society relations.

2. Background

2.1. Shale development

Shale oil and gas are referred to as *unconventional* fossil fuels because they are located in low-permeability source rock and thus cannot be extracted using methods that drill directly into conventional subsurface resource reservoirs (Stern et al., 2014). Instead, extraction from shale requires a combination of additional technologies, some new and some repurposed. These include high-volume, high-pressure hydraulic fracturing in which fluid and fine-grain sand are injected to open fissures in the shale in order to access the oil and gas it contains (CCST, 2015). Other technological advancements that have facilitated the expansion of shale development, particularly in the US, include the ability to drill horizontally for distances of up to two miles and seismic imaging of deeper subsurface areas (Maugeri, 2013). Government investment and fluctuations in global resource markets have played key roles in enabling these developments (Trembath et al., 2012). At the same time, concerns are emerging regarding the social and environmental consequences of extracting these previously inaccessible and relatively abundant fossil fuels (Hughes, 2013; Davis and Fisk, 2014), raising critical issues related to economic growth (including job creation), environmental impacts (such as water contamination), climate change and energy systems (Boudet et al., 2013; Demski et al., 2015).

The processes and technologies associated with shale gas and oil extraction by hydraulic fracturing which here we refer to as "shale development" are more commonly identified in public and political spheres as "fracking." We note that no single term is sufficient to capture all associated phenomena (Evensen et al., 2014) and that in US survey research "fracking" has been linked more to negative associations than "shale gas development" (Clarke et al., 2015). In contrast to such survey research, however, our deliberative conversations principally addressed in detail many aspects of "shale oil and gas extraction," from the formation of unconventional shale resources and some of the technical procedures involved in their extraction, to the range of associated social and environmental impacts. During these conversations, "fracking" would sometimes emerge as a shorthand term used by both participants and researchers. In the workshop protocol, however, we explicitly used "shale gas and oil extraction" as the primary focus for our discussions and informational materials, and our pre- and post-survey questions consistently used the phrase "hydraulic fracturing ('fracking')," partly in response to our expert reviewers' expressed pReferences

2.2. Public views on shale development

Research to date demonstrates that public views on shale development vary significantly both within the US and elsewhere (Graham et al., 2015; Thomas et al., 2016). Nationally, US surveys have found widespread unfamiliarity and uncertainty about whether to support or oppose it (Clarke et al., 2012; Boudet et al., 2013; Borick and Clarke, 2016), changing to greater awareness and more emphatic views, both for and against, in areas where shale development is underway (Lachapelle and Montpetit, 2014; Kromer, 2015). In states such as Pennsylvania that have seen significant shale extraction operations, studies have found social conflict amid polarized views on local drilling (Schafft et al., 2013; Jerolmack and Berman, 2016). In other areas, often those marked by prolonged rural poverty (Simonelli, 2014), 'pro natural gas' activism linked to the economic benefits of shale extraction has emerged in direct conflict with proposed state-wide bans in New York (Colosi, 2015). In addition to factors such as proximity, familiarity, and socio-economic status, studies have identified views on shale development are also influenced by political ideology, environmental values, gender, worldviews and media use (Boudet et al., 2013). Meanwhile, UK polls have found fluctuating levels of support and opposition, influenced both by US experiences (Mazur, 2014) and high-profile protest events (O'Hara et al., 2013, 2014). The best summary appears to be that social and ecological impacts of shale development are contested, and public

opinion remains divided both in the US and elsewhere (Clarke et al., 2015).

Qualitative studies on societal responses to shale development have tended to focus on directly affected communities and on how governments have framed the issues. Recent UK-based deliberative research on prospective shale development has highlighted public mistrust of decision-making processes (TNS BMRB, 2014) and the misalignment of dominant institutional framings which focus on safety and feasibility, with those adopted by UK publics which emphasize precaution (Williams et al., 2015). US-based focus groups research located in areas near intensive shale development has identified concerns about the longevity of extractive operations with a focus on community change, effects on agriculture, and localized health and environmental impacts (Schafft et al., 2013; Brasier et al., 2014). Many US and UK government and industry representatives have interpreted public concern as a lack of understanding about such documented impacts and risks – a stance that these studies criticize (Israel et al., 2015; Williams et al., 2015). However, following energy futures research that studies views on trajectories of social and environmental change in addition to more immediate issues of governance and particular socio-environmental impacts (Parkhill et al., 2013a), we also examine participants' imagined futures and longer-term concerns.

2.3. Shale development: a 'liminal' case in deliberation

The status of shale development in the US is considerably more varied than in the UK. Some states have seen significant shale development while in others, including California, onshore extraction from deep shale source rock is still under investigation. Estimated future oil production rates from California's Monterey shale have been high, yet unreliable (Hughes, 2013; CCST, 2015) and extraction will require technological advances to deal with seismic-impacted geology (Beckwith, 2013; Shauk and Malik, 2014). There have also been regional calls for outright bans and stricter state regulations approved in 2013 (Srebotnjak and Rotkin-Ellman, 2014). While well-stimulation techniques are in use in California, the majority of hydraulic fracturing operations are concentrated in the San Joaquin valley away from the coastal zone and are used almost entirely in shallower, vertical wells to access conventional oil reservoirs CCST, 2015, pp. 11–12). However, the experience of shale development impacts elsewhere in the US provided important reference points for participants in both countries. In the UK, shale extraction is not yet in commercial production (Cotton et al., 2014). Recent UK government licensing of land for shale development marks potential expansion into areas with no previous history of extraction, and this has led to localized opposition and national media amplification (O'Hara et al., 2014). In these changeable contexts, our cross-national approach enables analysis of data on US and UK views gathered in workshops that ran concurrently.

Although not part of a formal process of citizen participation, conceptually and methodologically this research draws on ideas of upstream public engagement: deliberation that opens up innovation processes to include public knowledge and reflection while policies and priorities are still being established (Wilsdon and Willis, 2004; Stilgoe et al., 2006; Rogers-Hayden and Pidgeon, 2007; Macnaghten, 2010; Owen et al., 2013). Participants are invited not to passively receive information but instead to discuss open-ended questions (Corner and Pidgeon, 2012), ideally within ongoing, relational processes of dialogue (Wynne, 2007; Chilvers and Kearnes, 2016). In the UK, following breakdowns in engagement efforts around GM crops, nanotechnologies became the test case for upstream engagement (RS, 2004; Pidgeon and Rogers-Hayden, 2007). This occurred before significant research and investment decisions had been made and thus when those decisions could in principle be redirected toward alternative trajectories (Wilsdon et al., 2005).

In the US, similar approaches have been developed in public deliberations on nanotechnologies (Pidgeon et al., 2009; Rogers-Brown et al., 2011; Harthorn et al., 2012a), and other models for dialogue between scientists and publics include Real-Time Technology Assessment (Guston and Sarewitz, 2002). The upstream metaphor is also applied to early stages of public awareness – where views are emergent (Rayner 2004; Satterfield et al., 2009, 2012) and before technologies are widely associated with established social representations (Pidgeon and Rogers-Hayden, 2007). The meaning of 'upstream,' however, is simultaneously contested by some proponents who criticize its implicit linear view of innovation, highlighting instead the dynamic, multiple ways in which technologies and societies interact with one another in the innovation and development process (Wilsdon et al., 2005; Rogers-Hayden and Pidgeon, 2007).

We located our workshops in places where shale development is still anticipated and largely unfamiliar to publics – contexts that typically generate upstream deliberative discussion on the broader visions, values and societal purposes of innovation and technology (Wilsdon et al., 2005). However, in other locations, shale development has already been implemented at scale with many of its tangible impacts already in evidence. As such, it also invites discussion of typically downstream issues of risk, harm, safety and control. We suggest that shale development is thus a *liminal* case for deliberation, following definitions of liminality as a domain "betwixt and between" established categories or definitions, where meanings about cultural objects and phenomena are disrupted and are characterized by ambivalence (Turner, 1967). By displaying characteristics of models of participation and governance that might otherwise be categorized as either anticipatory/upstream or reactive/downstream (Bosso, 2016), and by engaging publics with issues linked to both upstream and downstream contexts, shale development is a case unlike those previously addressed in upstream public deliberation. In particular, the *liminality* of shale development as a deliberation subject draws attention to the varying importance of concerns across different social and geographical locations – similarities and variations in public responses that this research examines. This liminal case also highlights the need for deliberative processes to address not only *what* is discussed and *when* but also with *whom* and *where* participation takes place.

2.4. Shale development, climate change and energy systems

In recent US Department of Energy reports, "energy systems" have become the explicit focus of research and policy that takes a "holistic view" of energy in interactions between the electric and natural gas grids, manufacturing, transportation, finance, and food, as well as water supplies, ecosystems and the global climate (DOE, 2015). Climate change in particular is implicated because shale development has not only increased US fossil fuel production, it has also introduced new options for the design of energy systems around the world, raising questions about how nations might successfully meet their own greenhouse gas reduction targets (Ciplet et al., 2015). In this context, advocates and opponents of shale development hold opposing views on the relationship between US shale extraction and climate change mitigation. Advocates in both countries argue that widespread US shale *gas* extraction has generated significant economic benefits *and* has reduced greenhouse gas emissions by reducing reliance on coal (Stern et al., 2014), describing natural gas as a "bridge fuel" to meet emission reduction goals (Levi, 2013; Sovacool, 2014). Replicating these shifts offers the UK government one route toward meeting short-term, legally binding carbon targets (HL-EAC, 2014).

However, recent research has called into question the projected climate benefits of natural gas from shale, given the high global warming potential of methane – the major component of natural gas – and widely varying estimates of methane leaks and emissions from shale extraction processes (Brandt et al., 2014; Schneising et al., 2014). Other studies suggest that post-2007 reductions in US emissions were largely driven by economic recession, not by substituting natural gas for coal in energy generation (Feng et al., 2015). Opponents also argue that shale development exacerbates the effects of climate change by increasing global fossil fuel production and dependence (Broderick and Anderson, 2012; Stern et al., 2014), potentially delaying both a transition to renewable energy sources and a reduction in overall consumption (Broderick et al., 2011; McGlade et al., 2016). Our project addresses the need for more qualitative research on concerns that have arisen around shale development in relation to such complex and contested issues as climate change and energy system change (Miller et al., 2013; Demski et al., 2015). This paper examines how public views on these issues are formed and articulated among diverse deliberative groups in the US and UK. We held open-ended

Pre-workshop survey
- Two-page pen and paper survey consisting of 11 questions relating to familiarity with and feelings about hydraulic fracturing for shale gas and oil.

40 mins: Introductions, ice-breakers and top-of-mind associations
- Welcome, introduction to the research team and project, ice-breaking, house-keeping. Followed by top of mind associations for five terms: Hydraulic fracturing 'fracking'; Technology; Energy; Environment; Climate change.

50 mins: Presentation and discussion
- 20-minute PowerPoint presentation including: an animation describing differences between conventional and unconventional oil/gas, how shale gas and oil are formed and how they are extracted by hydraulic fracturing; global, national and local shale development past and future; government and industry guidelines; overview of national energy sources and uses. The presentation was followed by a whole-group discussion.

75 mins: Advantages and disadvantages poster task
- Half of the group discussed a poster about potential advantages of shale gas and oil extraction, and the other half a poster about potential disadvantages (see *Supplementary Material*). The posters contained six advantages/disadvantages, each supplemented by a card containing more information. Participants were asked to a) stick a 1, 2 and 3 on the three advantages/disadvantages that they thought were most important and b) stick comments or questions to the posters. The groups then swapped to do the same with the other poster. Followed by whole-group discussion.

30 mins: Quotes task
- In half-size groups, participants were presented with 17 quotes attributed to different types of sources (industry spokesperson, commentator, scientist, politician, protester, public, non-governmental organization). Participants were asked to read the quotes and to comment on them (including whether they agreed/disagreed, how it made them feel, and whether they thought the quote reflected many peoples' opinion).

50 mins: City Council game
- Again in half-size groups, participants were asked to assume the role of city council members for a fictional town 'Salston'. They were provided with information about Salston, and presented with six energy development proposals for the town (shale gas, shale oil, nuclear, wind, coal and solar) with a map and information about each (e.g., number of jobs provided, monetary incentives, contributions towards climate change targets). Participants ranked the proposals in order of preference, first individually and then as a group; and were also asked to discuss any questions, comments or conditions that they had for the energy companies.

65 mins: Final discussion, reflections, feedback and wrap-up
- Members of the research team provided feedback from each City Council game group to stimulate discussion.
- Whole-group discussion around risks, benefits and trade-offs, responsibility, values and governance, trust, deliberation and the role of emotions in decision making.
- Wrap up discussion: questions and comments about the workshop, debrief and further project information.

Post-workshop survey
- Seven-page survey consisting of 35 questions. The first three questions were repeated from the pre-survey to chart how attitudes may have changed during the course of the workshop. These were followed by nine questions asking about thoughts on fracking (e.g., risk, benefit, trust in corporations and government). Next, an 'about you' section asked questions relating to values and world views, as well as demographic items such as age, income and educational level. Finally, participants were asked to provide an evaluation of the workshop.

Fig. 1. Workshop format.

deliberative conversations to explore these issues, and our research methods and materials were designed accordingly.

3. Methods

We conducted four one-day deliberative workshops in cities selected to represent two major population centers (Los Angeles; London) and two smaller coastal cities (Santa Barbara; Cardiff) located in areas not yet directly involved in deep shale extraction activities and hence not expected to have experienced significant risk amplification or attenuation (Pidgeon et al., 2003). The study is based on techniques used previously by our research team leaders to enable comparisons between public discourses on emergent technologies in different national contexts (Harthorn et al., 2012b; Pidgeon et al., 2009). These deliberative research contexts bring together members of the public in conversation on topics that may be unfamiliar, providing space to respond to new ideas and information – a mode of qualitative inquiry deployed widely deployed in northern Europe (Chilvers, 2010; Corner et al., 2013; Bellamy and Lezaun, 2015) and which has made substantive contributions to public engagement processes (Parkhill et al., 2013b).

Ranging from 10 to 16 participants (total n = 55), each workshop was facilitated by two researchers with two additional team-members as assistants. The protocol was designed to provide a progression of different ways to approach the issues (see Fig. 1): (1) free association responses to key terms; (2) a PowerPoint presentation of uniform technical information, with Q&A; (3) smaller group discussions of projected advantages and disadvantages as described in scientific literature (Advantages: *Energy Supply; Energy Independence/Security; Energy Prices; Economy & Jobs; Climate change; Local Benefits;* Disadvantages: *Water Usage; Water Quality; Earthquakes; Local Impacts; Climate change; Waste & Byproducts*); (4) responses to supportive or critical quotations; (5) ranking proposals for different types of energy systems (in small groups); and (6) a plenary review discussion. Our protocol and elicitation materials are available in Appendix B: Supplementary Material. Following the team's prior research protocols, we also gathered short-form Pre- and Post-workshop survey data from all participants.

Facilitation techniques are key to such deliberative contexts. Our research team members have extensive research experience in focus group methods and open-ended interviewing. We aimed to create discussions responsive to each particular group – not lead seminars – and do so with minimal intervention, for example to encourage full participation or in case of disruptive language or behavior. As in other deliberative group contexts, facilitators were equipped to counterbalance particularly critical views by providing information on benefits, or vice versa – also an efficient means of sharing information and stimulating reflection on how different views had been formed (Pidgeon et al., 2014). This is an advantage of group-based inquiry over other qualitative methods such as one-on-one interviews – that participants have more opportunity to lead the conversation (Gaskell, 2000) and pursue reflective 'system two' thinking requiring time and effort (Kahneman, 2003; Kahan, 2008).

In contrast to focus group research that tends toward shorter durations and homogeneity in group composition (Lehoux et al., 2014), we sought diversity and created day-long discussions in a community setting. To this end we recruited quasi-representative (Pidgeon et al., 2009) groups to match local demographics as closely as possible with regard to age, income, education, occupation, and race/ethnicity, balanced gender, and drawn from different parts of the cities. Despite these efforts, this procedure is unable to control for unpredictable sample attrition, which did result in higher than average levels of education in London, a group that was also less racially/ethnically diverse than our pre-specified sampling quota, and somewhat skewed gender composition of two groups (Santa Barbara and Cardiff). See Appendix A, Table 1 for a summary of workshop demographics.

Recruitment was done through neutral third parties and was topic-blind for discussion of "Technology and Society," seeking a quota sample of 12–15 as a group size suitable for focused discussion, with further interactive conversations when divided into 'World Café' type sub-groups (Pidgeon et al., 2009; Corner et al., 2013). Some scholars question participant selection in terms of representativeness (Flynn et al., 2009), and we note that some potential candidates might have self-selected out (declined to participate due to the stated workshop theme). This however affects virtually all social research, including surveys, and it is a requirement of ethics review committees that candidates have the right to refuse participation at any stage. The quota was designed to prevent skewing of group composition away from community/city norms.

Some scholars also question whether public deliberation groups engage a sufficient number of people (Besley et al., 2008). However, as Corner and Pidgeon (2012) argue, the range of views represented and the opportunity for interaction are also important. Thus while our workshop sampling could not be strictly representative in the statistical sense, we aimed for the qualitative equivalent (Pidgeon et al., 2014): groups including a range of political positions and diverse worldviews, such that participants draw on their own experiences, vulnerabilities and identities (Conti et al., 2011). Our sampling was limited to urban areas of different sizes. Future research could explore views of participants living in rural settings, where some survey research has identified differing levels of support and opposition (Davis and Fisk, 2014). Diverse groups within our city locations were important also because our methodology is designed explicitly to study attitudes as they emerge organically in social interaction and is attuned both to particular socio-political conditions (Macnaghten et al., 2015) and cultural contexts (Felt and Fochler, 2010; Strauss et al., 2013). Analyzing the cultural constructs people use in deliberations like these can further be used to better inform subsequent quantitative work (Satterfield et al., 2000; Henwood et al., 2010; Pidgeon et al., 2014; Harthorn et al., 2016).

Silverman (2007) argues that artificial research interactions produce public views rather than identify them and are too dependent on the materials and modes of facilitation used. However, while facilitator effects are inescapable, we deployed techniques to minimize them and to make them uniform across sites where they might occur. We conducted multiple pilot workshops (two in Cardiff; one in Santa Barbara) to standardize facilitation and assess effects of the protocol – developing a cross-culturally valid protocol used across all sites, with minor variations tailored to localized information on licensing and drilling activity. Based on current peer-reviewed scientific research and in consultation with a panel of five experts in both countries, materials were created by our research team – avoiding use of more accessible, often inflammatory, accounts found in the public domain. We sought a neutral effect of materials by providing a range of information and views and allowing participants to freely select among them. There remains some framing of the issues, of course, and our frames followed from prior research on nano-technologies and energy issues, including: risk and benefit perception in the face of technological change; energy systems; and responsible governance. The term 'energy futures' was absent from our workshop materials and discussions. Although participants were not specifically prompted to think about long-term futures, concerns of this kind were particularly widespread.

With participants' consent, audio and video recordings were made of all workshops, then transcribed using professional

services, anonymized, and checked for accuracy. Guided by the expressed views of participants and following established practices of analyzing qualitative data (Urquhart, 2013), our analysis was thematic and iterative. Through processes of reading and coding, we examined transcripts for the most salient themes. Initial observations were further analyzed in discussion among all research team-members. The resulting extensive data set covered a broad range of themes. Addressing the project objectives of studying shale development in the context of energy system change, here we focus on participants' longer-term views and perspectives, specifically dealing with diverse views on climate change, fossil fuels, and questions of responsibility.

4. Results

4.1. Looking ahead: participant views on climate change, fossil fuels and future generations

Observations from initial workshop discussions provide context for subsequent findings: extensive concern for sustainability and environmental care, and very little skepticism about whether climate change is happening and is human-caused. Each workshop began by fielding free association responses to a series of words and themes, including "Climate Change." In Santa Barbara, participants linked their personal experiences of changing weather conditions to the idea that climate change is real, present and related to a collective need "*to live sustainably*" (Olivia, Santa Barbara [SB]). These initial responses drew attention to a key contextual feature: a severe drought of several years' duration in California was ongoing at the time. In Los Angeles, immediate responses included terms such as "*drastic*," "*unpredictable*" and "*dangerous*," and some people also elaborated on personal experience, e.g., "*in California we don't have seasons anymore – we just stay hot*" (Frank, Los Angeles [LA]). Evidence from the US shows climate change views aligning with increasing ideological polarization (Stern and Kasperson, 2010), so we might have expected to encounter more climate skepticism. However, our groups closely matched California city demographics – Los Angeles, 5/10/1 (Republican/Democrat/None stated) and Santa Barbara, 3/7/5 – and yet just one participant in each of the Californian workshops voiced climate skepticism. We also maintain that political views intersect with many other factors (among them: gender, race, class, education) and, as such, participants speak from multiple identity positions (Alcoff, 2006; Barvosa, 2008).

In Cardiff (CF), terms volunteered in responses to "Climate Change" included *extinction*, *pollution*, *fragility*, as well as reference to both the effects and causes of climate change, including "*rising sea level*" and "*use of fossil fuels*." Again, a minority position voiced by only one person in Cardiff suggested that human influence on the climate was less significant than is claimed. Views in London were generally emphatic about concern for the environment, with no one speaking out against the reality and presence of anthropogenic climate change, e.g., "*We've already got dangerous climate change, haven't we*?" (Marion, London [LN]). Sanvi made explicit links between energy systems and future impacts: "*it's like environmental change, energy, it depends how we use those is going to affect the climate change in the future*" (Sanvi, LN).

Moving on to other segments of the workshop, in the UK, and particularly in our London group, many people voiced support for the national energy system to shift toward renewable sources – emphasizing how fossil fuels are ultimately finite and thus unsuitable as a basis for future energy systems: "*we've only got enough non-renewables or fossil fuels or whatever, to last us a certain amount of years. So does humanity only intend to survive for another thousand years?*" (Bea, LN). A preferred vision was to reduce current dependency on fossil fuels – which for some was a form of "*addiction*" (Paul, LN) – given their finitude: "*it's about cutting down our dependence on something that's* unreliable" (Lois, LN).

In our US workshops, similar ideas about past and present energy policy decisions as being suboptimal were articulated with less direct reference to the unsustainability of fossil fuels and slightly more emphasis on broader consequences of energy use and environmental interactions. For example, Joyce (SB) introduced the idea of humans ideally positioned as "*stewards*" of the natural world, and suggested we have collectively failed to live up to this ideal: "*Everybody needs to do their part . . . I mean we're beyond fortunate with our resources, and we have not been very good stewards of how we use them*" (Joyce, SB).

Also in our California workshops, people described both pervasive dependency on fossil fuels in their everyday lives, and the necessity of moving away from such dependency. Participants' written comments included, "*renewable sources are an ultimate goal*," and "*we need to move away from poisoning our precious environment*." Such moves were seen as not only necessary, but also possible, given the perceived wealth of technological resources available: "*If the United States is so technically advanced . . . we ought to look for other ways to, you know, become less dependent on oil*" (Susan, SB).

In both countries, future generations were mentioned explicitly in descriptions of anticipated negative consequences of contemporary actions. In London, Lois felt that any benefits today from fossil fuel extraction would "*screw the future generations or other countries or even people in my country now but who aren't* me" (Lois, LN) – sentiments echoed in Santa Barbara: "*we're* kind of screwing up collectively the world for the next generation" (Joel, SB). Martha (LA) more than once expanded the scope of the conversation to include "*next generations*," and Ray (SB) imagined being held directly accountable: "*We're* making decisions that are going to affect the planet from now on . . . what are we going to say to the next generations who follow us? We needed the money that bad?" (Ray, SB). For some, a perceived prioritization of the short-term by government and industry reflected preoccupation with the immediate more generally, e.g. "*people don't* see the strategic issues, they only see what's in front of their eyes, most people" (Dennis, CF). This tension between timescales led many to reassess notions of 'progress' (see Section 4.2, below) and to question the longer-term role of shale development in energy systems.

4.2. "Too little, too late" or "like a step backwards"

Facilitators and workshop materials presented expert assessments of climate change as linked to both advantages and disadvantages of shale development. The posters and related information sheets (see Appendix B) were the main tools in initiating these discussions, and in responding to subsequent questions regarding these two apparently contradictory positions. Materials included the statement that burning natural gas produces lower levels of carbon dioxide emissions than coal (per unit of electricity generated) and that this reduction could reduce effects of climate change. However, in all workshops we encountered doubt regarding these projected benefits. For example, Isabel in Santa Barbara said:

> "*I feel like fracking is not really going to have a huge effect on climate change at this point . . . the only way we're* going to minimize [or] reverse climate change is by going to renewable fuels. So I see it as maybe a small step, but I think that we need to make a much bigger step" (Isabel, SB)

Many participants linked climate change effects to the ongoing use of fossil fuels, something they felt urgently needed to be reduced. For example, Andrew in London said that lowering

emissions by replacing coal with natural gas would be doing "*too little, too late*": "*Reducing emissions, I believe, is now too small a step, too late on. Ideally, we want to be cutting them entirely*" (Andrew, LN). Other participants also thought such objectives would be impeded by reduced investment in renewable energy – a potential, indirect consequence of governmental support for shale development: "*the longer you rely on [what] you'*re used to, which are fossil fuels, that kind of [renewable] technology isn't going to be developed" (Laurel, CF). The sense of energy projects competing for finite financial resources in government and science/technology spheres was also expressed in our US workshops, for example when discussing the recent economic failure of a large solar plant in California: "*certainly the technology [is] there. It*'s [just] not subsidized and doesn't have the support that oil and gas has had for years" (Joyce, SB).

Many participants feared current changes to energy systems were insufficiently forward-looking. Shale development was seen as operating on relatively short timescales while renewable energy sources were more enduring. The prioritization of short-term goals by government and industry called some to question whether shale development represented societal *progress* or not:

> "*I find it really depressing that they won't invest in green energy. And the main argument is that it's expensive but there'*s no way that this [shale development] is cheap, and it is such a short-term solution" (Lois, LN)

The perceived short-termism of support for shale development was also critiqued in Cardiff. Jess said that it "*almost feels like a step backwards*" and added: "*[shale development'*s] obviously not renewable. It's only going to last for a certain amount of time . . . they could be developing wind power, solar power . . . rather than trying to look for a quick fix all the time" (Jess, CF).

In subtle contrast to this, US participants raised questions about how the story of shale had been relayed in repeated TV ads and other media. typically exaggerating the merits and obscuring the negative environmental impacts of "clean" natural gas, without comparison to the *cleanest* (renewable) energy sources:

> "*this big impetus toward natural gas . . . I*'m curious about [how] that information was brought forth to the public about how benign and beneficial natural gas was. And it's really easy when you compare it to coal because coal is ugly and messy . . . " (Miriam, SB)

We also encountered doubts in both countries about the trustworthiness of publicly available scientific information on shale development, and concerns that critical information was being withheld. Information might have been "*manipulated*" for public consumption, in order to achieve certain political ends: "*Often we are very much deceived, or there*'s a bit of massaging facts and figures" (Karen, CF). Others suggested that elected representatives and other officials – glossed as "they" – might deliberately conceal pertinent information in order to avoid opposition: "*they don't really want us to be, you know, aware of these things because then we'*re going to question it" (Sally, LA). In addition to issues of trust, these views raised a number of ethical issues concerning different kinds and degrees of responsibility.

4.3. Institutional and individual responsibilities for energy system change

Responsibility for changing energy systems in line with people's desired futures was seen as being differentially distributed among government institutions, industry, and individuals. In both countries, participants expressed concern about what were seen as short-term objectives and the apparent complicity between government and industry driving these. Some expressed unease at the apparent "*rush to frack*" in UK energy policy and at the social and environmental costs of meeting economic imperatives: "*there is a real danger that it's just a dash for cash . . . people are being asked to sort of give up land rights [for] corporate profit*" (Paul, LN).

In the US workshops, participants also expressed concerns about driving factors behind energy policy decisions, suggesting that fossil fuel industry pressure – and actions of "*lobbyists*" in particular – had led to a lack of political support for renewable initiatives. Such influences were seen as having a negative impact on technological change in general, and on the move toward non-carbon energy sources in particular, since energy policy was responsive primarily to economic interests: "*I think of the money in politics and who profits the most from our dependency on oil*" (Joel, SB).

The strength of unwarranted corporate influence on energy system change was described in both countries. In London and Cardiff, the economic interests of oil and "*the big six*" energy companies were thought to be protected at the cost of consumers, and their interests prioritized in energy policy: "*it*'s controlled by the BPs and the Shells of the world . . . if there was no profit in it, they wouldn't bother" (Bryn, CF). In Santa Barbara, the influence of corporations more generally was seen as limiting government support for clean energy:

> "*the government . . . basically just represents the corporations and what they want to do . . . No one says, 'Well, this is what the government should do: let's make the energy that we need for the future now'*" (Ray, SB).

As in other new technology deliberations, however, there were persistent tensions between different ways of assuming, or attributing, responsibility. Amid widespread criticism of governments and energy corporations, people also reflected self-critically on their individual responsibilities and the effects of their own (in) actions. This included political responsibility and the perceived need for citizens to hold governments and corporations to account: "*I think if people were truly not apathetic . . . companies [would] make sure that nothing bad would happen*" (Eric, LA). In London, Lois summarized these tensions between systemic/policy and individual/consumption responsibilities:

> "*we can't just say to the government, well you need to be making green energy and you need to be producing enough for us to continue life as we have it now*" (Lois, LN).

Individual responsibility was most frequently articulated in this register, describing patterns of consumption as being in excess of what is desirable or sustainable: "*we're not stopping from buying . . . we're still buying*" (Natalie, LA). However, appeals to the *necessity* of maintaining current levels of energy demand were questioned and viewed with some skepticism, highlighting instead the need to address actual levels of energy consumption, for example:

> "*It's a massive issue [of] moral sustainability . . . We seem to be not looking for ways to control our expenditures . . . We'*re just looking for new energy sources" (Bea, LN).

In Los Angeles, high sustained levels of consumption – of everyday and luxury products and, by extension, of fossil fuels that power their manufacture and distribution – were linked to changes in weather patterns. For some, these impacts were seen as the result of "*taking out*" excessive amounts of resources from the Earth:

> "*It kind of makes sense where our climate is weird because we're using more than we need. If [we] really just took out and not used more than we had to, then we wouldn't have this climate change, drastic, right?"* (Sally, LA),
> "*Right*" (Peter, LA).

Others questioned the idea of individual choice as the critical dimension and highlighted how individual actions are shaped by

structural factors, particularly in cutting fossil fuel use. Especially in the US, everyday dependency on fossil fuels and their products was seen as unavoidable, where for example people have witnessed food prices rise in line with gasoline price increases. At the same time, lack of alternatives was seen as further limiting individual capacity to reduce fossil fuel use: "*If we really had a choice about driving, if we had really good public transportation [and] safe ways to ride bicycles, it would be a no-brainer to use less fuel, less oil*" (Miriam, SB). Many participants in both countries thus felt they were directly, and differentially, implicated in political and economic processes they felt should be changed.

5. Discussion

Participants across all of our workshops critiqued arguments made in favor of shale development in terms of a perceived *short-termism* – the privileging of short-term interests over consideration of temporally distant consequences (Groves, 2014). In energy debates, such short-termism is evident in the assumption that addressing pollution or climate change can be deferred while more expedient or profitable policies are pursued with minimal disruption to current practices (Nixon, 2011). Since longer-term impacts were a real source of concern for most of our participants (due to environmental risks, and the widely-shared view that shale extraction would exacerbate climate change), shale development was not seen as real "*progress*" in the modification of energy systems. Such future-oriented views are in direct contrast to those of publics characterized by "future blindness" (Lorenzoni et al., 2007) or preoccupation with immediate priorities at the expense of longer-term or global concerns (Moser and Dilling, 2004).

Dryzek et al. (2009) argue there are structural reasons why deliberating publics in North America and Europe tend toward precaution and longer-term concerns while policy-makers tend toward expeditious support for technological innovation: policy-makers believe they are subject to short-term competitive imperatives, whereas 'lay publics' deduce risks underlie deliberative consultation and are thus inclined to express concern. However, these traits are neither uniform nor predictable: deliberative research on different technologies has variously found benefit-centricity, risk-centricity, precaution and techno-optimism (Marris, 2001; Walls et al., 2005; Bickerstaff et al., 2008; Pidgeon et al., 2009).

For those who saw it as incompatible with their broader visions for energy system change, shale development in both countries was what the Understanding Risk Group at Cardiff University have described, based upon a UK study, as a "non-transition" – not matching ideas of improvement or progress (Parkhill et al., 2013a; Demski et al., 2015). Many of our participants described shale development in these terms, in part because shale development was seen as doing little to address pervasive, everyday reliance on fossil fuels – something that participants across all four workshops felt should be changed but were unsure of their individual ability to effect.

Here the concept of *energy futures* (the potential design and configuration of energy systems in the future) is useful in interpreting participant views on competing energy choices and ideas about the future (Demski et al., 2015). Studies on inevitability have found that when people feel trapped by inescapable systems, they place less blame on systemic processes for situations of inequality, and articulate lower support for policies that seek to resolve those inequalities (Kay and Zanna, 2009). However, even though in our workshops current energy systems were widely seen as inescapable, this did not weaken the belief that those systems can, and should, be changed in the direction of more renewable energy sources. Blame for creating perceived barriers to these changes was typically apportioned not to one-off instances of corruption or recreancy but to failure at a more systemic level (Freudenburg, 2001; Macnaghten and Guivant, 2011). Most participants admitted their own culpability as consumers of energy while also suggesting that proposed changes would require governmental support. In this sense, views on energy futures addressed both the demand and supply side of energy system change (Parkhill et al., 2013a). To the extent that shale development was thought likely to be at the opportunity cost of further renewable technology research and investment, it was largely seen as contributing to a narrowing of alternatives, creating undesirable energy futures.

The sense that current US/UK energy systems are inescapable has consequences for how attitudes and actions on climate change are interpreted. Frequently, studies look for evidence of belief change in examples of behavior change (Lorenzoni et al., 2007; Rabinovich et al., 2010). However, as many of our participants articulated, failing to adopt more climate-friendly actions reflects not only individual agency and belief; it also reflects 'social barriers' such as a relative absence of alternatives that people can incorporate into their lives (Lorenzoni et al., 2007). Despite such a perceived lack of 'shared responsibility' that no one individual can fully overcome (Bickerstaff et al., 2006, Lorenzoni and Hulme 2009), doubt among our participants about the efficacy of action taken to address climate change – what Capstick and Pidgeon (2014) call *response skepticism* – did not result in a lack of concern about climate change and instead in renewed calls for more forward-looking energy systems. Almost all participants agreed that climate change was real and its effects already being felt – often based on personal experience – suggesting reduced perceptions of geographical, temporal or social distance from the *impacts* of climate change (cf. Spence et al., 2012; McDonald et al., 2015). In considering the *causes* of climate change, any sense of distance was reduced even further: people were aware of their implication in energy systems that adversely affect the climate, and described the lack of political will to change these in negative terms.

In these discussions, participants recognized that not everyone is equally responsible or influential in facilitating desired changes such as the transition to renewable energy sources (Pidgeon, 2012). On this theme of responsibility, we found subtle cross-national differences that replicated those in previous comparative US-UK research on nanotechnologies (Pidgeon et al., 2009). While government and industry operators were widely criticized in both countries, we encountered more direct criticism of the UK *government*, in this case for failing in its responsibility to source energy in less environmentally damaging ways – in a country where the image of a singular, national energy system controlled by central government is more readily applicable (Pidgeon et al., 2014). In the US, such critiques focused slightly more on *corporations* and their undue ability to influence policy-makers.

The distinctions drawn between individual and institutional responsibilities also affected issues of trust. Adam and Groves (2007) note that responsibility (as liability, or as blame) depends on knowledge. Those proposing technological change who possess knowledge – of different impacts, the potential for harm, and that some actions are higher risk than others – are likely to be held most accountable (Owen et al., 2013). Without such knowledge, direct responsibility may be significantly reduced (Adam and Groves, 2007). In our workshops, most participants felt that shale development would lead to environmental damage and would not result in a reduction in fossil fuel use. A result of this was distrust of governments and energy corporations supportive of shale development who were assumed to have knowledge of these potentially harmful impacts and their association with some energy choices more than others.

Officials in the UK – including then prime minister David Cameron – have echoed government rhetoric in prior risk

controversies and claimed that public opposition to shale development there is based on a "lack of understanding" (Dominiczak, 2014). Many of our participants took issue with this view and suggested instead that the apparent "*rush to frack*" reflects an institutional downplaying of uncertainty and a failure by government(s) to recognize that a lot of resistance to shale development is driven instead by the broader and future-oriented concerns reported above. The issue here is that definitive, official positions leave no space for other perspectives (Wynne, 1992) and reject people's abilities to place issues in social context and to evaluate them by the extent to which they threaten or support identities and visions for the future (Henwood and Pidgeon, 2013; Engdahl and Lidskog, 2014; Shirani et al., 2016).

Our findings show that benefit-centric government and industry discourse has added to public concerns. In the US, no-risk messaging in media campaigns around shale development and 'overselling' of the benefits of natural gas had caused people to question these claims. The UK government's explicit support for shale had similarly raised suspicions regarding information that might be withheld from public scrutiny. As in other studies on energy system change, this institutional 'body language' (Wynne, 1996) – apparent discrepancies in policy and rhetoric – led participants to further question the trustworthiness of information (Butler et al., 2013). The responses we have documented align with findings from research on other new technologies where emergent responses are influenced by ideas about who stands to profit, who is responsible for decision-making (Schütz and Wiedemann, 2008), and perceptions of fairness and trust (Satterfield et al., 2012).

Finally, some scholars suggest that publics favor renewable energy sources because the importance of climate change can 'crowd out' space for considering other consequences of emerging energy technologies (Davies and Selin, 2012). However, in our workshops, climate change concerns were not the only frame in which participants articulated the "incompatibility" between shale development and desired energy futures. As we have seen, other concerns included environmental impacts of various kinds (including risks of water contamination and increased seismic activity) as well as systemic issues such as the need to address energy consumption and the risk of reducing investment in renewable energy.

While we encountered engagement with these broad-scale issues in both countries, some cross-national differences emerged reflecting different national contexts and stages of shale industry development. Most oil and gas extraction in the UK to date has occurred offshore (Mair et al., 2012) while some areas of the US have seen extensive shale development and California itself has a long history of conventional oil extraction (CCST, 2015). More in the UK than US workshops, conversations explicitly addressed the "unsustainability" of fossil fuels, whereas in California the previously-witnessed impacts of extractive industries – both in state and beyond – apparently influenced different concerns such as the industrialization of rural areas affecting valued landscapes (in Santa Barbara) or of populated areas affecting human health (in Los Angeles), even among groups who were largely unfamiliar with shale development itself. Future public deliberation research could comparatively explore concerns in areas where shale development is currently active and its impacts already directly experienced.

6. Conclusion

The design, diversity and duration of our deliberation workshops enabled participants in two countries to explore a range of concerns that tend not to be addressed in survey-based research or short-form qualitative inquiry. While deliberative modes of qualitative inquiry are used increasingly in some parts of the world, particularly northern Europe, a key contribution of this study is to continue to extend this method of inquiry in the US. Furthering these research techniques, we have also reflected on how shale development as a *liminal* subject for deliberation draws attention to differences and similarities in views across different temporal, social and geographical locations (cf. also (Bickerstaff and Simmons, 2009)). This liminal case underlines the importance of also addressing with *whom* and *where* deliberative participation takes place in addition to *what* is discussed and *when*. Our analysis also highlights the need for further conceptual and empirical work on liminal spaces and objects in relation to engaging the public about novel risks.

Our whole-day deliberations were responsive to particular group dynamics, and opened up discussion to particular risks and benefits as well as broader multi-scale issues such as climate change and responsibility. We have identified critical similarities between diverse groups in the importance they place on concerns about the long-term future when assessing a range of projected impacts of shale development – challenging characterizations of public views as being 'future blind.'

Analyzing participant ideas about how shale development might undermine or reinforce the energy systems they consider necessary or desirable for the future – views on *energy futures* – this article has documented surprisingly strong and prevalent concerns around common themes. Many US and UK participants saw shale development as intrinsically incompatible with their desired energy futures, and articulated doubt in claims that shale development will have a positive impact on climate change. This was in groups characterized overall by acceptance of the reality and immediacy of anthropogenic climate change. Most participants across all four sites saw shale development as deepening, not transitioning away from, energy infrastructures that depend on fossil fuels – energy systems seen as simultaneously inescapable and in need of change. While grappling with these contradictions, most participants recognized that achieving desired energy futures requires both individual and institutional action. Support for and investment in shale development was seen as displacing more desirable alternatives – reducing the likelihood that renewable energy sources will be developed and adopted – amplifying concern about a perceived short-termism in energy debates and government-industry complicity in these processes.

These findings show that emergent views on shale development involve not only concerns about immediate social and environmental impacts – the focus of much prior social research, and of institutional assurances of its relative safety – but also concerns about the value and viability of different long-term energy futures and their sustainability. The views we have analyzed also reveal a remarkably widespread and deep commitment to making necessary changes in the present in order to secure a livable future.

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Appendix A

See Table 1.

Table 1
Summary demographics.

City		Los Angeles	Santa Barbara	London	Cardiff
Number of participants		16	15	10	14
Gender (female%)		50	67	50	71
Age profile (%)	18–34	44	27	40	43
	35–54	38	27	30	21
	55+	19	46	30	28 (7)
Ethnicity (non-white%)		75	53	30	7 (7)
Education (university degree or above%)		31	53	70	57 (7)

Percentages may not sum to 100 due to rounding effects; withheld responses are shown in parentheses.

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.gloenvcha.2016.11.002.

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