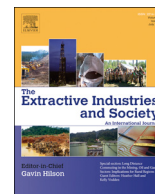


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Review article

Shale development in the US and Canada: A review of engagement practice

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ABSTRACT

Public and stakeholder engagement with shale development is difficult, but essential. We review 26 engagement processes carried out by US and Canadian companies, alliances, government agencies, academics and activists; systematically exploring who participates, the stage at which engagements take place, aims and methods, provision for multiway engagement, and issues of credibility. We find a multitude of actors carrying out engagement using a variety of formats, ranging from barbeque events and town hall meetings to citizen science and in-depth qualitative research. Whilst we find many strengths, we also highlight a number of weaknesses. Much of this engagement does not occur at the earliest stages of development, and rarely asks the most fundamental question - whether shale development should proceed at all - instead commonly focusing on questions of impact minimisation, regulation and gaining support. Furthermore, the majority of activities tend to elicit the responses of interested and affected parties, with much less attention to views of the wider public. We reflect on what may be limiting engagement practice, and discuss how engagement might be improved.

1. Introduction

1.1. Engaging with shale gas and oil extraction

Oil and gas production from shale deposits has grown significantly in the US and Canada during the last decade. This has been made possible in part by directional drilling and hydraulic fracturing ('fracking') techniques, whereby pressurised liquid, sand and chemicals are injected into deep shale formations to fracture the rock and facilitate the flow of oil and gas. Such techniques have been deployed for around 20 years in some US states, and in some cases full-scale extraction is now taking place (e.g., Pennsylvania, Texas). In others, proposals have been surrounded by significant environmental and legal controversy, on occasion leading to local, regional or statewide moratoria and bans (e.g., New York, Maryland). In Canada, rapid development has concentrated in the western provinces of British Columbia and Alberta, while the practice has been the subject of moratoria and bans in eastern provinces (Quebec, Nova Scotia, New Brunswick).

Engagement¹ is one key part of responsible development, particularly for controversial projects like shale gas extraction. On a basic level, people have a 'right to know' about the risks they may face (Renn and Levine, 1991). In democratic societies, potentially affected people also have a right to be heard, and public participation can both increase

legitimacy and improve confidence in decision makers (Beierle and Cayford, 2002; Fiorino, 1990). Another motive is that some aspects of lay risk judgments are as sound (or more so) than expert risk judgments, meaning that local knowledge can add a valuable layer to risk understandings and improve the quality of decisions; ultimately leading to more sustainable choices (Fiorino, 1990; Irwin and Wynne, 1996; Stern and Dietz, 2008). Some commentators cite shale development as a human rights issue, arguing that it should be the subject of detailed human rights impact assessments (Short et al., 2015). Indeed, Cotton (2017) argues that in the case of shale development, where risks and benefits are unevenly distributed, environmental justice can only be achieved by *re-localising* the scale of fracking governance, which in turn requires effective community participation and decision making.

Public engagement is not only desirable, but in some cases is a prerequisite for development. In Canada, governments have a constitutional obligation to consult First Nations (Indigenous Peoples) if their rights might be affected (Council of Canadian Academies, 2014). Likewise, a number of US states (e.g. Pennsylvania, Wyoming, Texas) are in some form required to publically disclose the chemical constituents of fracking fluid (FracFocus, 2018), although as discussed later, this is a complicated picture.

From an industry perspective, as opposition to shale development increases in many regions, companies are increasingly recognising that

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¹ We use the term 'engagement' to describe the ways in which industry, public and other actors interact with each other.

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effective engagement is essential in order to obtain a ‘social license’ to operate (see Brändle et al., 2016). Regardless of whether engagement is mandatory or voluntary, the oil and gas industry is realising that companies active in community engagement, and who listen and respond to community concerns, are viewed more positively (Potter et al., 2014). Indeed, the business and management approach tends to frame social license in terms of risk management, whereby engaging the public is a means to reduce reputational and economic risks (Jones et al., 2013; Morrison, 2014); and a company’s favourable actions may not only benefit themselves individually, but also the wider industry (Potter et al., 2014). Ultimately, without engaging the public in meaningful conversation, shale developers cannot hope to proceed in truly acceptable way. The public may wish to place conditions on development that can be easily met through discussion and adapting proposals; or alternatively, engagement may highlight ‘red-line’ issues (e.g. climate change or water quality), whereby no level of negotiation or compensation will lead to acceptance (Thomas et al., 2017a). In both cases, it benefits industry, policy makers and publics to have these conversations early.

This review surveys the enormous breadth of engagement activities that are taking place around shale development in two countries at the forefront of engagement - the US and Canada. In doing so, we shed light on the varied opportunities that are available for engagement between different stakeholders and publics², and help inform future engagement strategies, both here and in countries where shale development is more emergent. We begin by outlining a suggested ‘best practice framework’, based upon engagement and participation literature. We then review case studies of engagement processes in the US and Canada, before drawing on these to discuss implications for future engagement here and elsewhere. Whilst we concentrate on cases where the public are the participants rather than the conveners of engagement, we recognise that publics are proactively engaging with development across the US and Canada, and include a short discussion about engagement by activists, both in support of and in opposition to shale development (Section 3.5).

1.2. Why engagement is hard

A number of factors render engagement with shale development difficult. Firstly, there are the characteristics of this energy source itself. As with many other risk issues, information is contested, with the same data being interpreted to inform the conclusion that shale gas will mitigate or increase greenhouse gas emissions (e.g. Clarke et al., 2012). High levels of uncertainty render shale development a ‘post-normal’ risk - a problem too complex or too uncertain to yield to science alone (Rosa, 1998) - rendering public engagement a matter of co-production by publics and traditional science communication, whereby publics can participate in the risk characterisation process (Chilvers and Kearnes, 2015; Pidgeon et al., 2017). The complexity of shale development also encompasses local level and large-scale societal questions (Clarke et al., 2012), posing particular challenges associated with the ‘energy trilemma’ (the reconciliation of climate, security and affordability goals), which disparate publics are likely to evaluate differently (Pidgeon et al., 2017). All of these factors apply not only to the US and Canada, but elsewhere.

Secondly, there are issues relating to governance and regulation, which, while more country-specific, also show similar patterns in various countries. One factor is the ‘complex web’ of governance, which in

²For clarity, we use the term ‘publics’ to refer to a traditional conceptualisation of the ‘general public’, and ‘stakeholders’ to refer to those with a particular interest or concern in shale development, such as landowners, regulators etc. We recognise that publics are also stakeholders, and that these categories are somewhat arbitrary; however, some distinction is useful when considering engagement amongst different parties.

the US spans federal through regional, state and local (Whitton et al., 2017, p.12). While this might provide multiple opportunities to engage, it also provides a potentially confusing pathway for participation (Whitton et al., 2017). Here, shale companies function at a number of different scales: some operate more than a thousand wells in a state, while others operate only one (Nash, 2013), which means that inevitably some have a lot more capacity and resources for engagement than others. The dispersed nature of shale activities, and the changeable nature of the actors involved (e.g. as leases are bought and sold) also make it difficult to learn from experience (North et al., 2014). Another complicating factor is the private ownership of subsurface rights in the US, which limits wider participation in transactions (Whitton et al., 2017).

Alongside this, with some exceptions (New York State Department of Environmental Conservation, 2018), shale development has largely been regulated under the auspices of existing conventional oil and gas regulation, meaning that public engagement with new regulations has been limited (Whitton et al., 2017). Also, a lack of transparency in shale operations has meant that publics have found it difficult to access information in order to engage (Whitton et al., 2017), particularly in the US. As noted above, some US States require disclosure of the content of fracking fluid, for example, but others do not and commercial sensitivity has often been cited to constrain transparency. Equally, the sheer scale and pace of drilling operations can often render disclosure and monitoring impractical. Opportunities for participation are also limited in some states by legislation, for example in Boulder County (Colorado) and in Pennsylvania, where the Oil and Gas Act ‘essentially pre-empts the ability of local communities to regulate oil and gas activity’ (Whitton et al., 2017 p17). Denton, Texas, is another case point, where the town’s ban was overturned by state legislation that secures the state government’s unilateral authority over oil and gas development (Rice, 2016). Notably, this is also the case in the UK, where central Government overturned the decision by elected Lancashire County Councillors to refuse planning permission for shale gas drilling (Bradshaw and Waite, 2017).

Thirdly, and again in North America as well as elsewhere, there are the characteristics of the stakeholders and publics involved. As with any risk, different people require different information, depending on many factors including their values and experience (Clarke et al., 2012). People have different levels of knowledge about shale development, many showing little awareness of the issue, particularly in areas not affected by development (Thomas et al., 2017b). This can mean that if asked to state their opinion (e.g. in a one-off survey), they will draw on their ‘mental models’ of other technologies (Morgan et al., 2002) or respond to whatever information is available. For example, they may respond negatively to the word ‘fracking’ or positively to the word ‘technology’ (Evensen et al., 2014; Pidgeon et al., 2009). When asked, individuals are often ambivalent or polarised in their responses (Barvosa, 2015), meaning basing governance decisions upon their views can be difficult.

Despite these obstacles, effective engagement is essential. On the one hand, poorly executed dialogue and communication processes can ‘rapidly escalate concerns’ around the siting of energy technologies (Pidgeon & Demski, 2012, p. 41). On the other, well-executed engagement campaigns offer many potential benefits as outlined in Section 1.1. In our review, we provide clarity on this issue and insight into the strengths and weakness of particular case studies, in order to suggest implications for future engagement practices. We also discuss insights from the wider risk communication literature that may be relevant when developing engagement strategies. We hope that our findings will contribute to more meaningful opportunities for publics and other stakeholders to engage in the shale debate and shape the issues that might affect them.

2. Review methodology

Our review does not include all of the companies, interest groups, activists, agencies and academics that have been involved in shale-related engagement efforts in the US and Canada. Instead, we aim to reflect the enormous breadth of activities undertaken, and in so doing provide an overview useful to community, academic, government and industry stakeholders. The engagement efforts reviewed here were collated by snowballing from reports, recommendation by experts, and by carrying out internet searches using Google (e.g. “Canada anti-fracking”) and Google Scholar (e.g. “public engagement hydraulic fracturing USA”). Our criteria for including case studies in the review were firstly that they should be relevant, i.e. involve ‘engagement’, defined here as interactions between industry, public and other actors (including more unusual interactions such as film making and providing legal support). Secondly, they should together cover a wide variety of modes of engagement and types of participant, in order that we could thoroughly scope the engagement landscape in the two countries. Sources comprise mainly publically available reports and websites (e.g. Atherton et al., 2014; Boulder County, 2017b), with some peer reviewed literature (e.g. Theodori, 2013).

It is difficult to say definitively which engagement efforts have ‘succeeded’ and which have ‘failed’. This is because a multitude of factors come into play when decisions about development are made, and because formal evaluations of engagement exercises can be problematic (Bickerstaff et al., 2010; Rowe et al., 2005, 2008), and are thus rare (Kurath and Gisler, 2009). For a UK shale example, see Icaro (2014); for an example in the realm of genetically modified crops, see Rowe et al. (2005) and Pidgeon et al. (2005). Measurement can be challenging because of lack of knowledge about baseline beliefs and attitudes, compounded by difficulties in identifying an end-point to the engagement exercise (Rowe et al., 2005), if indeed there is such an end-point (Brändle et al., 2016). Plus, any effects may be due to other variables such as the social context of particular engagement activities (e.g. who participates and why), the nature of the problem (e.g. time-scale), or simultaneous events like local elections (Chess and Purcell, 1999). It also depends on whose preferred outcome is used to base an evaluation: it is not only the industry view that is relevant, but also sponsor perspectives, participant perspectives and normative perspectives on how engagement in general should be conducted (Rowe et al., 2005; Webler, 1995).

Due to these inherent subjectivities and conditionalities, participation efforts cannot be easily evaluated according to the success of their

outcome. We instead propose a ‘best practice framework’ focused on the engagement processes, summarised in Fig. 1. This framework is based upon the literature cited below, which includes contributions by various risk and public perceptions scholars, and particularly the work of Rowe and Frewer (2000).

2.1. Who participates and how

Literature suggests that organisers and facilitators should be appropriately qualified to carry out engagement exercises and that participants should ideally be broadly representative of the affected population (Rowe and Frewer, 2000). However, the notion that the only legitimate participants are representative (and ‘invited’) is contested in risk perception research. While it is essential to engage individuals in the immediate area, shale gas/oil development has national and global ramifications (e.g. impacts on energy security and climate change) as well as local ones, and thus it is also important to engage more widely (Partridge et al., 2017). Indeed, both invited and uninvited publics can have legitimate roles to play in risk engagement and decision-making. Not least, those with a stake in a development may have specialist or local knowledge, be disproportionately affected, be more likely to oppose/support a project, or voice concerns that are not necessarily included in formal risk assessments (Pidgeon, 1998). While invited publics may be expected to more closely represent the views of the ‘average citizen’, uninvited publics can challenge the normative assumptions and framings that accompany ‘invited’ participation – for example what should be left to the organisers rather than the participants, and what questions are valid (Wynne, 2007). Having said this, defining the ‘community’ of interest may not be straightforward, and Cotton (2017) points out that injustices may occur when a community is defined by spatial proximity (e.g. those closest to a well), or by role involvement (e.g. members of social movements).

It is also important to recognise that views are changeable: an individual may simultaneously hold conditional, ambivalent and sometimes contradictory views about a given technology (Henwood and Pidgeon, 2014). Furthermore, the importance of context means that a ‘one size fits all’ approach may not be appropriate (Thomas et al., 2017a). Communicators may wish to seek to understand the local and national context in which participation occurs, and be sensitive to cultural and social differences, gender, values and so on. This includes how publics view their locales, and understand place attachments and sense of identity (Pidgeon and Demski, 2012), which might influence, for example, the strength of feeling about proposed changes to that

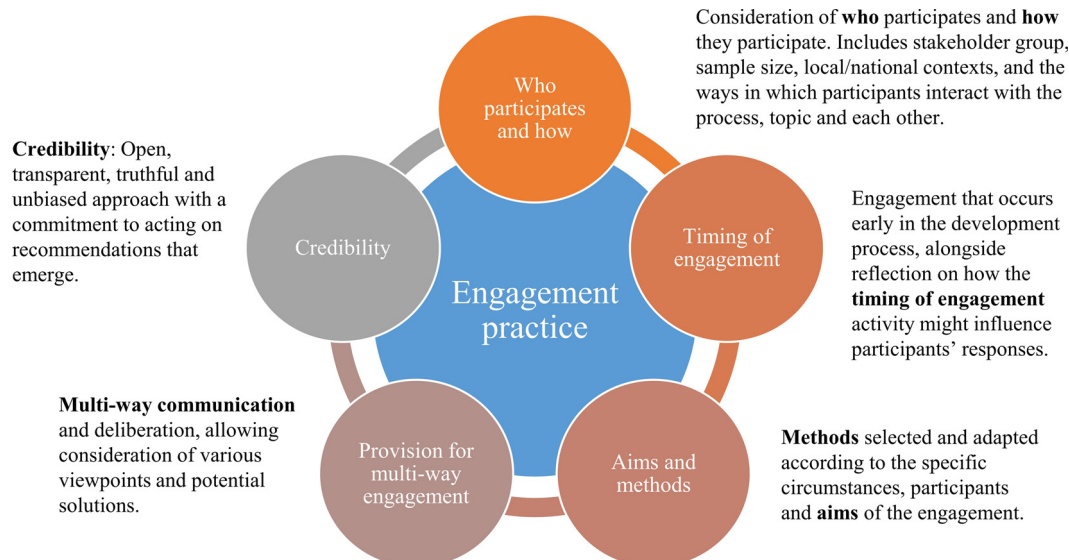


Fig. 1. A framework for engagement best practice.

place.

There is a growing literature focusing on the ways in which people participate in engagement exercises. Any participation exercise will be complicated by the ways in which public roles are framed by the very settings in which public engagement occurs (Bickerstaff et al., 2010), and in turn the ways in which the participants themselves transform these roles and identities, and construct themselves in relation to wider publics (Felt and Fochler, 2010) and other participants (e.g. Thomas et al., 2018). In other words, how engagement *makes* and is *made by* those who participate in it (Michael, 2009). Chilvers et al. (2015) argue that energy participation should take account of the diverse, complex and continually emerging ways in which people engage with issues, and that a participatory practice should be recognised as being shaped by, and in turn shaping, the object (e.g. fracking), models (participatory practice/method) and subjects (participants).

2.2. Timing of engagement

It is recommended that engagement begins as early as possible in the development process (Chess and Purcell, 1999; Rowe and Frewer, 2000; Royal Commission on Environmental Pollution, 1998; Ruckelshaus, 1983; Stern and Fineberg, 1996; Wilsdon and Willis, 2004), and continues throughout development (IOGP, 2017; TNS-BMRB, 2014). Not only can failure to attend to dialogue during early stages be particularly costly in subsequent stages of risk characterization (Stern and Fineberg, 1996); but anticipation can open up ‘what if’ style questions that recognise uncertainty, thus increasing resilience to potential outcomes (Stilgoe et al., 2013). In discussions of ‘upstream’ public participation in the context of nano-technologies, Rogers-Hayden and Pidgeon (2007, p. 359) argue that ‘early engagement doesn’t necessarily mean that controversy will be avoided or even that this should be/is a goal of early engagement’. They further point out that engagement needs to happen *early* enough to be constructive but *late* enough to be meaningful (or at least involve appropriate, well-grounded deliberation). Literature on the ‘social license to operate’ also makes clear the need for continual engagement throughout the project in order to keep communities informed as development continues (Brändle et al., 2016). Thus, while early engagement may not be a panacea, timing is clearly important and should be carefully considered, alongside suitable methods for engagement (see 2.3).

In our review we utilise a typology described by North et al. (2014) who describe public and stakeholder participation in shale development in terms of the various stages of an environmental decision process (Stern and Fineberg, 1996). There are nine stages in all, here distilled to the following six aspects for our analysis: early engagement (problem formulation and process design, including selecting options and outcomes), learning (including joint fact-finding and citizen science), decision-making, and post-development (monitoring, evaluation and adjustment). In practice, these categories often overlap. For example, early engagement may include fact finding by interested citizens.

2.3. Aims and methods

Literature also suggests that aims (what issues are explored and desired outcomes) should be clearly defined (Rowe and Frewer, 2000) and should heavily influence the choice of method. Different modes may be appropriate for different purposes and for different people (Chess and Purcell, 1999; Rowe and Frewer, 2000), and the most appropriate method will depend on the context of the issue, the desired outcome, the stage of development, and the participants and their preferences (e.g. TNS-BMRB, 2014). For example, drop-in centres and town hall meetings may be effective modes for engaging ‘neighbours’, while early, upstream engagement and moderated online discussion forums may be more effective for activists (Cotton, 2013).

The chosen methods in turn have important implications for the nature and depth of the discussions that emerge. For example, when

aiming to elicit informed rather than uninformed preferences (Corner and Pidgeon, 2012), lengthier deliberation sessions that facilitate two-way communication may be more appropriate than a traditional survey (e.g. Thomas et al., 2017a; Williams et al., 2015). It is important to note that *how* the method is used can be more important than *which* method is used, and organisers might consider modifying traditional methods or using a combination of different techniques (Chess and Purcell, 1999; Rowe and Frewer, 2000). When doing so, materials should be carefully calibrated to provide sufficient balanced information (Satterfield et al., 2012), as well as being sensitive to assumptions and considering how the mode and materials might frame the topic (Corner and Pidgeon, 2015). It might be appropriate to follow a methodology that ‘unframes’ the issues (Bellamy and Lezaun, 2015) or allows the public to some extent frame the issues themselves (Rowe et al., 2005; TNS-BMRB, 2014).

2.4. Provision for multi-way engagement

Participation can occur on a number of levels: from nonparticipation through informing (‘tokenism’) to partnership and citizen control where citizens have the most power in determining the end product (Arnstein, 1969). Historically, public engagement with risks per se would have been limited to a one-way flow of information between communicators and the public, who it was felt just needed to ‘understand the numbers’ in order to accept a risk (Fischhoff, 1995). However, multi-way communication enables publics to have meaningful input into decision processes rather than simply be communicated to (Fischhoff, 1995). Therefore, public engagement has moved beyond constituting a means of persuasion to a two-way exchange that recognises the importance of psychological, cultural and social factors (Fischhoff, 1995; McComas, 2006; Pidgeon et al., 1992). Such questions may be particularly relevant in controversial issues such as shale development, where politics, culture and worldviews are shown to be important in shaping perceptions (see Cotton, 2013; Demski et al., 2015; Devine-Wright, 2009; Thomas et al., 2017b).

2.5. Credibility

In our framework, we use the term ‘credibility’ to encompass a number of factors that can be described as contributing to the integrity and trustworthiness of an exercise. These involve being open and transparent during the engagement process (e.g. adequately publicising forums and results), being truthful and unbiased throughout, and appropriately responding to outcomes. Firstly, effectively publicising open events reduces the risks of excluding potential participants and exacerbating self-selection biases (Chess and Purcell, 1999). Secondly, truthful engagement practices reduce risks of alienating the public and (further) reducing levels of trust; although this is not a straightforward issue and accusations of bias and ‘untruths’ abound on both sides of the debate (e.g. Energy In Depth, 2012; Mobbs, 2015). It is suggested that organisers should not promise to listen to feedback if there is no mechanism for doing so (Cotton, 2013), and be clear about what is known and not known, what the public can influence and what they cannot (TNS-BMRB, 2014). This is particularly important in an arena where the public perceives a lack of transparency and harbours a mistrust of industry and government (Thomas et al., 2017b). Participants will likely demand ‘confirmed facts’ and statistics (Thomas et al., 2017a; TNS-BMRB, 2014); but uncertainties should be explicitly acknowledged where they exist (Pidgeon and Fischhoff, 2011; Ruckelshaus, 1983).

Finally, the literature suggests that participation efforts should be carried out in an independent and unbiased way – and be viewed as such – and should also have a genuine impact on policy and be seen to do so (Rowe and Frewer, 2000). Indeed, responsible innovation requires developers to respond accordingly and rapidly to public input, even if it is not what they were hoping for (Potterf et al., 2014; Stilgoe et al., 2013). In practice, this can be challenging: for example, when

Table 1
Summary of case studies reviewed.

	Who participates and how	Timing of engagement	Aims and methods	Provision for multi-way engagement	Credibility and other factors
'INVITED' ENGAGEMENT					
Industry					
Industry-led community liaison	<i>Organisers:</i> Individual companies and their representatives (e.g. PR firms); intermediate organisations. <i>Participants:</i> Various, including: concerned individuals, community beneficiaries, community leaders	Various	<i>Aims:</i> Disseminating information, gaining community acceptance/support, minimising impacts. <i>Methods:</i> Various, including: sponsorship of public events, employing community liaison officers, conferences	Varies	See Cabot Oil and Gas Corp (below) for specific example. Potter et al (2014) found that some corporations were viewed as going above and beyond while others were perceived as making donations to look good but having little community level impact
Cabot Oil and Gas Corp, Pennsylvania (Cabot Oil & Gas Corporation, 2016, 2017)	<i>Organisers:</i> Company. <i>Participants:</i> Public	Post-development	<i>Aims:</i> Information dissemination, general information on hydraulic fracturing, specifics about policies, information about Dimock trial. <i>Methods:</i> Various, including Twitter Q&A, Instagram, blog, presentations and podcasts	Focus on information dissemination, with some interactive activities	Some engagement is in response to Dimock water contamination trial, but some engagement was occurring beforehand
Grievance / complaint hotlines	<i>Organisers:</i> Companies. <i>Participants:</i> Concerned public, industry officials	Post-development	<i>Aims:</i> Hearing concerns. <i>Methods:</i> Phone-lines, sometimes in-person meetings	Tends to be limited	Little is known about how often / how effectively complaints are addressed (North et al., 2014)
Social Impact Assessments	<i>Organisers:</i> Usually consultants. <i>Participants:</i> Various stakeholders	Throughout, from early engagement to post-development	<i>Aims:</i> Identification and management of potential social impacts (e.g. positive and negative, long-term and short term). <i>Methods:</i> Various, including qualitative interviews, quantitative data collection	Yes	Social Impact Assessments are not currently mandatory in the US or Canada
Comprehensive Development Plans (CDPs) e.g. Maryland Department of Planning (2017)	<i>Organisers:</i> Applicants (companies). <i>Participants:</i> Industry, public, government (reviews the Plans)	Early	<i>Aims:</i> Land-use planning. <i>Methods:</i> Public meetings	Unclear	Some have criticised CDPs for removing state authority to approve, deny or place conditions on plans (Earthworks, 2016)
Alliances and Consortia					
Marcellus Shale Coalition (2017)	<i>Organisers:</i> Marcellus Shale Coalition (alliance of industry stakeholders). <i>Participants:</i> Industry, policymakers, regulators, media and 'other public stakeholders'	Various	<i>Aims:</i> To provide information on the positive effects of responsible natural gas production. <i>Methods:</i> Website, fact sheets and reports, speakers, conferences.	Minimal	Oriented towards positive aspects of shale development.
CRSD (Center for Responsible Shale Development, 2016)	<i>Organisers:</i> Center for Responsible Shale Development (alliance of energy producers and environmental organisations). <i>Participants:</i> Environmental organisations, shale development companies	Post-development	<i>Aims:</i> Development of performance standards, independent certification. <i>Methods:</i> Stakeholder collaboration	Limited public input	Degree of transparency through publishing summary audit reports on website
FracFocus Chemical Disclosure Registry (FracFocus, 2017a, 2017b)	<i>Organisers:</i> Ground Water Protection Council and Interstate Oil and Gas Compact Commission (US); British Columbia Oil and Gas Commission (Canada). <i>Participants:</i> Industry, public	Learning / post-development	<i>Aims:</i> To provide public access to reported chemicals used in hydraulic fracturing. <i>Methods:</i> Searchable website database containing chemical disclosure information provided by companies	Limited	Disclosure is obligatory in some US states. Some chemicals are state secrets so are not listed.
Government					
Interstate Oil and Gas Compact Commission (IOGCC, 2017)	<i>Organisers:</i> Government agency. <i>Participants:</i> Stakeholders (government, industry, environmental organisations); public (limited).	Learning and post-development	<i>Aims:</i> Maximise oil and natural gas resources while protecting health, safety and environment; disseminate information to this effect. <i>Methods:</i> Stakeholder engagement via training, meetings, research projects. Public engagement via website, presentations and outreach activities, e.g. 'Energy Awareness Month'	Limited public input	Part of their remit is to manage FracFocus, designed to provide public access to reported chemicals used in hydraulic fracturing

(continued on next page)

Table 1 (continued)

	Who participates and how	Timing of engagement	Aims and methods	Provision for multi-way engagement	Credibility and other factors
Did You Feel It? Citizen Science (USGS, 2017)	Organisers: United States Geological Survey (USGS). <i>Participants</i> : Public with access to the internet (likely interest sample)	Learning and monitoring	Aims: Record earthquakes (including those potentially caused by hydraulic fracturing operations). <i>Methods</i> : Online reporting of earthquake experiences by public	Yes – citizens provide the data, and can freely access the maps, plots and datasets created by USGS.	The USGS is the science agency for the US Department of the Interior. Maps show earthquake report clusters in Oklahoma, where wastewater disposal from hydraulic fracturing has been linked with increased incidents of earthquakes (e.g. Elsworth, 2013)
Marcellus Shale Advisory Commission (Governor's Marcellus Shale Advisory Commission, 2011)	Organisers: Committee of experts convened by the Governor of Pennsylvania. <i>Participants</i> : (Interested) public; stakeholders (particularly industry, also health professionals and others).	Post-development (adjustment)	Aims: Review statutes, legislation, regulation and policies on the Marcellus Shale, and provide recommendations to mitigate environmental and social impacts. <i>Methods</i> : Public meetings, invited input via letters and emails. Publically available report	Yes	Potential bias due to make-up of the Commission. Lack of transparency when listing public comments (not clear what criteria are used for inclusion)
Boulder County, Colorado (Boulder County, 2017b)	Organisers: Boulder County, Colorado. <i>Participants</i> : Public, industry, legal advisors, County staff. Interested and affected parties (not representative)	During a moratorium prior to expansion of oil and gas drilling	Aims: Information gathering, revisions to regulations, extension of moratorium. Clearly defined. <i>Methods</i> : Public meetings, hearings and open house events	Variable – e.g. open houses 'to give interested residents more information' about proposed changes. Hundreds of public comments recorded	Website with lots of information and links, including videos of public hearings. Genuine impact on policy is limited due to Colorado Supreme Court having stated that local bans and lengthy moratoria are not permitted under state law (Boulder County, 2017a)
Alberta Energy Regulator (formerly Energy Resources Conservation Board), Alberta (ERCB, 2012)	Organisers: Alberta Energy Regulator / Energy Resources Conservation Board – regulatory body. <i>Participants</i> : Regulators in Canada, US and outside of North America.	Early	Aims: To learn how other jurisdictions were regulating unconventional gas development. <i>Methods</i> : Written and telephone survey, plus 8 interviews. Publically available report	Yes – elicits responses from regulators. No public engagement phase.	Information sharing with the participating regulators (and report is available online). Public perceptions communicated via regulator
BAPE, Quebec (BAPE, 2011)	Organisers: BAPE (office of public hearings on the environment). <i>Participants</i> : Individual citizens, groups, municipalities and the industry	Early	Aims: Scoping of issues around sustainable development of the shale gas industry. <i>Methods</i> : Public inquiry including numerous public hearings. Publically available report	Yes	Difficult to evaluate in this review due to language barrier (main report in French).
Nova Scotia Independent Review Panel on Hydraulic Fracturing (Atherton et al., 2014)	Independent panel of experts, commissioned by Province of Nova Scotia and the Nova Scotia Department of Energy. <i>Participants</i> : Citizens, environmental organisations, industry, municipalities, community organisations	Early	Aims: Scoping of various issues including potential (positive and negative) impacts. <i>Methods</i> : Submission of evidence, commentary on discussion papers, public meetings. Publically available report	Yes	High degree of transparency and participation. Includes: independent panel of experts; public feedback on discussion papers; acceptance of all views as legitimate; understandable terminology and format; traceable impact of participants' views
New Brunswick Commission on Hydraulic Fracturing (2016)	Organisers: Government commission. <i>Participants</i> : Various stakeholders including industry, community, indigenous elders, environmental groups, academics	Early	Aims: Evidence-based review into hydraulic fracturing, to understand the root causes of the conflicts surrounding shale gas and to identify how New Brunswick might move forward. Focus on values as well as 'facts'. <i>Methods</i> : Meetings and online submissions. Publically available report	Information gathering from various stakeholders. Unclear what information was provided by the commission	Report is relatively brief and provides limited detail on how conclusions were reached
Academic Physicians, Scientists and Engineers for Healthy Energy (PSE Healthy Energy, 2017)	Organisers: Academics. <i>Participants</i> : Academics, policy makers, grassroots and advocacy groups	Various	Aims: Generates, translates and disseminates information to identify 'reasonable, healthy and sustainable energy options'. <i>Methods</i> : Information dissemination via website: original research, summaries, presentations, infographics, links to data and information on how to access scientific papers. Also provides online educational modules	Limited	Focuses on unconventional gas and oil, but also provides information on renewable energy. Aims to increase scientific transparency and provide understandable scientific information for policy makers, academics, grassroots and advocacy groups

(continued on next page)

Table 1 (continued)

	Who participates and how	Timing of engagement	Aims and methods	Provision for multi-way engagement	Credibility and other factors
Pennsylvania State University Marcellus Educational Consortium (PennState PennState Extension, 2017)	Organisers: Pennsylvania State University and business partners. <i>Participants:</i> University, businesses, local stakeholders	Learning	Aims: Helps identify educational needs; provides expertise on Marcellus topics; facilitates discussions among community members, business leaders and others; disseminates information. <i>Methods:</i> Educational programs Aims: Various, including exploring awareness, perceptions of risks and benefits, attitudes, views on regulation and comparisons with other energy options. <i>Methods:</i> Surveys, interviews, focus groups, ethnographic research etc.	Limited	Includes sections for landowners, community and government. Features webinars, maps and frequently asked questions
Scholarly studies of public perceptions of shale development	Organisers: Academics, think tanks. <i>Participants:</i> A variety of samples including interested and affected parties, stakeholders and more representative samples. Tend to be in areas already experiencing development, with some pre-development studies also	Have tended to be post-development, but some pre-development studies also		Tends to be largely one-way elicitation of public opinion via surveys and interviews, but some multi-way deliberative approaches	Transparency of results and methods at point of publication tends to be good, though transparency of process can be difficult to gauge without formal evaluation procedures
'UNINVITED' ENGAGEMENT					
Activism					
Individual action	Organisers: Individuals. <i>Participants:</i> Individuals engaging directly with government, industry, other community members and law professionals	Various, often pre-development	Aims: Various – can include supporters and opponents of shale development. <i>Methods:</i> Voting, placing placards on lawns, participating in protests and rallies, etc. Aims: Information dissemination, focusing on hazards associated with hydraulic fracturing. <i>Methods:</i> Documentary film and associated website including blog, Twitter feed, interactive map	Varies	Activists can come from all walks of life, with many for example having not participated in environmental campaigns before (Willow, 2014, p. 246) The Gasland film was pivotal in shaping public perceptions of fracking in the US and elsewhere. It was perceived as biased by some commentators, for example in a controversial scene in which a resident ignites water from a tap The anti-fracking movement in the US and Canada appears to have had some success in contributing to bans, though impact is often difficult to attribute
Gasland film and website (Gasland, 2017)	Organisers: Written and directed by Josh Fox. <i>Participants:</i> Aimed at public audience. Affected publics are film's subjects. Often screened at public events	Post-development (region dependent)		Yes. Affected publics are featured in the film. Publics can participate by hosting film screenings, contacting elected officials, supporting local organisations, and posting stories on website	
Anti-fracking groups	Organisers: large organisations to local grassroots movements. <i>Participants:</i> Various, including NGOs, local communities, interested publics. Some movements involve celebrities	Early through to post-development	Aims: Focus on the risks associated with fracking, and a common goal to ban the practice. <i>Methods:</i> Information provision, protest, political lobbying, support for legal challenges	Yes	
Denton Drilling Awareness Group, Texas (Frack Free Denton, 2017)	Organisers: Non-profit educational group, whose board members are all long-time Denton residents, and include professors, a lawyer and a professional musician. <i>Participants:</i> public, voters	Post-development (secured a ban on drilling after it had been underway for some years)	Aims: Ban fracking within city limits. <i>Methods:</i> Public vote. Activists raised awareness by e.g. canvassing, voter registration, puppet shows and coffin races (Rice, 2016)	Yes	The success of the engagement exercise was thwarted by State and industry. The story was covered in mainstream media in the US and further afield
Council of Canadians (2017)	Organisers: Social action organisation. <i>Participants:</i> Activists, members of the public	Various	Aims: Oppose fracking and facilitate others to do so. <i>Methods:</i> Information provision including blogs, factsheets and guides. They also organise demonstrations, speakers, events and meetings	Encourages public participation, e.g. through lobbying government officials	The Council campaigns on trade, water, health care, democracy, and energy and climate
FracTracker Alliance (2017)	Organisers: Non-profit organisation that 'studies, maps, and communicates the risks of oil and gas development'. <i>Participants:</i> Includes the alliance's own data sets and crowd-sourced data. U.S. focus with some international data	Learning / post-development	Aims: Provision of information to increase transparency of and access to data and information. <i>Methods:</i> Website with data, maps and studies; research collaborations and outreach activities. Supports advocacy groups	Yes – public contributions encouraged, e.g. by digitising lease data, engaging in citizen science, sharing photos and videos	Focuses on the risks associated with oil and gas development
Landowner coalitions	Organisers: Community committee of landowners. <i>Participants:</i> industry, community members (directly via committee, and through educational seminars)	Early, before leases are signed	Aims: Information gathering and better deals on leases for residents. Also includes attempts to widen benefits beyond landowners to the broader community. <i>Methods:</i> Committees negotiating between drilling companies, legal representatives and the community. Information gathering and sharing.	Yes between stakeholders, though general public (non-landowners) input may be more limited	Provision of information to other communities by making lease information publicly available. Communication and updates to other members

individuals are ambivalent or polarised in their responses (Barvosa, 2015), it can be particularly difficult to base governance decisions upon their views. Aspects of ‘credibility’ are hard to gauge in the absence of formal evaluations (which, as discussed above, are rare) and thus have not been assessed for all of the engagements we reviewed. Relevant comments are in the final column of Table 1.

3. Review findings

In this section, we provide an overview of engagement by each type of stakeholder: industry, alliances/consortia, government, academic, and activist. These are summarised in the five sections of Table 1, within which there is inevitably some overlap. First are those that might be described as constituting solicited, or ‘invited’ public input (Chilvers, 2010; Clarke et al., 2012; Wynne, 2007): that is, engagement by industry, alliances/consortia, government and some academic studies. These are followed by those that might constitute unsolicited or ‘uninvited’ input: typically activists campaigning to bring about change, such as securing a lease deal or banning fracking in their municipality. For each, we provide a summary of the following facets: who runs the process and who participated; timing of engagement; aims and methods of engagement; whether there was provision for multi-way communication; and factors including the credibility of the engagement. We also provide a brief overview of each type of engagement (3.1–3.5). For a more thorough description of each case study, see Thomas and Pidgeon (2017).

3.1. Industry

We find that much industry engagement focuses on disseminating information about a project and gaining community acceptance/support, and therefore tends to be one-way. However, some engagement (particularly in Social Impact Assessments, or SIA) is more interested in identifying -and facilitating the management of- potential social impacts, and therefore seeks a higher level of public participation.

Engagement activities are wide-ranging, and include: sponsorship of public events; public meetings; using social media such as Twitter and Instagram; providing information via blogs and podcasts; maintaining grievance or complaint hotlines (see North et al., 2014); in-person meetings; and in the case of SIA, qualitative and/or quantitative data collection. Activities can be quite eclectic and innovative, for example the ‘Adopt-a-School Program’ run by large independent drilling company Williams Energy (The Williams Companies, 2017) and the ‘Rig Up and BBQ’ run by smaller independent company Payson Petroleum (2017). The stage at which engagement occurs inevitably relates to the aims and methods of engagement. In SIA this tends to be prior to exploration, but often it is during operations.

Engagement by industry can be organised by the companies themselves (commonly by dedicated community liaison officers or outsourced to public relations/media companies), by consultants, by intermediate organisations that act as go-betweens for industry-community communication (e.g. STEER, 2016), or as part of a consortium (Section 3.2). Participants tend to be members of the host communities and/or stakeholders such as landowners, community leaders and community beneficiaries.

3.2. Alliances and consortia

A number of alliances have been formed with the purpose of bringing together interested parties to share information, to improve shale development practices and facilitate interactions across state boundaries (e.g. Small et al., 2014). They include government consortia (e.g. IOGCC, 2017) and educational consortia (e.g. PennState PennState Extension, 2017), which are discussed in Sections 3.3 and 3.4 respectively. Here we discuss alliances between shale development companies (e.g. Marcellus Shale Coalition, 2017), between industry and

environmental agencies (e.g. Center for Responsible Shale Development, 2016), and joint initiatives between non-profits and government bodies (e.g. FracFocus, 2017b).

The Marcellus Shale Coalition run a variety of engagement programmes including training, providing ‘fact sheets’ and maintaining a Speaker’s Bureau that can be booked for community events (Marcellus Shale Coalition, 2017). Another example is the Center for Responsible Shale Development (US), which provides independent third-party certification for companies who meet their performance standards (Center for Responsible Shale Development, 2016). Perhaps the most well-known alliance is FracFocus: the ‘national hydraulic fracturing chemical registry’, managed by the Ground Water Protection Council and Interstate Oil and Gas Compact Commission in the US (FracFocus, 2017b). The FracFocus website was created to provide public access to reported chemicals used for hydraulic fracturing, and offers information on the fracturing process, groundwater protection and the purposes that various chemicals serve. While it is not intended to replace state governmental information systems, it is used by 23 states as a means of official chemical disclosure (FracFocus, 2017b). However, participating oil and gas companies submit the data on both a voluntary or regulatory basis, and some chemicals are not named due to trade secrets provisions (FracFocus, 2017b). Rules also vary as to whether disclosure must happen before fracking commences, as well as to factors such as the disclosure of geological formations that the well traverses, and the requirement for a factual justification of claims for confidentiality under trade secret exemptions (McFeeley, 2012). A companion website is run by the British Columbia Oil and Gas Commission in Canada (FracFocus, 2017a), and provides similar disclosure information to the US site. Our case studies mainly show limited direct public engagement, instead focusing on engagement with industry and regulatory stakeholders, albeit with publically accessible websites.

3.3. Government

Governmental engagement ranges from encouraging conversations between stakeholders across different states (e.g. IOGCC, 2017) to facilitating citizen science via online interfaces, such as the *Did You Feel It?* initiative, which collects and displays earthquake intensity data submitted by members of the public (USGS, 2017). However, a large part of governmental engagement consists of detailed assessments. These include the Marcellus Shale Advisory Commission (Governor’s Marcellus Shale Advisory Commission, 2011; Whitton et al., 2017) and Boulder County’s (Colorado) engagement in the US; as well as Alberta Energy Regulator’s jurisdictional review (ERCB, 2011), and Quebec’s Bureau d’audiences publiques sur l’environnement (BAPE, 2011) in Canada.

Such reports vary in quality, but Canada’s *Nova Scotia Independent Review Panel on Hydraulic Fracturing* (Atherton et al., 2014) stands out as particularly thorough and transparent. The full report covers various aspects of shale development, including development processes, the resource base, development scenarios, various potential positive and negative impacts, public participation, regulatory issues, and a set of recommendations. An independent panel of experts from a range of disciplines oversaw the exercise, and stakeholders (individuals, organisations, members of the public) were invited to participate in a number of ways. These included: commenting on skill sets to incorporate into the selection process for expert panellists; recommending candidate panellists; bidding for technical advisory work; submitting written evidence; participating in online discussions, surveys and public meetings; and providing commentary on discussion papers and recommendations. Although quite long and detailed, the report does contain a good deal of background information about processes and defines relevant terminology, which we suggest aids its clarity and usability. Appendices include the most common questions asked at public meetings, and answers to them. Part of the engagement effort was a Public Participatory Risk Assessment, in which 238 unique

submissions were analysed, and issues of concern ranked and related to the literature, including a synthesis of the academic review results with the views of the participants.

Most of the governmental assessments we reviewed engaged members of the public. While the Alberta Energy Regulator (AER)/ERCB report focussed on engaging regulators (ERCB, 2011), this body has since published a promising Stakeholder Engagement Framework (Alberta Energy Regulator, 2017), which details a strategy that aims to incorporate a number of the aspects we recommend in the suggested framework. These include: careful planning and preparation; inclusion and demographic diversity; openness and learning; transparency and trust; impact and action; sustained engagement; as well as involving two-way engagement and incorporating recommendations. This framework is designed for AER staff to plan engagement activities, and as a standard that stakeholders and publics can expect when engaging with the AER.

Common methods of governmental engagement are public meetings and invited input via letters and emails, which indicates that engagement tends to elicit input from the most concerned individuals rather than a more representative sample of the public. Most of the reports that we reviewed were carried out at early stages of development (or during moratoria) as fact-finding and scoping projects, with the exception of the Marcellus Shale Advisory Commission that was undertaken while large-scale shale development continued. As a side note, there was concern over the composition of the Marcellus Shale Advisory Commission, which was perceived by some of the participants to have too many members of the natural gas industry and of the Governor's Administration (Governor's Marcellus Shale Advisory Commission, 2011). Despite this drawback, the engagement exercise did have a clear impact on policy, with the Commission's recommendations forming the foundation for Act 13, which updated state legislation (Whitton et al., 2017).

In another case with traceable impact, Boulder County carried out public engagement concerning the revision or maintenance of oil and gas regulations during a temporary moratorium on accepting new applications for oil and gas development (Boulder County, 2017a). During the consultation, the website stated that 'based on the Public Hearing, the Board believes that the responsible state and federal agencies may not be adequately addressing these impacts' (Boulder Boulder County, 2017b). It should be noted, however, that while the public were asked to consider whether existing regulations are sufficient or should be modified, and whether a moratorium should be extended, many of the public comments indicated that a more appropriate question would have been, 'should shale development go ahead at all?', i.e. what Cotton (2017) terms the 'need case'. An important point here is that such a question is rendered largely irrelevant in this case, because the Colorado Supreme Court has stated that local bans and lengthy moratoria are not permitted under state law (Boulder County, 2017a).

3.4. Academic

Engagement by academics includes that designed to disseminate information, and that designed to learn more about public and other stakeholder perceptions of development. First we considered the work of two US-based academic groups working to engage interested parties via disseminating evidence-led information: Physicians, Scientists and Engineers (PSE) for Healthy Energy (PSE Healthy Energy, 2017), and Pennsylvania State University Marcellus Educational Consortium (PennState Extension, 2017). Though they take different stances on shale development, both aim to provide evidence-based and unbiased research to various stakeholders, have a focus on information dissemination, and appear to involve a limited level of multi-way engagements.

We also considered scholarly perception studies. These are relevant in a discussion of engagement activities firstly because such perceptions have been shown to be a precursor to civic action (Theodori, 2013), and

secondly because the very act of eliciting these perceptions is an engagement exercise in itself. This research includes a limited amount of work looking explicitly at how members of the public engage with shale development (including voting behaviour, protest and landowner coalitions), and is discussed in Section 3.5 below. More commonly it is interested in public perceptions of shale development more generally, as discussed by Thomas et al. (2017b), who show that scholarly engagement has tended to be more inclusive of individuals less directly affected by development than other types of engagement, on account of recruiting wider populations in addition to directly affected ones.

3.5. Activists

Activism describes a process of campaigning to bring about change. It can take many forms: the anti-fracking movement in the US and Canada includes large international environmental groups such as Greenpeace (2017) through small grass roots groups formed to oppose shale development in a particular locale, to high-profile celebrities such as Mark Ruffalo (Navarro, 2011). Methods of engagement include protests and disseminating information via social media, with anti-fracking activists in particular having generated a strong internet presence (Willow, 2014). Another method of engagement involves providing support for legal challenges. For example Earth Justice, the US's largest non-profit environmental law organisation, provided legal representation when an oil and gas company appealed against a ban in Dryden, New York, in 2014; culminating in a victory that sent a state-wide precedent upholding the rights of local communities to use municipal zoning powers to ban or limit fracking (Jordan-Bloch and Sutcliffe, 2014).

Activism can have very different aims, and community-led activism in particular is proving successful in negotiating lease deals and lobbying for (responsible) gas drilling (Jacquet and Stedman, 2011; Liss, 2011). For example, in the case of Mistletoe Heights, Texas, the community appointed a committee of residents to negotiate a better deal for leases and succeeded in attracting competition from another company, which significantly increased the bonuses secured for leasing (Liss, 2011).

Our activist case studies show that individual action as well as collective action has exerted considerable influence in the US and Canada. For example, the 2010 film *Gasland*, which has been promoted by anti-fracking campaigners worldwide, was largely the vision of one man; the director Josh Fox. The film attracted considerable media attention (Jaspal et al., 2014) and popularised 'potent images of hazard' including flaming water and tainted aquifers (Mazur, 2014, p. 207). It also contributed to anti-fracking mobilisations that in-turn affected the passage of local fracking moratoria (Vasi et al., 2015).

4. Discussion

It is clear from our review that some sectors and stakeholders are investing significant time and resources in engagement around shale development. But how effective is this engagement? In this section, we draw upon the 'best practice framework' (Fig. 1) to discuss the strengths and weaknesses of this engagement practice in the US and Canada, and the implications for future engagement.

4.1. Who participates and how

We found a variety of participants engaging with shale development. These ranged from industry representatives to engaged activists, but tended to focus on interested individuals in part due to the types of methods utilised (e.g. information campaigns on websites, complaint hotlines, public meetings). Moving forward, a number of questions might be answered before an engagement exercise proceeds. Should the aim be to engage a 'mini-public' of average citizens, or more interested proponents/opponents ('uninvited' publics) who may have a more

direct stake in the issue (Pidgeon et al., 2017)? Should participation garner the deep engagement of a small sample, or a lighter touch engagement with a large population? Is the aim to elicit the views of those who are most likely to protest, or the views of those whose voice has not yet been heard (Rowe et al., 2005)? Or are there key stakeholders who can act as go-betweens with the wider community (e.g. IOGP, 2017; Potterf et al., 2014)?

Morgan et al. (2002) further recommend that communicators explore what participants already know and perceive of the issues before further engagement commences. This strategic listening (Pidgeon & Fischhoff, 2011, p. 35) is important because ‘there is no way to know what information people need without doing research that begins by listening to them.’ We would stress here however that participants may have deep local, lay (or indeed ‘expert’) knowledge, and some of the documents that we reviewed stressed the importance of local knowledge in designing and carrying out engagement exercises (IOGP, 2017; Potterf et al., 2014). Furthermore, academic engagements have shown that attitudes towards development stem from a lot more than just knowledge (Thomas et al., 2017b); again reiterating the importance of context.

4.2. Timing of engagement

We found that engagement efforts tend to have predefined aims such as scoping potential impacts, reviewing existing legislation, and providing information; and that the stage of engagement corresponds with these aims. For example, early engagement is used to scope the risks from shale development in SIA, and to understand the causes of conflicts (e.g. in the New Brunswick Commission on Hydraulic Fracturing). Conversely, complaint hotlines are used during development to hear concerns; and citizen science projects are utilised to monitor impacts as they occur. In the meantime, anti-fracking media (e.g. *Gasland*) are drawing upon the experiences of impacted areas to engage people in regions not yet affected. Despite this range of engagement stages, we concur with North et al. (2014) in noting that not enough engagement happens at the beginning of development, particularly amongst industry, alliances and consortia. If the right methods are used (for example those which involve deliberation), engagement can happen much earlier.

4.3. Aims and methods

While the archetypal public meeting is certainly a popular form of engagement (North et al., 2014), our review shows that a myriad of engagement methods are being used across the US and Canada. Methods range from a Tweet, through in-depth interviews with affected landowners, to ongoing stakeholder collaborations. Some methods are quite innovative (on both sides of the debate), and include coffin races (Rice, 2016) and ‘Rig Up and BBQ’ events (Payson Petroleum, 2017). As recommended in the framework (Section 2.3), particular methods appear to be chosen depending on the aim of engagement and who participates. For example, while government assessments often favour public meetings (e.g. *Governor’s Marcellus Shale Advisory Commission*, 2011), web-based fora are important for industry-led community liaison projects and citizen-science (e.g. *Cabot Oil & Gas Corporation*, 2017; *USGS*, 2017). Scholarly participation efforts on the other hand use a wide range of methodologies, including quantitative surveys (e.g. Evensen et al., 2014), qualitative interviews (e.g. *Jacquet and Stedman*, 2011), and occasionally deliberative fora (e.g. *Thomas et al.*, 2017a), each with their own merits and challenges (see *Thomas et al.*, 2017b for a discussion).

4.4. Provision for multi-way engagement

With such a variety of engagement methods, the level of multiway communication varies. Governmental reports and activist engagements

tended to perform a good deal of multi-way engagement, but alliances and consortia much less. A common industry focus on one-way information provision and public hearings (see also North et al., 2014; *Whitton et al.*, 2017), perhaps reflects an information deficit approach that assumes providing more information will lead to acceptance. While one-way information provision is in some cases an improvement for a traditionally secretive industry, future engagements might consider advice from risk communication experts (Fischhoff, 1995; *McComas*, 2006; *Pidgeon et al.*, 1992) and public relations commentators alike (Minty, 2016) who have recognised that providing more information alone is not an effective form of engagement.

4.5. Credibility

Some engagement efforts take considerable steps to increase independence and reduce bias (e.g. the Nova Scotia Independent Review Panel on Hydraulic Fracturing, *Atherton et al.*, 2014). However, many of the sources that we reviewed (reports, papers, company websites etc.) do not tend to provide sufficient detail to be able to state whether engagement processes were independent and unbiased, and unfortunately formal evaluations (e.g. *Icaro*, 2014) are hard to come by. In their absence, we can surmise to some extent whether engagement efforts were likely to be viewed as credible, by considering who ran the process (*Thomas et al.*, 2017b). For example, an engagement exercise run by university researchers or community members is more likely to be viewed as independent than one run by industry or anti-fracking groups.

Similarly, as noted in Section 2, it is difficult (if not impossible) to trace how particular engagement exercises may influence development outcomes. Some engagement exercises, such as the Marcellus Shale Advisory Commission, had a clear impact on policy (*Whitton et al.*, 2017) while some, such as the film *Gasland*, attracted considerable media attention. Without reading each individual public contribution and analysing the nature of any deliberations, it is not possible to say definitively whether end results reflect the wishes of the public. However, in some cases it is clear that they do not. In Denton, Texas, activist-led public engagement efforts were successful in securing a ban, but the ban was subsequently overturned. Indeed, oil and gas companies have filed various lawsuits objecting to democratically implemented fracking bans such as this, and US Government regulation is only adjusting modestly to public concerns about the technology; leading *Barvosa* (2015, p. 497) to suggest that the ‘incorporation of public perspectives into science and technology governance is clearly still limited’. This is exacerbated by our finding that many engagements neglect to ask the most fundamental question -whether shale development should occur at all- and instead focus on where development should occur, how negative impacts should be minimised and benefits maximised, and what regulations should be in place. Without asking the right questions, and responding to them appropriately, shale engagement cannot be truly ‘credible’.

5. Conclusions

While evaluating the *outcomes* of engagement campaigns is problematic, we have here highlighted examples of best practice in engagement *processes*. We have found that extensive engagement is occurring among various parties in the US and Canada, and a number of engagements exhibit multiple elements of our best practice framework. Particularly notable are: the Nova Scotia Review (*Atherton et al.*, 2014) for its early engagement, thoroughness and transparency; academic studies for their involvement of a wide variety of participants (including non-interest samples); industry and activists for employing a range of innovative methods; and governmental reports and activist engagements for multi-way engagement. There are promising signs that engagements will improve in future, particularly with the publication of AER’s recent guidelines in Canada (*Alberta Energy Regulator*, 2017)

and similar frameworks elsewhere (Australian Energy Regulator, 2017).

However, we also find common themes where engagement practice could be improved. Firstly, much engagement does not occur at the earliest stages of development, and rarely asks whether shale development should proceed at all. Furthermore, the majority of activities tend to elicit the responses of interested and affected parties with much less attention to views of the wider public, which are relevant due to the national and global implications of shale development (e.g. energy security, climate change). Another common problem is varying levels of transparency and commitment to acting upon engagement feedback. Unfortunately ‘there is no guarantee that political decisions will follow the logic of processes [...] however well designed and executed’: a public engagement can be exemplary, and yield excellent results, but this does not mean that the ‘correct’ or ‘appropriate’ corresponding decisions will be made (Wheeler et al., 2015, p. 306). We therefore stress that, alongside well-designed and executed engagement, there must be an unwavering commitment from decision makers to follow truthfully (or at very least respond to) the recommendations that emerge from these exercises.

What is limiting engagement processes, and what can be done to ensure more effective engagement for all concerned? As discussed in our introduction, engaging the public and other stakeholders with shale development is difficult due to many factors including inequitable impacts, scientific uncertainty and mistrust of industry and government. Furthermore, the elements of best practice are intertwined such that poor practice in one element may impact another (e.g. choosing inappropriate methods may lead to recruiting biased samples of participants). We might add to this issues of socio-technical lock-in/path dependency (Arthur, 1989) and motivated reasoning (Kunda, 1990), which may render organisers reluctant to ask whether shale development should go ahead at all, and disinclined to act upon recommendations that suggest it should not. In many cases, best practices are hampered by resource constraints (notably for very small companies and lone activists) and restrictions upon following recommendations (as in the cases of Denton Drilling Awareness Group and the Boulder County engagement). Further research could therefore explore the extent to which such constraints affect engagement, and how to address them so best practice can be adopted more widely in future.

While our findings are broadly applicable to engagement activities more generally, there are of course important differences between US and Canadian shale development and that occurring elsewhere. Not least, different levels of economic benefit (e.g. local vs national) as well as differences in mineral rights ownership, geology, population distribution, and regulatory contexts may all impact perceptions and engagement strategies, rendering engagement challenging across multiple contexts. Indeed, the available literature shows a heterogeneous engagement landscape abroad as here, and it seems that the capacity and appetite for engagement varies considerably within and between countries (e.g. Lis and Stankiewicz, 2017; Rivetti and Cavatorta, 2018; Scottish Government, 2017). On account of inevitable heterogeneities amongst national and local contexts, we reiterate the importance of considering circumstance when designing and interpreting engagement campaigns while resource extraction from shale deposits continues to grow (U.S. Energy Information Administration, 2017, 2018).

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References

Alberta Energy Regulator, 2017. Alberta Energy Regulator Stakeholder Engagement

- Framework. Alberta Energy Regulator, Calgary.
- Arnstein, S.R., 1969. A ladder of citizen participation. *J. Am. Inst. Plann.* 35 (4), 216–224.
- Arthur, W.B., 1989. Competing technologies, increasing returns, and lock-in by historical events. *Econ. J.* 99 (394), 116–131.
- Atherton, F., Bradfield, M., Christmas, K., Dalton, S., Dusseault, M., Gagnon, G., Hayes, B., MacIntosh, C., Mauro, I., Ritcey, R., 2014. Report of the Nova Scotia Independent Review Panel on Hydraulic Fracturing. Cape Breton University, Sydney, Nova Scotia.
- Australian Energy Regulator, 2017. Revised Stakeholder Engagement Framework. AER.
- BAPE, 2011. Sustainable Development of the Shale Gas Industry in Québec: Inquiry and Public Hearing Report. Translation - Excerpts From Report 273. Bureau d’audiences publiques sur l’environnement.
- Barvosa, E., 2015. Mapping public ambivalence in public engagement with science: implications for democratizing the governance of fracking technologies in the USA. *J. Environ. Stud. Sci.* 5 (4), 497–507.
- Beierle, T.C., Cayford, J., 2002. *Democracy in Practice: Public Participation in Environmental Decisions: Resources for the Future.*
- Bellamy, R., Lezaun, J., 2015. Crafting a public for geoeengineering. *Public Underst. Sci.* 1–16. <https://doi.org/10.1177/0963662515600965>.
- Bickerstaff, K., Lorenzoni, I., Jones, M., Pidgeon, N., 2010. Locating scientific citizenship: the institutional contexts and cultures of public engagement. *Sci. Technol. Hum. Values* 35 (4), 474–500.
- Boulder County, 2017a. Boulder County Commissioners Pledge to Continue to Protect Public Health, Safety, and the Environment From Local Oil & Gas Development. Retrieved 09 June, 2017, from <https://www.bouldercounty.org/news/boulder-county-commissioners-pledge-to-continue-to-protect-public-health-safety-and-the-environment-from-local-oil-gas-development/>.
- Boulder County, 2017b. Landuse Pages. Retrieved 07 March, 2017, from <https://www.bouldercounty.org/departments/land-use/>.
- Bradshaw, M., Waite, C., 2017. Learning from Lancashire: exploring the contours of the shale gas conflict in England. *Glob. Environ. Change Part A* 47, 28–36.
- Brändle, C., Lis, A., Fleischer, T., Evensen, D., Mastop, J., 2016. Prerequisites for a Social Licence to Operate in the (Shale) Gas Industries. M4ShaleGas Consortium.
- Cabot Oil & Gas Corporation, 2016. Social Responsibility. Retrieved 16 March, 2017. .
- Cabot Oil & Gas Corporation, 2017. Well Said. Retrieved 16 March, 2017, from <https://wellsaidcabot.com>.
- Center for Responsible Shale Development, 2016. Vision. Retrieved 08 March, 2017, from <http://www.responsibleshaledevelopment.org/who-we-are/vision/>.
- Chess, C., Purcell, K., 1999. *Public Participation and the Environment: Do We Know What Works?* ACS Publications.
- Chilvers, J., 2010. Sustainable Participation? Mapping Out and Reflecting on the Field of Public Dialogue on Science and Technology.
- Chilvers, J., Kearnes, M., 2015. *Remaking Participation: Science, Environment and Emergent Publics.* Routledge.
- Chilvers, J., Pallett, H., Hargreaves, T., 2015. Rethinking energy participation as relational and systemic: scoping note. In: UKERC (Ed.), *UKERC Decision Making.* UK Energy Research Centre.
- Clarke, C., Boudet, H., Bugden, D., 2012. *Fracking in the American Mind: Americans’ Views on Hydraulic Fracturing in September, 2012.* Yale University and George Mason University, New Haven. New Haven, CT Yale Project on Climate Change Communication.
- Corner, A.J., Pidgeon, N.F., 2012. Nanotechnologies and upstream public engagement: dilemmas, debates and prospects? In: Herr Harthorn, B., Mohr, J.W. (Eds.), *The Social Life of Nanotechnology Vol. 18* Routledge, Abingdon, Oxford.
- Corner, A., Pidgeon, N., 2015. Like artificial trees? The effect of framing by natural analogy on public perceptions of geoeengineering. *Clim. Change* 130 (3), 425–438.
- Cotton, M., 2013. Shale gas—community relations: NIMBY or not? Integrating social factors into shale gas community engagements. *Nat. Gas Electr.* 29 (9), 8–12.
- Cotton, M., 2017. Fair fracking? Ethics and environmental justice in United Kingdom shale gas policy and planning. *Local Environ.* 22 (2), 185–202.
- Council of Canadian Academies. (2014). *Environmental Impacts of Shale Gas Extraction in Canada.* In The Expert Panel on Harnessing Science and Technology to Understand the Environmental Impacts of Shale Gas Extraction (Ed.). Ottawa, Canada Council of Canadian Academies.
- Council of Canadians. (2017). Retrieved 12 March, 2017, from <https://canadians.org/>.
- Demski, C., Butler, C., Parkhill, K.A., Spence, A., Pidgeon, N.F., 2015. Public values for energy system change. *Glob. Environ. Change Part A* 34, 59–69.
- Devine-Wright, P., 2009. Rethinking NIMBYism: the role of place attachment and place identity in explaining place-protective action. *J. Community Appl. Soc. Psychol.* 19 (6), 426–441.
- Earthworks, 2016. Comments on Maryland’s Proposed Oil and Gas Drilling Regulations. Retrieved 08 June, 2017, from https://www.earthworksaction.org/library/detail/comments_on_marylands_proposed_oil_and_gas_drilling_regulations#_WTKxoWeGO70.
- Ellsworth, W.L., 2013. Injection-induced earthquakes. *Science* 341 (6142) 1225942.
- Energy In Depth, 2012. *Debunking GasLand.*
- ERCB, 2011. *Unconventional Gas Regulatory Framework — Jurisdictional Review: Energy Resources Conservation Board.*
- ERCB, 2012. *Regulating Unconventional Oil and Gas in Alberta: A Discussion Paper.* Energy Resources Conservation Board, Alberta, Canada.
- Evensen, D., Jacquet, J.B., Clarke, C.E., Stedman, R.C., 2014. What’s the ‘fracking’ problem? One word can’t say it all. *Extr. Ind. Soc.* 1 (2), 130–136.
- Felt, U., Fochler, M., 2010. *Machineries for making publics: inscribing and de-scribing publics in public engagement.* *Minerva* 48 (3), 219–238.
- Fiorino, D.J., 1990. Citizen participation and environmental risk: a survey of institutional mechanisms. *Sci. Technol. Hum. Values* 15 (2), 226–243.
- Fischhoff, B., 1995. Risk perception and communication unplugged: twenty years of

- process 1. *Risk Anal.* 15 (2), 137–145.
- FracFocus, 2017a. FracFocus Chemical Disclosure Registry (Ca). Retrieved 08 September, 2017, from <http://fracfocus.ca/>.
- FracFocus, 2017b. FracFocus Chemical Disclosure Registry (US). Retrieved 07 March, 2017, from <http://fracfocus.org/>.
- FracFocus, 2018. Chemicals and Public Disclosure. Retrieved 07 July, 2018, from <https://fracfocus.org/chemical-use/chemicals-public-disclosure>.
- Frack Free Denton (2017). Retrieved 12 March, 2017, from frackfreedenton.com.
- FracTracker Alliance, 2017. FracTracker Alliance. Retrieved 09 March 2017, from <https://www.fracktracker.org/>.
- Gasland, 2017. About the Film. from <http://one.gaslandthemovie.com/about-the-film>.
- Governor's Marcellus Shale Advisory Commission (2011). Pennsylvania.
- Greenpeace, 2017. Fracking. Retrieved 12 March, 2017, from <http://www.greenpeace.org/usa/global-warming/issues/fracking/>.
- Henwood, K.L., Pidgeon, N.F., 2014. Risk and Identity Futures *Future Identities Programme: Government Office of Science/Foresight*.
- Icaro, 2014. Evaluating the Public Dialogue Process on Shale Gas and Oil Developments: Report for Sciencewise.
- IOGCC, 2017. Interstate Oil and Gas Compact Commission. Retrieved 17 March 2017, from <http://iogcc.ok.gov/about-us>.
- IOGP, 2017. International Association of Oil and Gas Producers. from <http://www.iogp.org/>.
- Irwin, A., Wynne, B. (Eds.), 1996. *Misunderstanding Science? The Public Reconstruction of Science and Technology*. Cambridge University Press, Cambridge.
- Jacquet, J., Stedman, R.C., 2011. Natural gas landowner coalitions in New York State: Emerging benefits of collective natural resource management. *J. Rural Soc. Sci.* 26 (1), 62–91.
- Jaspal, R., Turner, A., Nerlich, B., 2014. Fracking on YouTube: exploring risks, benefits and human values. *Environ. values* 23 (5), 501–527.
- Jones, P., Hillier, D., Comfort, D., 2013. Fracking and public relations: rehearsing the arguments and making the case. *J. Public Aff.* 13 (4), 384–390.
- Jordan-Bloch, C., Sutcliffe, K., 2014. Dryden: the Town That Changed the Fracking Game. Retrieved 17 March 2017, from <http://earthjustice.org/features/photos-dryden>.
- Kunda, Z., 1990. The case for motivated reasoning. *Psychol. Bull.* 108 (3), 480.
- Kurath, M., Gislser, P., 2009. Informing, involving or engaging? Science communication, in the ages of atom-, bio-and nanotechnology. *Public Underst. Sci.* 18 (5), 559–573.
- Lis, A., Stankiewicz, P., 2017. Framing shale gas for policy-making in Poland. *J. Environ. Policy Plan.* 19 (1), 53–71.
- Liss, J., 2011. Negotiating the Marcellus: the role of information in building trust in extractive deals. *Negot. J.* 27 (4), 419–446.
- Marcellus Shale Coalition. (2017). About. Retrieved 08 September, 2017, from <http://marcelluscoalition.org/about/>.
- Maryland Department of Planning, 2017. Comprehensive Plans. Retrieved 08 June, 2017, from <http://planning.maryland.gov/OurWork/CompPlans/Welcome.shtml>.
- Mazur, A., 2014. How did the fracking controversy emerge in the period 2010–2012? *Public Underst. Sci.* 1–16.
- McComas, K.A., 2006. Defining moments in risk communication research: 1996–2005. *J. Health Commun.* 11 (1), 75–91.
- McFeeley, 2012. State Hydraulic Fracturing Disclosure Rules and Enforcement: A Comparison *NRDC Issue Brief*. Natural Resources Defense Council.
- Michael, M., 2009. Publics performing publics: of PiGs, PiPs and politics. *Public Underst. Sci.* 18 (5), 617–631.
- Minty, E., 2016. Fracking – A Lesson in Public Engagement. Influence: for Switched-on Public Relations Professionals. Retrieved from <http://influence.cipr.co.uk/2016/05/25/fracking-engagement-battle-lost-started/>.
- Mobbs, P., 2015. “Frackademics” – A Study of the Relationships Between Academia, the Fossil Fuels Industry and Public Agencies. A Report Commissioned by Talk Fracking and Produced by Paul Mobbs' Environmental Investigations. Retrieved 20 November, 2015, from <http://www.talkfracking.org/frackademics/frackademics-report/#introduction>.
- Morgan, M.G., Fischhoff, B., Bostrom, A., Atman, C.J., 2002. *Risk Communication: A Mental Models Approach*. Cambridge University Press, Cambridge.
- Morrison, J., 2014. *The Social License: How to Keep Your Organization Legitimate*. Palgrave Macmillan, Basingstoke.
- Nash, J., 2013. *Assessing the Potential for Self-regulation in the Shale Gas Industry*. Paper Presented at the Workshop on Governance of Risks of Shale Gas Development.
- Navarro, M., 2011. Ruffalo Embraces a Role Closer to Home. Retrieved from <http://www.nytimes.com/2011/12/04/fashion/mark-ruffalo-actor-embraces-anti-fracking-role.html>.
- New Brunswick Commission on Hydraulic Fracturing, 2016. *The Findings*. New Brunswick Commission on Hydraulic Fracturing.
- New York State Department of Environmental Conservation, 2018. *High-Volume Hydraulic Fracturing in NYS*. Retrieved 07 July, 2018, from <https://www.dec.ny.gov/energy/75370.html>.
- North, D.W., Stern, P.C., Webler, T., Field, P., 2014. Public and stakeholder participation for managing and reducing the risks of shale gas development. *Environ. Sci. Technol.* 48 (15), 8388–8396.
- Partridge, T., Thomas, M., Harthorn, B.H., Pidgeon, N., Hasell, A., Stevenson, L., Enders, C., 2017. Seeing futures now: Emergent US and UK views on shale development, climate change and energy systems. *Glob. Environ. Change Part A* 42, 1–12.
- Payson Petroleum, 2017. Investor Experience. Retrieved 2017, 23 March, from <http://www.paysonpetro.com/investor-experience/>.
- PennState Extension, 2017. Marcellus Educational Consortium. Retrieved 07 March, 2017, from <http://extension.psu.edu/natural-resources/natural-gas/consortium>.
- Pidgeon, N., 1998. Risk assessment, risk values and the social science programme: why we do need risk perception research. *Reliab. Eng. Syst. Saf.* 59 (1), 5–15.
- Pidgeon, N.F., Demski, C., 2012. From nuclear to renewable: energy system transformation and public attitudes. *Bull. At. Sci.* 68 (4), 41–51.
- Pidgeon, N., Fischhoff, B., 2011. The role of social and decision sciences in communicating uncertain climate risks. *Nat. Clim. Change* 1 (1), 35–41.
- Pidgeon, N., Hood, C., Jones, D., Turner, B., Gibson, R., 1992. *Risk Perception Risk: Analysis, Perception and Management*. The Royal Society, pp. 89–134.
- Pidgeon, N., Poortinga, W., Rowe, G., Horlick-Jones, T., Walls, J., O'Riordan, T., 2005. Using surveys in public participation processes for risk decision making: the case of the 2003 British GM nation? *Public debate. Risk Anal.* 25 (2), 467–479.
- Pidgeon, N., Harthorn, B.H., Bryant, K., Rogers-Hayden, T., 2009. Deliberating the risks of nanotechnologies for energy and health applications in the United States and United Kingdom. *Nat. Nanotechnol.* 4 (2), 95–98.
- Pidgeon, N., Thomas, M., Partridge, T., Evensen, D., Harthorn, B.H., 2017. Hydraulic fracturing – a risk for environment, energy security and affordability? In: Kasperson, R.K. (Ed.), *Risk Conundrums: Solving Unsolvable Problems*. Earthscan, London.
- Potterf, J.E., Petrzalka, P., Jackson-Smith, D., Ellis, C., Theodori, G.L., Carmichael, C.A., 2014. *Community Perceptions of the Oil and Gas Industry in the Eagle Ford Shale Play*. Utah State University, Logan, UT Institute for Social Science Research on Natural Resources.
- PSE Healthy Energy, 2017. Mission. Retrieved 08 June, 2017, from <http://www.psehealthyenergy.org/ABOUT/Mission>.
- Renn, O., Levine, D., 1991. Credibility and trust in risk communication. In: Kasperson, R.E., Stallen, P.J.M. (Eds.), *Communicating Risks to the Public*. Kluwer Academic Publishers, Netherlands, pp. 175–218.
- Rice, C., 2016. The Struggle for Shared Governance in Hydraulic Fracking Policy: An Interstate Comparison of Texas, Oklahoma, and Colorado *CLOSUP Student Working Paper Series*. Center for Local, State, and Urban Policy, Gerald R. Ford School of Public Policy, University of Michigan, Michigan.
- Rivetti, P., Cavatorta, F., 2018. Algeria: oil and public opinion. In: Overland, I. (Ed.), *Public Brainpower*. Springer, pp. 23–40.
- Rogers-Hayden, T., Pidgeon, N., 2007. Moving engagement “upstream”? Nanotechnologies and the royal society and royal academy of engineering's inquiry. *Public Underst. Sci.* 16 (3), 345–364.
- Rosa, E.A., 1998. Metatheoretical foundations for post-normal risk. *J. Risk Res.* 1 (1), 15–44.
- Rowe, G., Frewer, L.J., 2000. Public participation methods: a framework for evaluation. *Sci. Technol. Hum. Values* 25 (1), 3–29.
- Rowe, G., Horlick-Jones, T., Walls, J., Pidgeon, N., 2005. Difficulties in evaluating public engagement initiatives: reflections on an evaluation of the UK GM Nation? *Public debate about transgenic crops. Public Underst. Sci.* 14 (4), 331–352.
- Rowe, G., Horlick-Jones, T., Walls, J., Poortinga, W., Pidgeon, N.F., 2008. Analysis of a normative framework for evaluating public engagement exercises: reliability, validity and limitations. *Public Underst. Sci.* 17 (4), 419–441.
- Royal Commission on Environmental Pollution, 1998. *Setting Environmental Standards*, 21st Report. London, RCEP.
- Ruckelshaus, W.D., 1983. Science, risk, and public policy. *EPA J.* 9, 3.
- Satterfield, T., Conti, J., Harthorn, B.H., Pidgeon, N., Pitts, A., 2012. Understanding shifting perceptions of nanotechnologies and their implications for policy dialogues about emerging technologies. *Sci. Public Policy* 40 (2), 247–260.
- Scottish Government, 2017. Onshore Oil and Gas. 11 January 2018, Retrieved 14 February, 2018, from <http://www.gov.scot/Topics/Business-Industry/Energy/onshoreoilandgas>.
- Short, D., Elliot, J., Norder, K., Lloyd-Davies, E., Morley, J., 2015. Extreme energy, fracking and human rights: a new field for human rights impact assessments? *Int. J. Hum. Rights* 19 (6), 697–736.
- Small, M.J., Stern, P.C., Bomberg, E., Christopherson, S.M., Goldstein, B.D., Israel, A.L., Jackson, R.B., Krupnick, A., Mauter, M.S., Nash, J., 2014. *Risks and Risk Governance in Unconventional Shale Gas Development*. American Chemical Society.
- STEER, 2016. *South Texas Energy & Economic Roundtable*. Retrieved 23 March, 2017, from <http://www.steer.com/>.
- Stern, P.C., Dietz, T. (Eds.), 2008. *Public Participation in Environmental Assessment and Decision Making*. National Academies Press.
- Stern, P.C., Fineberg, H.V. (Eds.), 1996. *Understanding Risk: Informing Decisions in a Democratic Society*. The National Academies Press, Washington, D.C.
- Stilgoe, J., Owen, R., Macnaghten, P., 2013. Developing a framework for responsible innovation. *Res. Policy* 42 (9), 1568–1580.
- The Williams Companies, 2017. *Community Partnerships*. Retrieved 2017, 21 April, from <http://co.williams.com/communitystakeholder-relations/community-partnerships/>.
- Theodori, G.L., 2013. Perception of the natural gas industry and engagement in individual civic actions. *J. Rural Soc. Sci.* 28 (2), 122–134.
- Thomas, M., Pidgeon, N., 2017. *Shale Gas Engagement in the US and Canada: a Case-Study Review and Recommendations for Best Practice Vol. D18.3 M4ShaleGas Consortium*.
- Thomas, M., Partridge, T., Harthorn, B.H., Pidgeon, N., 2017a. Deliberating the perceived risks, benefits, and societal implications of shale gas and oil extraction by hydraulic fracturing in the US and UK. *Nat. Energy* 2, 17054.
- Thomas, M., Pidgeon, N., Evensen, D., Partridge, T., Hasell, A., Enders, C., Harthorn, B.H., Bradshaw, M., 2017b. *Public Perceptions of Hydraulic Fracturing for Shale Gas and Oil in the United States and Canada*. Wiley Interdisciplinary Reviews: Climate Change.
- Thomas, M., Partridge, T., Pidgeon, N., Harthorn, B.H., Demski, C., Hasell, A., 2018. Using role play to explore energy perceptions in the United States and United Kingdom. *Energy Res. Soc. Sci.*
- TNS-BMRB, 2014. *Public Engagement With Shale Gas and Oil: a Report on Findings From Public Dialogue Workshops*. Sciencewise.

- U.S. Energy Information Administration, 2017. International Energy Outlook 2017.
- U.S. Energy Information Administration, 2018. Annual Energy Outlook 2018 With Projections to 2050.
- USGS, 2017. Earthquake Hazards Program: Did You Feel It? Retrieved 16 March, 2017, from. <https://earthquake.usgs.gov/data/dyfi/>.
- Vasi, I.B., Walker, E.T., Johnson, J.S., Tan, H.F., 2015. No fracking way!" Documentary film, discursive opportunity, and local opposition against hydraulic fracturing in the United States, 2010 to 2013. *Am. Socio. Rev* 0003122415598534.
- Webler, T., 1995. "Right" discourse in citizen participation: an evaluative yardstick. In: Renn, O., Webler, T., Wiedemann, P.M. (Eds.), *Fairness and Competence in Citizen Participation: Evaluating Models for Environmental Discourse*. Kluwer, Dordrecht, The Netherlands, pp. 35–77.
- Wheeler, D., MacGregor, M., Atherton, F., Christmas, K., Dalton, S., Dusseault, M., Gagnon, G., Hayes, B., MacIntosh, C., Mauro, I., 2015. Hydraulic fracturing—integrating public participation with an independent review of the risks and benefits. *Energy Policy* 85, 299–308.
- Whitton, J., Brasier, K., Charnley-Parry, L., Cotton, M., 2017. Shale gas governance in the United Kingdom and the United States: opportunities for public participation and the implications for social justice. *Energy Res. Soc. Sci.* 26, 11–22.
- Williams, L., Macnaghten, P., Davies, R., Curtis, S., 2015. Framing 'fracking': exploring public perceptions of hydraulic fracturing in the United Kingdom. *Public Underst. Sci* 0963662515595159.
- Willow, A.J., 2014. The new politics of environmental degradation: un/expected landscapes of disempowerment and vulnerability. *J. Political Ecol.* 21 (1), 237–257.
- Wilsdon, J., Willis, R., 2004. *See-through Science: Why Public Engagement Needs to Move Upstream*. Demos, London.
- Wynne, B., 2007. Public participation in science and technology: performing and obscuring a political–conceptual category mistake. *East Asian Sci. Technol. Soc.* 1 (1), 99–110.