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Theorising social representations in socio-technical transitions with the case of shale gas

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Abstract

While sociologists of science and technology have long understood technological diffusion and adoption as processes of social embedding, the psycho-social processes involved have received relatively little attention in the socio-technical transitions literature. Here we consider the value of Moscovici's social representations theory in terms of its potential contribution to a theory of socio-technical change, the multi-level perspective (MLP). Using fracking-derived shale gas as a technology case study and newspaper representations of the technology in Poland, Germany and the UK as data, we address and illustrate connections between the processes of anchoring and objectification that are central to social representations theory and the socio-technical dynamics observed. In so doing, we set out an approach for further work on agency in the MLP and socio-technical change processes generally, informed by a social psychological approach that aligns with structuralist concepts.

Keywords

Shale gas; fracking; public opinion; social representations; socio-technical transitions

1. Introduction

It is somewhat surprising that theorisation of socio-technical system change has to date said relatively little about the role of public opinion in system change from a psychological perspective. Nelson and Winter's (1982) technological regime concept originally referred to shared cognitive routines among engineers and technologists, which sociologists of technology broadened to include a wider range of actors (Bijker, 1995, in Geels and Schot, 2007). Yet theories of perception, behavioural, attitudinal or practice change relating to a broader range of system actors appear largely absent in the socio-technical transitions literature, including that on the multi-level perspective (MLP) (Whitmarsh, 2012). The public do sometimes make an appearance as consumers and by proxy as civil society (e.g. Geels, 2013), but detail on (and particularly integration of) psychological processes is largely missing. The same applies to the role of broadcast and other news media, which arguably play a role in both shaping and reflecting public discourse, as both cause and effect (Habermas, 1984). It is not that socio-technical transitions theorists are unaware of the role of the public as citizens or consumers, but they do seem to have paid this role relatively little attention.

Seeking to remedy this and taking the MLP as an exemplar model of socio-technical change (Geels and Schot, 2007), here we develop a cognitive perspective on the interaction between niche, regime and landscape levels, drawing specifically on social representations theory (Moscovici, 1985). In particular, we comment on how the processes of anchoring and objectification, central to social representations theory, interact with the processes posited in the MLP. Accordingly, we view actors as agents who both produce and are affected by social representations. Through linkage with the

MLP, we locate and illustrate social representations as produced in actors' communications and interactions, which become part of the wider background reality that the MLP describes as the landscape of a given socio-technical change, but which also operate at regime and niche levels. In short, we suggest that social representations theory allows us to see the three levels of MLP as interacting with each other through the cognitive practices of the actors involved. Our focus is thus more ideational than material, but it is not on discourse per se, but rather on the use of communication in conjunction with the specific social psychological processes posited in social representations theory.

Empirically, we examine these interactions through a comparative case study of media representations of shale gas in the UK, Germany and Poland, for which there is little similar literature to date, with the exception of e.g. Jaspal and Nerlich (2013). For this purpose, representations of shale gas are particularly apt: being controversial, shale gas exploitation has been diversely thematized in the national media of European nations by a variety of actors from several perspectives, enabling a spread of representations to be observed. In terms of research design, the paper combines empirical illustration with theory development. Our aim is to propose a theoretical perspective for further research rather than to make widely applicable, empirically conclusive statements. The perspective that we develop is intended to be of relevance for both emerging and established socio-technical systems and also for different cultural contexts – hence we use empirics from several countries, illustrative of different political backgrounds, albeit a single class of communications source (newspapers). We begin with an overview of the shale gas sector in the case study countries of the UK, Poland and Germany, selected for their contrasting experiences of shale gas exploitation in Europe. We then provide overviews of the two theories that we wish to bring together; a statement of methods and data follows; finally we discuss connections between the theories and directions for further work.

In Europe, particularly Eastern Europe, exploratory drilling for shale gas has been undertaken by oil and gas majors such as Total and Chevron, as well as smaller operators (Williams and Amiel, 2014), though the extent of the commercially viable resource remains to be seen. In many respects, fracking for shale gas is a regime-level activity of the natural gas extraction industry, supplying a core fossil fuel product and involving the major petroleum service companies such as Halliburton, Schlumberger and Baker Hughes (Westenhaus, 2012). Hence Montgomery and Smith (2010) describe the extensive development and use of fracking in the US particularly (but not only), as having a decadal history, on-going through the second half of the 20th century and up to the present day.

By contrast, fracking in the UK to date has involved mostly lesser-known companies (Griffiths, 2013) and in terms of the exploration and extraction it is only more recently that one of the oil and gas majors (Total) has become involved (BBC News, 2014). On the distribution side in the UK, one of the large distribution firms, Centrica, has part-funded

the exploratory activities of the firm Cuadrilla (Carrington, 2014), itself formed in 2005. In general, fracking activity in the UK up to the time of writing has involved very few of the major international energy firms.

In Poland, the possibility of shale gas exploitation has attracted both global companies like Total, Chevron and ExxonMobil and Polish state-owned companies such as PGNiG, Lotos or PKN Orlen[1]. Since 2007, over one hundred exploration licences have been issued to over thirty companies covering almost 30% of Poland's territory. A large number of licences are in hands of a relatively new player on the oil and gas market, San Leon Energy Plc (17 licences), founded in 1995 with headquarters in Ireland. San Leon Energy Plc is 50% owned by the Quantum Fund of the American philanthropist George Soros and the company Tosca Fund, having acquired its first oil exploration assets in Morocco only in 2007. Most of the licences, though, belong to the Polish state-owned companies. Foreign companies, including the global giants, own between one and five licences each.

In Germany, at the time of writing, the government has stated in a coalition treaty that unconventional gas exploration will not be undertaken at least for the duration of the Grand Coalition government. This followed a widespread furore when, in February 2013, Chancellor Angela Merkel announced draft regulations that would permit use of large scale fracking techniques. The draft legislation was motivated by concerns over high energy costs and came from the Federal Department of Economics, then led by the pro-business Free Democrats. Following an influential 2012 report by the Federal Environment Agency (Umweltbundesamt, 2012), the coalition statement is environmentally precautious, stating that fracking is potentially very high risk; that the use of environmentally toxic substances as part of fracking is rejected; that a request for approval can only be considered when there is sufficient data for the purpose and that any adverse change in water quality can be categorically avoided (Deutschlands zukunft gestalten, 2013).

In terms of public opinion, studies of public attitudes to energy sources and technologies consistently show that the European public favours renewable sources (see Whitmarsh et al, 2011 for a UK-oriented review inclusive of Eurobarometer results). In the UK, attitudes to shale gas show considerable ambivalence and uncertainty – as of June 2014, of the 74% of the British public who have heard of it, half neither oppose nor support it, with support and opposition each accounting for around one-quarter (DECC, 2014). In Poland, there is a general public support for shale gas exploitation in Poland, ranging from 59% in areas surrounding exploration activities to 78% at the country level (CBOS, 2013). In Pomerania, one of the two regions where most of the licences are located, 76% inhabitants have expressed support for shale gas exploration (Jackman & Sterczyńska, 2013, p. 383). In the other most occupied region, Lubelskie, support is even higher and reached 88% (Polish Shale, 2014). In terms of German and Polish activism, Lis (2014) reports that the German anti-fracking movement is stronger than the Polish equivalent,

1 For further information, see: http://gazlupkowy.pl/koncesje/

particularly in North Rhineland-Westphalia and Lower Saxony, i.e. in the most prospective shale gas regions. In addition to local groups and environmental organizations, Bundesverband Bürgerinitiativen Umweltschutz e.V. (Federal Association of Environmental Action Groups) opposes hydraulic fracturing. Lis (ibid) observes that the German movement is better organized and its propositions more far-reaching. Polish opposition centres are mostly local and seldom request a ban on fracking across the whole of Poland.

2. Theoretical perspectives

2.1 The multi-level perspective of socio-technical change

The multi-level perspective argues that transitions come about through different types of interaction between processes at the three levels, via: niche-protected innovations gradually becoming more powerful; landscape-level change that pressures the socio-technical regime; and/or destabilisation of the regime enabling niche-innovations to gain their own momentum (Geels and Schot, 2007). At the micro-level, technological niches are conceived of as the location at which path-breaking innovations emerge. In terms of the original evolutionary metaphor, they are akin to genetic mutations, involving novelty and diversity that may or may not develop further and that the niches act to protect (if only temporarily) (Kemp et al, 1998), often through the actions of small networks of dedicated actors (Geels and Schot, 2007). Hence niches are protected spaces that policies may passively or actively protect, nurture, empower (Smith and Raven, 2012) or hinder. At the macro-level, the socio-technical landscape is conceived of as an exogenous environment that is beyond the direct influence of niche and regime actors and which includes macro-economic and political trends, plus deep cultural patterns (Geels and Schot, 2007). In terms of change processes, summarily, systems of production may take alternative pathways, including transformation, reconfiguration, technological substitution, de-alignment and realignment as the regime is destabilised and previously niche innovations are assimilated into an adapted regime (Geels and Schot, 2007).

In Box 1 we define the processes that are particularly supported by the empirics the present case, returning to these in section 5. Several of these processes are taken from the transition typology of Geels and Schot (2007) - which we treat as general categories of MLP processes - and are supplemented by more general processes. The latter follow from fracked shale gas having strong elements of path dependence in that it continues fossil fuel usage; and also the way in which high expectations of fracked shale gas underpins recent investment in Europe.

Box 1 Selected socio-technical transition processes

Path dependence
Path dependence refers to the way in which critical junctures at an early stage in the development of a socio-technical system persist through self-reinforcing means. Self-reinforcing means that once a choice – for example to use a particular technology – has been made, it is likely to be repeated even if there are better alternatives (Arthur 1994, Pierson 2004). Arthur (1989) defined four major causes for self-reinforcing: (1) large set-up or fixed costs, (2) learning effects, (3) coordination effects, and (4) adaptive and self-fulfilling expectations.

Path creation
From a socio-technical transitions perspective, system transformation based on path creation of more sustainable trajectories requires the active role of entrepreneurs, mindfully deviating from old practices, reflecting and mobilizing of diverse sets of objects and people to create new paths (Garud and Karnoe 2001).

Expectations
Before their future feasibility becomes clear, technoscientific pathways seek support on grounds that lie beyond evidence of technical progress. Such grounds have been theorised as technological expectations, i.e. 'real-time representations of future technological situations and capabilities' (Borup et al., 2006). Rather than simply predicting future realities, expectations mobilise technological and economic activities, thus directing investment towards some pathways rather than others.

Alignment
The Multi-Level Perspective conceives of transitions as outcomes of alignments between developments at multiple levels of the technology system (Geels and Schot, 2007). Radically new technologies have a hard time to break through, because factors such as regulations, infrastructure, user practices and supportive networks are all aligned to the existing technology (Smith, 2007).

De-alignment
De-alignment processes involve deviations from alignment, due to pressures within the regime, or from the niche or landscape levels. Stresses and pressures may arise from new technologies or changing expectations or regulations etc. Regardless of where the processes originate, they involve stresses and pressures that drive and accentuate change in parts of the system.

2.2 Social representations theory

One of the major social psychological theories of perception and social influence is Moscovici's (1988) Social Representations Theory, which identifies two key processes involved in understanding and evaluating changes in the social and physical environment: these are *anchoring* (categorising according to pre-existing cognitive

frameworks, thus rendering the unfamiliar familiar); and *objectification* (translating the abstract into the concrete and tangible, usually involving a mental image), such that new and potentially complicated and abstract concepts acquire tangible and 'real' qualities.

Moscovici (2000) argued that social representations have two functions. First, they conventionalise new concepts and give them a recognisable and common form, thus enhancing communication and coordination within a group: "These conventions enable us to know what stands for what" (ibid p.22). Second, representations prescribe ways of thinking about topics: "they are forced upon us, transmitted, and are the product of a whole sequence of elaborations and of changes which occur in the course of time and are the achievement of successive generations" (ibid p. 24). Moscovici also emphasises that social representations are not static, unlike the Durkheimian concept of representations that served as his inspiration. Instead, social representations are constantly changing as the communities through which they travel themselves change and take up other, new concepts, which in turn are being anchored to older representations; these in turn also become shaped by what comes after. In short, social representations are dynamic and cumulative processes, simultaneously ideational and cognitive.

Bauer and Gaskell (1999), whom we draw on below, visualise the dynamic of social representation as the triangular relationship between: (a) the subjects, or carriers of the representation; (b) the object that is being represented and (c) the "pragmatic context" of the group that holds the representation. Social representation theory concerns the interaction between the three points of the triangle, with each point having an influence on the other two. Bauer and Gaskell thus introduce an explicit time-axis in their visualisation, with the triangle moving in time and thus constantly changing, resulting in their "Toblerone" model of social representation.

In terms of critique of Moscovici's theory, Mckinlay and Potter (1987) argue that social representations are likely further reducible to individual, cognitive processes; however we would still assert that there remains a strong social dimension to knowledge and learning, even if the latter takes place ultimately within individuals (cf Wenger's (1998) concept of learning as taking in place in - and being a product of - social contexts).

2.3 Connecting theories

Both the MLP and social representations theory focus on different types and objects of change, involving different change processes. Yet the two approaches can be readily connected. When Bauer and Gaskell (1999, 2008) refer to a triangular relationship between subject, object and domain (or 'project'), this domain can as well take the form of a socio-technical system as any other phenomenon. The matter of theoretical connection then becomes one of investigating how social representations and related processes affect the processes of the MLP: notably, alternative pathways of transformation, reconfiguration, technological substitution, de-alignment and

realignment, in response to interactions between the niche, regime, landscape, entrepreneurs or new entrants, incumbents and policy at all levels.

In Figure 1 below we bring together the basic concepts graphically, drawing on Geels and Schot (2007) and Bauer and Gaskell (1999). In our empirical illustration we show some of these connections and each connection may in principle be followed in detail, over different periods of time and with varying emphases. Observation of the development of the full range of these connections requires an historical perspective. Our empirics here involve a contentious technology at an early and contested stage of social acceptance in the countries considered, enabling us to observe how social representations can differ substantially, have different strengths and indeed that social embedding of new technology may not take place at all.

< Figure 1 >

In Figure 1, following Bauer and Gaskell (1999), there is more than one subject (S1 and S2) who perceives object (O): we are dealing with social representations, not the cognition of a single individual. There are also multiple points in time (t-1, t and onwards into the future), as representations change. Figure 1 juxtaposes the basic concepts of niche and landscape pressures, with regime states changing in response to pressures. In this conception, social representations interplay in mutual relationship with the positions of political actors, institutions, corporations and other actors. Similarly social representations are involved in a broad range of processes, including those of socio-technical lock-in and path dependence (Arthur, 1989; David, 1985); conversely, processes of path creation (Garud et al, 2010); processes of alignment and dealignment (Geels, 2002); and psycho-social processes of expectation, shaping and imagination (van Lente, 2000), to name only a few of the main processes that have been prominent in the literature of STS and socio-technical change. Associated with those processes are the construction and deconstruction of socio-technical networks that connect material and non-material resources.

In terms of conceptual connections between social representations theory and the MLP, there are precedents in the consideration of the cognitive, normative and regulative rules and institutions involved in co-ordinating human activities (Geels, 2004; Geels and Schot, 2007). For example, Geels and Schot (2007, p.405), drawing on Bijker (1995), discuss closure around a particular interpretation of a new technology, which "involves the build-up of a shared cognitive frame", as an important aspect of social-technical transition processes[2]. Social representations are thoroughly embedded in the collaborative and competitive aspects of social life. What is distinctive about Moscovici's theory, though, and what social representations theory offers beyond ideas of shared cognitive frames, closure and so on, are the particular processes of *anchoring* and *objectification*: it is these processes posited as underpinning shared perception that we

[2] We acknowledge a reviewer for pointing out these further connections with the MLP.

suggest contribute to or hinder socio-technical change processes. Socio-technical outcomes are the result of the interplay of all of the above and more; social representations are only one element in this, but they are an important element that is both influencer and influenced: in part, both explanans and explanandum.

Moreover, as Geels and Schot (2007) emphasise, some social representations are more influential than others, a function of their social, political and material positions. Similar to Callon's (1991) *inscriptions*, we suggest that the most widely shared representations come to form part of the dominant regime *at the cognitive level*. Those representations that are little shared remain as niche-level representations, while those that are cultural and connect to the most widely shared values form part of the slower-changing landscape. While there is discussion of competition between ideas and discourses in the existing socio-technical transitions literature, the cognitive detail of the processes by which ideas come to move from niche to regime have been less addressed. Moscovici's argument (e.g. 2008; originally 1971 and based on an empirical analysis of how the language of psychoanalysis moved from niche medical practice to common parlance) is that for new ideas to succeed, they need to become appropriated and integrated (anchored) into existing frames. While this parallels thinking in discursive entrepreneurship (e.g. Phillips et al, 2004), the analytic processes posited are firmly cognitive.

3. Method

Our aim here is to illustrate some of the connections between MLP and social representations processes, rather than to be exhaustive in terms of the MLP processes covered: there is plenty of scope for further work in this regard. Similarly, we support the theorisation with empirics sampled in a way that reflects the relative incidence of themes, rather than in a way that ensures all of their variety is represented. Hence we used systematic rather than stratified sampling, selecting every *n*th article (e.g. every 5^{th} article in the UK sample). This largely provides a picture of regime-level representations, with niche representations present but on a numerically smaller scale.

For the case studies, the method involved collating representations of fracking and shale gas in recent newspaper articles in each of Poland, Germany and the UK. The choice and number of newspapers examined in each country reflects a combination of the availability of electronically-searchable sources and the aim to represent a range of reporting styles (rather than political representativeness per se). Hence we selected in each country newspaper titles that spanned both the 'serious' press and titles that are lighter in news content. This selection criterion is intended to provide a wide range of types of representation, rather than only different positions.

For the UK, the number of articles was defined by the limits of the NexisLexis search engine and covered in total the most recent 500 articles in The Sun, a popular tabloid that mixes news with entertainment and humour, and the Nexis broadsheet group of 7 newspapers, providing detailed current affairs and business news coverage. The UK

newspapers are: City A.M, Independent.co.uk, Independent on Sunday, telegraph.co.uk, The Daily Telegraph (London), The Guardian (London), The Independent (London), The Observer, The Sunday Telegraph (London), The Sunday Times (London), thetimes.co.uk, The Times (London). As this type of database search does not always produce consistent or accurate output (see Deacon, 2007, in Becker et al, 2012), the search was repeated to provide the full range of newspapers.

For Poland, different search strategies were used, again reflecting data availability. Sampling was again carried out on a systematic basis (every *n*th) article, intended to reflect the relative incidence of opinion rather than its variety. For two selected broadsheets, a search was again carried out through NexisLexis database search engine. For comparison, a search was carried out in open-access internet archives of the professional newspaper for the energy sector Wirtualny Nowy Przemysł as well as for the tabloid FAKT. For Germany, the newspapers inspected were the tabloid Bild and a broadsheet group of four national papers (Tagesspiegel, Frankfurter Rundschau, Süddeutsche Zeitung and Die Welt). As the number of articles per time unit differed in the three countries, and also the date of the first reference found varied, the time periods for which we have data also vary as follows: UK 09/11-06/13; Germany 01/11-06/13; Poland 06/10-06/13. While strict comparability is difficult to obtain due to international differences in factors such as the prevalence of broadsheets, essentially the data represent a broad spread of news discourse on fracking and shale gas in the three countries in the period 2011-13. In total 303 newspaper items were manually coded from a total of 1,334 available items in the above newspapers in that period, i.e. a sample of 23% nearly one quarter of the total available in the 15 newspapers examined.

A theme was defined as the main, or a key, message of the article. Themes were derived bottom-up from the data, by manually inspecting the selected articles and incrementally identifying common themes across articles. Only explicit, not implicit themes were coded and we sought to reflect only themes clearly prominent in the article. Theme coding was undertaken twice, first on an individual country basis and then again where themes were found to be recurrent within a single country but had not been initially searched for in the other countries.

4. Results and discussion

Here we first provide an overview of the themes evident in newspaper representations of shale gas exploitation in the three countries. We then draw on these to illustrate connections between social representations theory and the MLP socio-technical transitions framework. Figure 2 provides quantitative detail, showing the overall thematic frequency (in percentage terms, internally referenced within each newspaper or newspaper set) for selected broadsheets (‘quality press’) across the three countries. Figure 3 shows the overall thematic frequency (in the same terms) in the tabloid (lighter) newspapers of the three countries. Separating the two types of newspapers was intended to provide a more comparable basis than would a mix and assumed different patterns of representations in the quality and lighter press. In fact while visual

comparison of Figures and 2 and 3 allows observation of some such differences, overall thematic incidence among the newspapers and newspaper classes was *not* statistically significant and we refer to this further below.

4.1 United Kingdom

During 2012, The Sun appears unsure about the advantages and disadvantages of fracking and where its position lies. Hence at an early stage in the UK debate, the newspaper reports in a neutral way the Irish visit of Nigerian campaigner: "In my home country of Nigeria we have seen oil companies destroying our land… Your country is beautiful - you must not let it be destroyed." (The Sun (England), August 18, 2012). By the end of 2012, however, The Sun has shifted to a strong use of humour and punning, combined with an emphasis of the potential benefits of shale gas not only at the national scale, but also in terms of reduced household bills. There is more of an emphasis on territoriality, with shades of patriotism (these are strong and long-standing themes in the style of this particular newspaper).

Fracking was given the go-ahead by the UK Government in mid-December 2012, but the likelihood of this was this was anticipated and strengthened through officially-commissioned reports such that of Public Health England, which assessed the likely health impacts as low in October 2012 (PHE, 2013). During the months prior to this, the potential economic value of the resource in the UK and the actual economic value of the resource in the US appear to coincide with a shift in both columnist and news articles in both the broadsheets and The Sun to a more concerted favouring of the exploitation of shale gas. This shift over time is illustrated by The Sun's increasing reference to the household benefits of fracking and the newspaper's use of humour (appended Figures A3a, b, c). The predominant themes in this more recent period are an appreciation and positive approval of the perceived benefits of the fossil fuel resources, with the broadsheets reporting the many commercial deals involved. Indeed Total has since gone ahead with investment in UK fracking (BBC, 2014).

In both UK newspaper types (broadsheet and tabloid), there is a strong theme of fracking-derived shale gas as revolutionary and this is portrayed through a variety of metaphors: as tectonic plates shifting (The Sunday Times (London), February 24, 2013) (see Box 2); as the Opec 'stranglehold' being broken by the shale 'revolution' (thetimes.co.uk, January 17, 2013); as a 'wake-up call that will change the world' (Independent.co.uk, December 14, 2012) and a confounding of the thesis of peak oil: "Bob Dudley, the chief executive, said: 'Conventional wisdom has been turned on its head. Fears of oil running out appear increasingly groundless.'" (independent.co.uk, January 17th 2013). In the UK broadsheets the global implications are seen as potentially profound, extending well beyond energy security: "The geopolitical implications are huge: what if the dollar sharply strengthens, and Washington grows less inclined to meddle in the Middle East?" (The Independent on Sunday, February 10, 2013).

Following UK Government approval of the resumption of fracking, a notable theme in the broadsheets is government support for fracking being symptomatic of a weakening of the government's position on climate change targets, also with the associated, internal differences within Government that are endemic to Whitehall : "Climate minister keeps his distance from 'dash for gas' (thetimes.co.uk, December 6, 2012); and "The pledge reinforced George Osborne's aim of making a 'dash for gas' the main thrust of Britain's future energy policy, raising more concerns that the Coalition was moving away from its promise of being the 'greenest government ever'" (Independent.co.uk, October 9, 2012). The appendix offers additional thematic and timing detail on the UK case by way of illustration.

4.2 Germany

With the exception of only the earliest articles on fracking, which started to appear in 2011, the German press almost invariably described fracking as "controversial" ("umstritten"), even within the more positive or neutral articles. Even articles outlining the views of proponents of fracking included an acknowledged that this is a contested technology. Overall, the coverage of fracking has not been positive and this is the case for the tabloid as well as the 'quality' press.

With the technology having been established as a contentious public issue, fracking featured in the German news extensively during the latter part of the period surveyed. As the country was at that time heading for a federal election (held in September 2013), politicians of all the main parties aimed to clarify their positions on this and other issues. Additionally several regional Landtag elections were to be held during the period. Mindful of the generally negative attitude of the German public, statements rarely offered unqualified support for fracking (especially so in the regions); instead the positions ranged from complete rejection to very stringent demands of assurances on safety before fracking should be allowed (e.g. "Following the Bavarian environment minister Marcel Huber (CSU), the SPD has also called for a fundamental prohibition of gas extraction using fracking, as long as dangers to the environment cannot be ruled out" Bild, 1.3.2013).

Also notable in the German press are references to the relative "cleanliness" of natural gas in terms of CO_2 emissions ("a reputation for being environmentally friendly" Frankfurter Rundschau, 30.5.2012), which has allowed fracking to be framed as a transition technology in the more positive articles. Similarly fracking has been presented in terms of the benefits for the national economy and, less so, for individual energy companies and local economies. Energy security was featured mostly in discussions of fracking in the US and consequently about the benefits to US energy security and the resulting geopolitical changes, rather than with reference to Germany. Indeed the geopolitical changes that fracking might drive were given substantial attention. This was sometimes framed positively and often in association with culturally-specific opinion (one Bild comment piece argued that, as Saudi-Arabia's influence wanes due to the West supplying its own fuels, it will be less likely to fund religious fundamentalist schools all

over the world (Bild, 18.2.2013)). More neutrally observed geopolitical consequences of fracking in the US centred around a projected reduction in the military presence of the US in the Middle East and elsewhere.

While geopolitics was thus a major theme of discussion, controversy over fracking in Germany has centred mainly on local environmental issues. These were sometimes not further defined, but very frequently the issue that stood out was the contamination of groundwater supply. Within this particular debate, there was an interesting difference in the terminology used to refer to the water supply. Particularly so in the tabloid, the term used in the earlier articles, before the public debate reached the peak of the last few months of the analytic period, tended to be "ground water" ("Grundwasser": 10 references in the broadsheets, 11 in Bild). This gradually shifted to "drinking water" ("Trinkwasser": 14 references in the broadsheets, 25 in Bild) as the debate became more heated and as newspaper articles - and the politicians reported on - shifted to a more negative stance. In general, "drinking water" has health risk connotations that are less obvious in the term "ground water". This concern over drinking water contamination finally resulted in a somewhat idiosyncratic German furore over the traditional German beer purity laws, after the German Brewers Federation (Deutscher Brauer-Bund) entered the debate, with fears that they may no longer be able to guarantee uncontaminated beer, and thus endanger a part of German "cultural heritage" (Bild, 23.5.2013).

4.3 Poland

The Polish case study shows how shale gas representations were changing over time from primarily economic and related to energy security to being associated with specific issues of taxation and environmental regulations. One can also see how through media representations shale gas becomes cognitively embedded into the fossil fuel regime of energy production in Poland.

Between 2010 and 2012, two main themes in *Gazeta Wyborcza* (GW) were dominant: that shale gas is geopolitically game changing (21 times) and that it will enhance Poland's energy security (6 times). One could read that: "shale gas is a great chance for Poland. Thanks to shale gas exploitation Poland may gain independence in energy policy" (GW, May 24, 2013). Shale gas was a controversial topic (11 times) raising patriotic feelings from time to time (9 times). For example, in September 2011 information leaked to the press that Russian capital stands behind companies with licences to explore shale gas in Poland and that Russia may be trying to obstruct exploration processes in Poland (GW, 23 September, 2011). The government issued a statement that Polish regulations will not let Russian companies block shale gas exploration (GW, 23 September, 2011). These quite general expressions of fear of Russia's interference have become more substantiated when in mid-2012 Exxon Mobil announced moving its exploration activities away from Poland. This has immediately been connected to Russia's interest in spoiling Poland's plans to exploit shale gas in the future: "Maybe it is not convenient for Exxon to invest in Poland because this is not what Gazprom with its stranglehold on our gas supplies wants" (GW, 28 December, 2010).

From 2010 throughout 2013, *GW* presented shale gas as having great economic importance for Poland (18 times) and a commercial value for companies (4 times). The search for shale gas was compared to the 'gold rush' and its impact on the American economy was emphasized (GW, 27 January, 2010). The 'gold rush' metaphor also referred to the level of interest of foreign companies in Poland's shale gas reserves: "in our country 'all the great ones of this world' - for example, Exxon Mobil, Chevron, ConocoPhillips, Marathon Oil Corp. are looking for shale gas" (GW, 27 January, 2010). Companies' interest in Polish shale gas reserves brought about hopes for energy security: "they will earn money and we will gain energy security" (GW, 27 January, 2010).

In *Dziennik Gazeta Prawna* (*DGP*), shale gas is also generally framed as a unique chance for Poland to achieve independence from Russian gas supplies with lower energy prices that will boost Polish economy. It feels that Poland 'hit the jackpot'. Between 2010 and 2011, shale gas was often presented as geopolitically game changing with frequent references made to the environmental controversies of fracking. In March 2012, a report on Polish shale gas reserves, carried out by the Polish Geological Institute, estimated the quantity of exploitable shale gas at about 10 times lower level than the earlier optimistic estimations made by the US Energy Information Agency (340-760 billion m^3 compared to 5,300 billion m^3). After 2012, new frames came forward: supply limits, uncertain effects on fuel costs and concerns about environmental damage. According to the tabloid *FAKT*, that was: "the end of the dream" (FAKT, 4 December, 2012.).

In *WNP*, geopolitically game changing role of shale gas has frequently been mentioned (10 times) with regard to Poland's relations to Russia, to the EU, as well as to Germany. In October 2013 the *WNP* wrote "First of all, shale gas is dangerous for many companies. By betting on renewable energy sources, Germany has, with a great style, developed production and research in this sector. For them shale gas is a serious competitor" (WNP, 10 October, 2013).

In the second half of 2011 the government started to prepare a special law to regulate taxation from shale gas exploration (GW, 7 October, 2011). Most of the articles on taxation (4 out of 7) appeared from October till December 2011. In November 2011 *GW* wrote that the Polish companies were not worried about new taxation as it is "a song of the future" (GW, 23 November 2011).

In *GW* references to environmental damage were made 8 times. It has often been worried that environmental concerns may hold back exploitation activities (5 times in *GW*, 7 times in *DGP*, 7 times in *WNP*). In *DGP*, environmental concerns appear mostly in articles that report opponents' activities (6 times). This perhaps reflects the rather business oriented than environmental oriented character of the broadsheet. Only four times, *DGP* makes a point that shale gas extraction requires a high level of environmental protection. In July 2013, the WNP wrote "On Thursday, the environmental committee of the European Parliament adopted regulations unfavourable for shale gas exploitation. It wants shale gas exploration activities to be covered with a

full environmental impact assessment which may make shale gas exploitation less profitable" (WNP, 11 July, 2013).

In *FAKT* environmental protestors are presented as "hordes of eco-terrorists came running to us to convince people that gas exploration is a tragedy which destroys the environment" (FAKT, 27 February, 2012). *Fakt* presents shale gas mainly as a controversy (18 times), but at the same time manageable in terms of potential adverse effects (12 times) and thus safe (10 times). Remarkably, in the second half of 2012, *Fakt* published a series of ten educational articles in form of questions and answers (allegedly readers' questions), explaining various aspects of shale gas exploration, fracking, its impact on environment, risks and benefits. The articles present shale gas under the headings, like 'we refute the myths', 'the old, good fracking', 'the law is protecting us' and 'we are not afraid of shale gas'. The whole series of articles creates the strong impression of being sponsored by gas companies, even more so because the name of one gas company is repeated in most of the articles. *FAKT* also expresses hope for cheaper gas for households (FAKT, 13 September, 2012 and FAKT, 19 September, 2012).

5. Discussion

Considered alongside socio-technical transitions concepts, social representations theory implies that building more comprehensive accounts of technological change requires looking beyond the materiality of competing technological options and corporate environments. For many actors, representations are intended to be performative, in this context helping to bring to life imagined futures of prosperity and energy independence, or helping to avoid damaged landscapes and a problematically warmer world. It is in the sites and situations of socio-technical controversy that we perhaps best see the social dimensions of technological change: Doise et al (1993, in Laszlo, 1997) emphasise that social representations distinguish as well as bind social groups. This applies both within and between countries and may be relatively constant or change over time. We see evidence of all of this in the media representations: in the change in tone over time in *The Sun*, *Gazeta Wyborcza* and *Dziennik Gazeta Prawna*, in the consistent scepticism of the German newspapers, and in the competing, alternative discourses and metaphors found simultaneously within each of the countries.

While there are some important commonalities across the countries, notably issues of energy security and geopolitics, there are also clear national differences in media discourse (and possibly also reporting standards, given the apparent sponsorship of articles in FAKT). As Laszlo (1997) argues, anchoring as a concept would hold limited analytic value if it was not culturally or socially context-specific. Hence alternative anchors - alternative ways of making new phenomena familiar - are almost inevitable and themselves form part of the competitive environment in which different, partly substitutable technologies are developed and promoted. Some of these anchors cross well between countries and cultures and others do not, remaining culturally specific or at least holding more resonance in one country than in another (e.g. the German *trinkwasser* anchor). Moreover, the anchoring of shale gas in the media discourses

brings the different levels of the MLP together, but this is always in the context of local, situated practices (in our case at national levels), which then lead to different objectifications of risks, both contributing to and reflecting different policy results.

In Poland, for example, shale gas is cognitively aligned with a valued fossil fuel regime through media representations of economic prosperity and energy independence from Russia. Related economic and geopolitical visions constitute the main cognitive frame for interpreting activities related to shale gas exploration. Shale gas in Poland is conceived of within this frame and hence when the 'global giants' come to frack for shale gas in Poland, this is aligned with national hopes for energy security, prosperity and independence from a powerful neighbour. When Exxon Mobil announces its withdrawal, this is aligned with the fear of Russian influence on Polish energy supplies. Interestingly, shale gas was never - in the Polish articles examined - presented as posing a threat to the Polish coal sector. Rather, technological substitution is made 'thinkable' at the geopolitical level. Rather the discussion was of Russian gas being substituted with Polish fracked gas, rather than in terms of coal substitution. In psychological terms, Polish social representations of shale gas do not create a cognitive space for a dissonance between shale gas and coal sectors. Shale gas and coal are anchored together and viewed as aligned, coexisting in a future fossil fuel regime. A relative scarcity of environmental themes in Polish media discourse on shale gas underscores the conclusion that the finding of shale gas does not herald any major technological shift, but rather a path-dependent development in the Polish energy sector.

Anchoring involves not only cognitive but also moral dimensions: the assimilation of new phenomena involves connections to shared values as well as shared perceptions, worldviews, opinions and concepts. Objectification takes this a stage further through familiarisation. A notable example in *The Sun* (UK) is a commentator's domesticated image:

"To get at this vast reservoir of natural resources, you have to use a system called fracking. It's perfectly simple. You squirt water into the rocks far below the surface. They split. And the gas that comes out is piped to your mum's home to keep her toes toasty this winter. . "(Clarkson, The Sun, 15.12.12).

While *The Sun* eventually treats shale gas as just another form of heating fuel, albeit one that the UK potentially owns, so the UK broadsheet group and Polish *DGP* treat shale gas as corporate news of commercial and economic significance. Most of the UK broadsheet articles are in fact entries in the Business sections of the newspapers, involving financial and commercial themes. By contrast the most prevalent themes of articles in *Die Welt* are ones of controversy and environmental concern, objectified in terms of grundwasser and latterly trinkwasser. Opposition in Germany in the period considered was substantial, widespread, hardened over time and mostly related to concern about potential, local environmental impacts. Nonetheless, the international, geopolitical implications of fracking and shale gas were discussed repeatedly and frequently, not only Germany, but in each of the three countries. Indeed statistical analysis (factorial anova

using square root normalised percentage incidence of sub-themes on a per newspaper basis) shows no significant difference in the overall variance of themes between the newspapers (p=0.729, df=5, F crit 2.279), but does show significant difference in the incidence of the terms per se ($p=1.18e^{-7}$, df=28, F crit 1.557). The anova tests for sources of variance and the pattern of commonality across the newspapers, but above chance (p=0.05) variance among the themes is repeated when (a) the three country broadsheets are compared with each other and (b) when the three country tabloids are compared with each other, reinforcing the impression of shared representations across the countries.

Returning to Figure 1, it should be emphasised that as representations vary and compete, what may be, for example, a form of path creation for one actor can be a form of path dependency for another. These contrasts are further illustrated in Table 1, which provides some examples of article headlines and content (some of which are also referred to above), organised according to selected socio-technical processes. It should be noted that while these processes have discrete meanings in the abstract, in the material world a given phenomenon often exhibits the characteristics of more than one process. As mentioned above, the processes in Table 1 are taken from the transition typology of Geels and Schot (2007), which we treat as general categories of MLP processes, supplemented by more general processes that are evident in representations of fracked shale gas in the countries considered.

Box 2 provides examples of (a) anchoring as the process of connecting to pre-existing conceptual categories and (b) objectification as connection with visual or tangible imagery. Metaphor is often strong in the latter. Where representations are of activities or objects that already have a tangible, physical dimension, rather than being primarily conceptual, the colouring, associative aspect of the association is often conveyed through particular choice of verbs and nouns, with objectification being associative rather than direct. Objectification may also be more or less strong. It is possible that fracking is becoming objectified as the ‘fracking rig’ in the public mind, but at this stage, this is speculation. By contrast, cloning has been suggested as firmly objectified in the public mind during the 1990s through images of ‘Dolly the Sheep’ (Bauer and Gaskell, 1999).

Table 1 Social representations of fracked shale gas (FSG) as cognitive dimensions of socio-technical change processes (examples from Poland, Germany and the UK)

Socio-technical processes	**Pro shale gas representations**	**Anti-shale gas representations**
Path creation	*FSG as a new energy source that is geopolitically revolutionary* E.g. The US may soon be self-sufficient in fuel, with profound economic, political and environmental consequences (thetimes.co.uk, July 25, 2012 and Bild, April 19, 2012). E.g. As a result of these changes, most probably, new coalitions will be made on the geopolitical scene which will replace the old state of power relations. (Dziennik Gazeta Prawna, November 15, 2012)	*FSG as an unwanted variant in fossil fuel extraction* E.g. The risks posed by fracking chemicals exceed the benefits (Frankfurter Rundschau, May 21, 2013). E.g. Having respect for environmental goals and for the need to reduce greenhouse gases, especially CO_2, we decided to still bet on coal (…) – added Prime Minister Tusk (WNP, September 10, 2013).
Path dependence	*FSG maintains existing ways of life* E.g. A cheap and plentiful supply of gas means society can keep on going. People can still drive cars and have patio heaters and take foreign holidays (The Sun, December 15, 2012). E.g. Lower costs of energy will increase competitiveness of the industries and may attract new investments, especially in the situation when the previous investors' attractor – the lower labour costs – is slowly disappearing. (WNP, September 2, 2013).	*FSG entrenches fossil fuels* E.g. The shale-gas boom could undermine investments in renewable energies (Die Welt, April 21 2011).
Expectations and visions	*FSG will support national and commercial prosperity* E.g. …with the controversial extraction method of fracking, the energy prices will be lowered considerably (Tagesspiegel, May 31, 2013). E.g. Shale gas can be a chance for re-industrialization in Poland (WNP, September 2, 2013). Abundance of domestic gas is also a chance for modern chemical industries, petrochemical industries and for the production of	*Investor concerns about FSG* E.g. Oil and gas explorers come under pressure to clamp down on controversial extraction process (Independent.co.uk, June 15, 2012). E.g. In order to succeed we need legal regulation favorable for the risky gas extraction investment. And we do not have such – notes a representative of the gas industry. (Dziennik Gazeta Prawna, May 22, 2013)

	equipment for shale gas extraction. (Gazeta Wyborcza, May 27, 2011)	
Alignment (regime-level)	*FSG fits with the existing socio-technical system (positive)* We are looking at power shortages in two or three years, and the first new nuclear plant is at least a decade off. Fracking is a godsend (the.times.co.uk, February 24, 2013). Natural gas will become the oil of the 21st century (Tagesspiegel, Feb 13, 2012). E.g. Oil and coal dominate global energy consumption. Natural gas has a large share of the market as well. And the future belongs to gas. (Dziennik Gazeta Prawna, November 15, 2012)	*FSG fits with the existing socio-technical system (negative/mixed)* It is also debatable whether it will be worth it for the gas industry, because every bit of regulation will drive the costs higher (Frankfurter Rundschau, Feb 2, 2013).
De-alignment (landscape-level)	*FSG-induced geopolitical change viewed positively* E.g. the prospect of a self-sufficient Britain is causing alarm in gas-rich Russia, where President Vlad Putin assumed he had Western Europe at his mercy (The Sun, September 21, 2012. E.g. Should something horrible happen in the middle east, then I can easily imagine that a US president would say: 'I don't care. We have enough energy (Tagesspiegel, Feb 22, 2013). E.g. Such developments may cause that Russia, the main player on the global conventional gas market, will start losing around 1 percent of PKB each year. (Dziennik Gazeta Prawna, April 29, 2013)	*FSG-related geopolitics as posing dilemmas* E.g. Germans would import Russian gas without worrying about environmental impacts in Russia… I would call this hypocrisy, Oettinger [EC Commissioner for Energy] said (Das Bild, 29 May 2013).

Box 2 Examples of anchoring and objectification: UK article headers

Example from 'The Sun', UK tabloid
Not for shale; THIS PRETTY VILLAGE COULD BE SITTING ON VAST RESERVES OF FUEL YET GETTING TO THEM MEANS USING CONTROVERSIAL FRACKING TECHNIQUE. BUT ANGRY LOCALS SAY THEY'RE... The Sun (England), May 15, 2013 Wednesday, NEWS; Pg. 22, 847 words, OLIVER HARVEY; STEWART WHITTINGHAM In the US it has been credited with kick-starting their economy by providing cheap energy and jobs and could make the country self-sufficient in energy by 2030. Yet the usually sedate villagers of Balcombe in West *Sussex have a message for the oil men: Frack off…*

Here fracking is anchored to the imagery of territorial defence. Punning is endemic in The Sun and has the effect of reducing the mystique of fracking, rendering it more familiar through association with informal discourse. Here there are puns on 'sale' ('not for shale') and the abusive F word ('frack off'), a recurrent fracking pun in The Sun. Although the editorial stance of the paper appears to shift to a positive stance on fracking during the period examined, the imagery in this example is of a situation in which outsiders seek to buy off local residents, who crudely reject the offer in response. In general, humour has a long history in signalling and supporting political resistance (Lockyer, 2006).

Example from The Sunday Times, UK broadsheet
Uncle Sam won't share his shale gas goodies; IRWIN STELZER AMERICAN ACCOUNT, The Sunday Times (London), February 24, 2013 Sunday, BUSINESS; Pg. 4, 859 words, IRWIN STELZER. The tectonic plates are shifting is an over- used expression, deployed by fashionistas when skirt lengths change by a few inches, and by politicians when some unknown soars to his 15 minutes of fame. When it comes to the energy industry, however, the expression is apt.

Here fracking is anchored to imagery including a parody of selfishness (perhaps of a child), followed by a seismic image, both evocative metaphors used to convey a sense of what fracking has given to the USA and the associated international, geopolitical implications.

Example from The Sunday Times, UK broadsheet
Exxon eyes UK shale. The Sunday Times (London), December 16, 2012 Sunday, BUSINESS; BUSINESS; FRONT PAGE; Pg. 1, 72 words. THE world's largest oil company is considering a bet on Britain's nascent shale gas revolution, writes Danny Fortson. Exxon Mobil has entered talks to buy a stake in the Bowland drilling operation in northwest England owned by IGas, the London-listed developer. The interest of the $400bn (£245bn) American giant emerged just days after the British ban on fracking was lifted. Shell, Total and Statoil are mulling bids.

Again this example uses a greed-related or covetous metaphor to portray the oil major, accompanied by connotations of speculation. The fracking development itself is new-born, emergent and revolutionary. Revolution is a very common theme in newspaper articles on fracking during the period examined.

Table 1 splits a number of examples of different processes into 'pro' and 'anti' camps to emphasise that the cognitive dimensions of processes of system change can be competitive or collaborative, contested or shared. Often a specific newspaper article will contain several co-existing but different representations, while at other times, particularly if the item is a letter or commentary, the view expressed is one-dimensional. News media articles provide an insight into the struggle of ideas, which in turn underpin the political struggle for supportive or hindering regulation of fracking for shale gas and the deliberation of actors as they seek to respond and position themselves. As mentioned, the processes are ideational but also psychological: while social representations theory can be distinguished from discursive theories by its emphasis on psychological processes, there is a commonality in the data that both approaches use. The ideational and material aspects of the situation are represented in different ways by different people and authors, but nonetheless in a way that integrates these into pre-existing, socialised cognitive schemata.

6. Conclusions

Social representations have many functions, including the capacity to propose, defend and justify particular perspectives: as Howarth (2006) expresses it, social representation 'is not a quiet thing'. Here we have brought together social representations theory and the multi-level perspective of socio-technical change, directing attention to socio-technical structures and change processes in which social representations are likely to play a role and providing illustrations of anchoring and objectification for Poland, Germany and the UK, European countries with a recent but different recent histories of fracking debate and practice. In connecting theories and allocating representations to particular processes posited in the MLP and to socio-technical change processes generally, we have shown how news media representations of a 'new' technology indicate the dynamics involved, while at the same time performatively support the construction of socially shared, but also competing, understandings.

Each technology case will involve particular representations involved in particular interactions of niches, regimes and particular aspects of the landscape. Fracking for shale gas is in some ways unusual in that fracking is as much a practice as a closely coupled set of technologies. Moreover shale gas as a commercial resource is not 'new': the first commercial natural gas well in the US was reportedly dug in 1821 in Fredonia, Chautauqua County (NYSDEC, 2007). Natural gas, its supply and distribution infrastructure and the companies and institutions involved in its delivery are all long established: in many ways, shale gas is the product of an incumbent sector. Nonetheless, the technology of hydraulic fracturing and the scale of exploitation of this resource are new globally and particularly new to Europe and its publics.

Nonetheless, the theoretical linkage proposed is intended to offer a psychologically informed and focussed account of agency and of differential social embedding, the first of which has been highlighted as under-emphasized in the MLP as originally conceived. While actors have always been part of the MLP and the processes by which agency is

expressed are increasingly specified (Geels, 2014), the psychological dimensions of agency in the MLP have been largely missing (Whitmarsh, 2012) and processes of agency in general under-played (Meadowcroft 2009). By connecting Moscovici's processes of anchoring and objectification to socio-technical change processes, we aim to have opened a way of thinking about this topic that can be further explored with more detailed case studies. Tracking the co-evolution of the social representations of a technology and its societal embedding in an historical case would be particularly interesting. Moreover, rather than simply referencing the MLP and associated dynamics as a contextual framework, we show that there are close theoretical connections to be made between social representations theory and the structural dynamics of socio-technical perspectives. By focusing on a theory of social representations rather than on processes of individual psychology, we hope to have limited the problems of conceptual incommensurability that attempts to integrate different perspectives often encounter (Kuhn; 1962; Feyerabend, 1962 in Oberheim and Hoyningen-Huene, 2013). There is more to say on this topic, but for the time being we leave the discussion here and offer a perspective for further use.

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References

Arthur, B., 1989. Competing Technologies, Increasing Returns, and Lock-In by Historical Events. The Economic Journal 99(394): 116-131.

Bauer, M. and Gaskell, G. 1999. Towards a paradigm for research on social representations. *Journal for the Theory of Social Behaviour* 29, no. 2: 163-186.

Bauer, M. and Gaskell, G. 2008. Social Representations Theory: A progressive research programme for social psychology. *Journal for the Theory of Social Behaviour* 38, no. 4: 335-353.

BBC, 2014. French oil giant Total to invest in UK shale gas. *BBC News online*, January 14th 2014, London: BBC. http://www.bbc.co.uk/news/uk-25695813 [accessed 21.01.14]

Becker, S. Bryman, A. and Ferguson, H. 2012 (eds) Understanding Research for Social Policy and Social Work: Themes, Methods and Approaches, Bristol: The Policy Press.

Bijker, W.E., 1995. *Of Bicycles, Bakelites and Bulbs: Towards a Theory of Sociotechnical Change*. Cambridge, MA, London, England: The MIT Press.

CBOS. 2013. Społeczny stosunek do gazu łupkowego. [Social attitude towards shale gas], public opinion research conducted in May 2013, Warszawa: Fundacja Centrum Badania Opinii Społecznej, http://www.cbos.pl/SPISKOM.POL/2013/K_076_13.PDF, accessed October 1, 2013.

Callon, M. 1991. Techno-economic networks and irreversibility. In *A sociology of monsters: Essays on power, technology and domination*, ed. J. Law, 132-161. London and New York: Routledge.

Carrington, D. 2014. Emails reveal UK helped shale gas industry manage fracking opposition. *The Guardian online* 17.01.14. London: The Guardian, http://www.theguardian.com/environment/2014/jan/17/emails-uk-shale-gas-fracking-opposition

DECC, 2012. *The unconventional hydrocarbon resources of Britain's onshore basins - shale gas*, DECC, London, https://www.og.decc.gov.uk/UKpromote/onshore_paper/UK_onshore_shalegas.pdf [accessed 14.01.14]

DECC, 2014. *DECC Public Attitudes Tracker – Wave 10*. Department of Energy and Climate Change, London. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/342426/Wave_10_findings_of_DECC_Public_Attitudes_Tracker_FINAL.pdf [accessed 15.12.14]

Deutschlands zukunft gestalten, 2013. *Koalitionsvertrag, zwischen CDU, CSU, SPD*, http://www.bundestag.de/dokumente/textarchiv/2013/48077057_kw48_koalitionsvertrag/koalitionsvertrag.pdf [accessed 14.01.14]

Doise, W., 1993. Debating Social Representations, ed. G. M. Breakwell and D. Canter *Empirical Approaches to Social Representations*. Science Publications: Oxford.

Feyerabend, P. 1962. Explanation, Reduction and Empiricism, in H. Feigl and G. Maxwell (ed.) Scientific Explanation, Space and Time. Minnesota Studies in the Philosophy of Science, Volume III. Minneapolis: University of Minneapolis Press: 28-97.

Garud R., Kumaraswamy, A., Karnøe P. 2010. Path dependence or path creation? J. Manag. Stud. 47, 760–774.

Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory. Research Policy 33, 897-920.

Geels, F.W. (2002) Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. Research Policy 31(8-9), 1257–1274.

Geels, F.W., 2012. A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. *Journal of Transport Geography*, 24: 471-82.

Geels, F.W., 2013. The impact of the financial–economic crisis on sustainability transitions: Financial investment, governance and public discourse. Environ. Innov. Soc. Transitions 6(0): 67–95.

Geels, F.W. 2014 Regime Resistance against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective. Theory, Culture and Society doi:10.1177/0263276414531627

Geels, F. W., and Schot, J. 2007. Typology of sociotechnical transition pathways. *Research Policy* 36, no. 3: 399-417.

Griffiths, 2013. Shale gas rush: the fracking companies hoping to strike it rich. *The Guardian online* 12.03.13. London: The Guardian, http://www.theguardian.com/environment/2013/mar/12/shale-gas-rush-fracking-companies [accessed 21.01.14]

Habermas, J., 1984. The Theory of Communicative Action, Vol. 1. Boston, MA: Beacon.

Hess DJ. 2014. Sustainability transitions: A political coalition perspective. *Research Policy* 43, no. 2: 278–283.

Howarth C. A. 2006. Social representation is not a quiet thing: Exploring the critical potential of social representations theory. *Br. J. Soc. Psychol*. 45, no. 1: 65–86.

Jackman, M. and Sterczyńska, S. 2013. Gaz z łupków w oczach mieszkańców, samorządów, koncesjonariuszy i instytucji województwa pomorskiego. [Shale gas in the perception of the inhabitants, local authorities, license holders and institutions from the Pomorskie Region] Przegląd Geologiczny, 61(1), 381–385.

Jaspal R, Nerlich B. 2013. Fracking in the UK press: Threat dynamics in an unfolding debate. *Public Underst. Sci.* online August 13, 2013 doi:10.1177/0963662513498835

Kemp, R., Schot, J., and Hoogma, R., 1998. Regime Shifts to Sustainability Through Processes of Niche Formation: The Approach of Strategic Niche Management. *Technology Analysis & Strategic Management* 10: 175-195.

Kuhn, T. 1962. The Structure of Scientific Revolutions. Chicago: University of Chicago Press.

Laszlo, J. 1997. Narrative organisation of social representations. *Papers on social representations* 6: 155-172.

Lente, H. van. 2000. From promises to requirement, in Brown, N., Rappert, B. and Webster, A. (eds) Contested Futures: A sociology of Prospective Technoscience, Aldershot, Ashgate.

Lis, A. 2014. Public Controversies Over Shale Gas In Europe – Germany. News service of Polish Geological Survey, Warsaw, http://infolupki.pgi.gov.pl/en/society/public-controversies-over-shale-gas-europe-germany [accessed 17.12.14].

Lockyer, S. 2006. A two-pronged attack? Journalism Studies 7(5), 765–781. http://dx.doi.org/10.1080/14616700600890422.

Mckinlay, A. and Pottter, J. 1987. Social representations: a conceptual critique. Journal for the Theory of Social Behaviour 17: 471-487.

Meadowcroft, J. 2009. What about the politics? Sustainable development, transition management, and long term energy transitions. Policy Sciences 42: 323-340.

Montgomery, C.T. and Smith, M.B. 2010. Hydraulic Fracturing. History of an enduring technology. Journal of Petroleum Technology archives, December 2010. http://www.ourenergypolicy.org/wp-content/uploads/2013/07/Hydraulic.pdf [accessed 30.12.14]

Moscovici, S. 1988. Notes towards a description of social representations. *European Journal of Social Psychology* 18: 211–250.

Moscovici, S. 2000. *Social representations*. Cambridge: Polity

NYSDEC, 2007. New York's oil and natural gas history - a long story but not the final chapter. New York State Department of Environmental Conservation, http://www.dec.ny.gov/docs/materials_minerals_pdf/nyserda2.pdf [accessed 14.01.14]

Nye, M., Whitmarsh L, Foxon T. (2010) Socio-psychological perspectives on the active roles of domestic actors in transition to a lower carbon electricity economy. Environ. Plan. A 42(3): 697–714 (2010).

Oberheim, E. and Hoyningen-Huene, P. 2013. The Incommensurability of Scientific Theories. In Edward N. Zalta (Ed.) The Stanford Encyclopedia of Philosophy (Spring 2013 Edition), http://plato.stanford.edu/archives/spr2013/entries/incommensurability/

PHE, 2013. Review of the potential public health impacts of exposures to chemical and radioactive pollutants as a result of the shale gas extraction. London: Public Health England. http://www.hpa.org.uk/Publications/Environment/PHECRCEReportSeries/1310Reviewofthepotentialhealthimpactsshalegas/ [accessed 23.01.14]

Phillips, N., Lawrence, T., Hardy, C. 2004. Discourse and Institutions. *Academy of Management Review* 29 (4): 635–652.

Polish Shale. 2014. Mieszkańcy Lubelszczyzny popierają wydobywanie gazu łupkowego, [Inhabitants of Lubelskie support shale gas exploration], LupkiPolskie.pl, www.lupkipolskie.pl/aktualnosci/newsy-z-polski/03-2013/mieszkancy-lubelszczyzny-popieraja-wydobywanie-gazu-lupkowego#, accessed 26.03.2013

Raven R, Schot J, Berkhout F. 2012. Space and scale in socio-technical transitions. *Environ. Innov. Soc. Transitions* 4, no. 0: 63–78.

Riley, A. 2012. The Shale Revolution's Shifting Geopolitics. *The New York Times*, Opinion Pages, 25/12/12, http://www.nytimes.com/2012/12/26/opinion/global/the-shale-revolutions-shifting-geopolitics.html?_r=0 [accessed 14.01.14]

Smith, A. 2007. Translating Sustainabilities between Green Niches and Socio-Technical Regimes, Technology Analysis Strategic Management19(4), 427–450.

Smith, A. and Raven, R., 2012. What is protective space? Reconsidering niches in transitions to sustainability. *Research Policy* 41: 1025-1036.

Środowiskowe aspekty poszukiwań i produkcji gazu ziemnego łupkowego i ropy naftowej łupkowej. 2011. Ministerstwo Środowiska oraz Państwowy Instytut Geologiczny-Państwowy Instytut Badawczy, Warszawa, https://www.mos.gov.pl/g2/big/2011_08/d048c148f02734c384a119266ba159b8.pdf, accessed 27.03.14.

Umweltbundesamt 2012. *Umweltauswirkungen von Fracking bei der Aufsuchung und*

Gewinnung von Erdgas aus unkonventionellen Lagerstätten. http://www.umweltbundesamt.de/sites/default/files/medien/461/publikationen/4346.pdf

Wenger, E. 1998. Communities of practice: learning, meaning, and identity. Cambridge University Press.

Westenhaus, B. 2012. New Fracking Technology to Bring Huge Supplies of Oil and Gas to the Market. www.oilprice.com, 16 January 2012. http://oilprice.com/Energy/Natural-Gas/New-Fracking-Technology-To-Bring-Huge-Supplies-Of-Oil-And-Gas-To-The-Market.html [accessed 22.01.14]

Whitmarsh, L., Upham, P., Poortinga, W., Darnton, A., McLachlan, C, Devine-Wright, P., & Sherry-Brennan, F. 2011. *Public Attitudes to Low-Carbon Energy - Research Synthesis*. RCUK. http://www.rcuk.ac.uk/RCUK-prod/assets/documents/energy/EnergySynthesisFINAL20110124.pdf

Whitmarsh L. 2012. How useful is the Multi-Level Perspective for transport and sustainability research? *J. Transp. Geogr.* 24(0): 483–487.

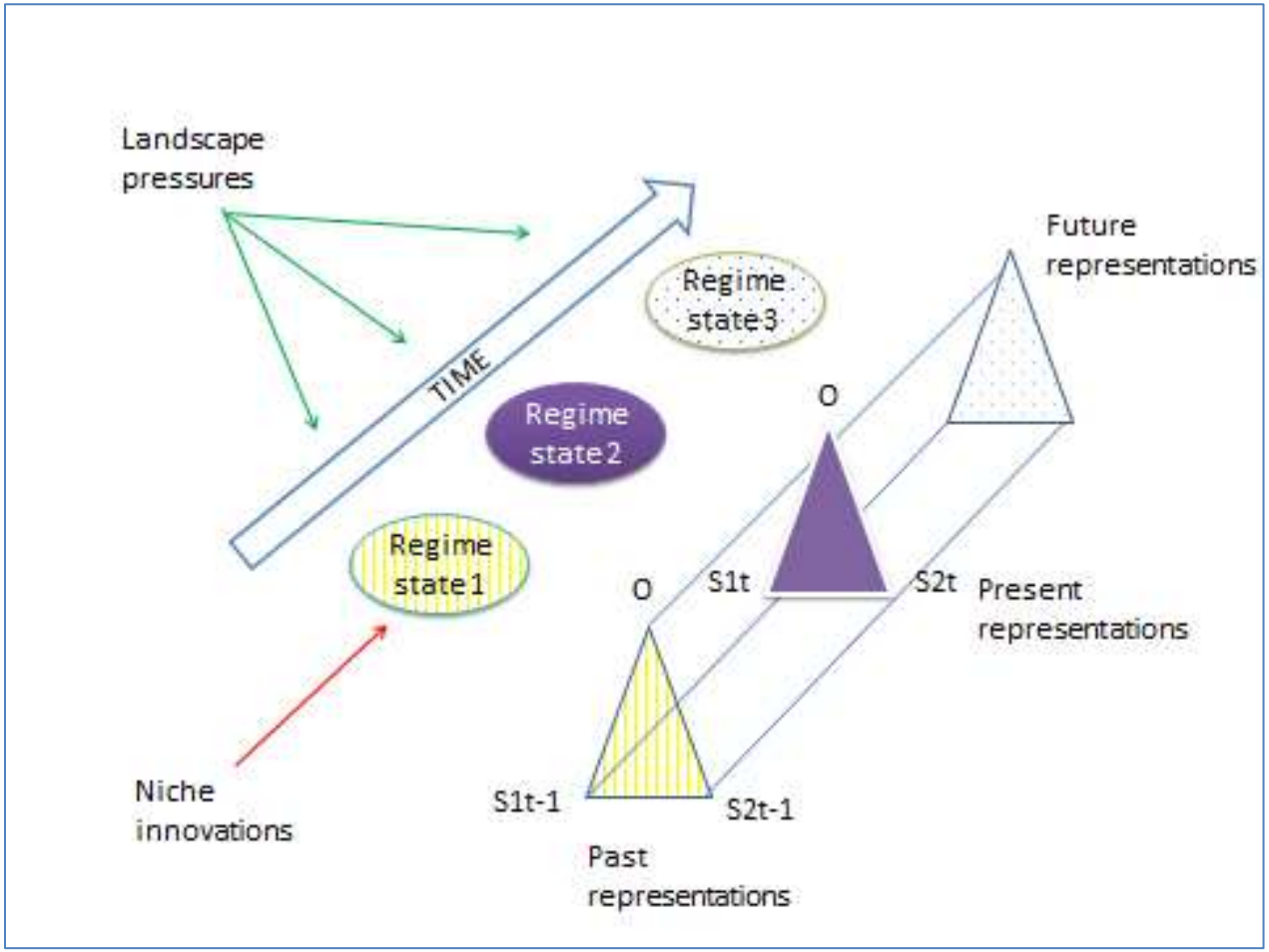
Figure captions

Figure 1 Processes of evolving social representation and socio-technical change

Figure 2 Thematic frequency (%) in the broadsheets of the three countries (key, explicit themes only)

Figure 3 Thematic frequency (%) in the tabloids of the three countries (key, explicit themes only)

Figure 1 Processes of evolving social representation and socio-technical change (after Bauer and Gaskell, 1999)



Note to Figure 1: In the simplification posed by Bauer and Gaskell (1999), there are two subjects (individual perceivers)

who carry a social representation, S1 and S2. O is the object of their representation and they are related in a project or domain represented by a triangle. This relationship has a past (t-1), a present (t) and a future. Again maintaining the simplification, we take the domain in question to be the state of the regime for a particular socio-technical system, itself subject to niche and landscape pressures, positing that the changing state of that regime is in part a function of changing and competing social representations. Niche representations are those that are marginal relative to dominant, regime-level representations. Landscape representations are long-lasting, relatively stable representations.

Figure 2 Thematic frequency (%) in the broadsheets of the three countries (key, explicit themes only)

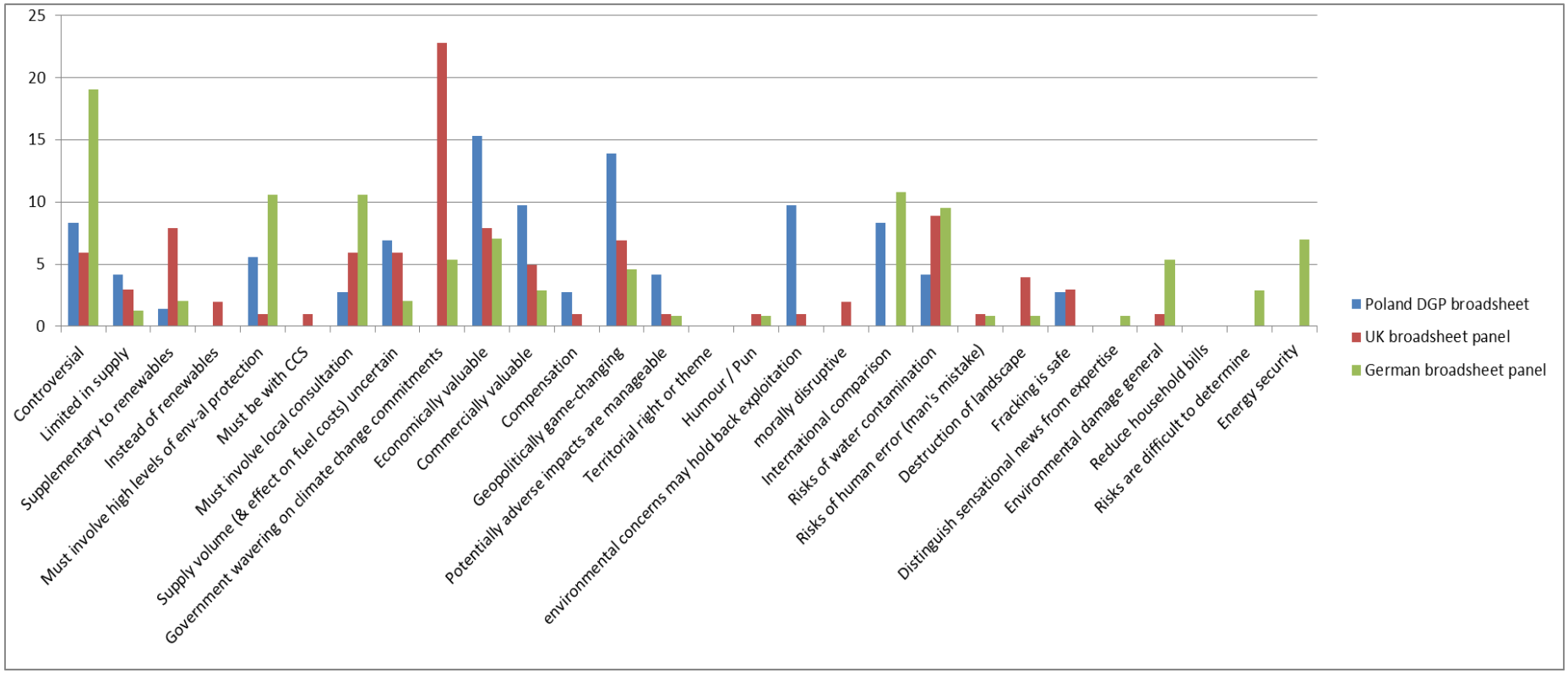
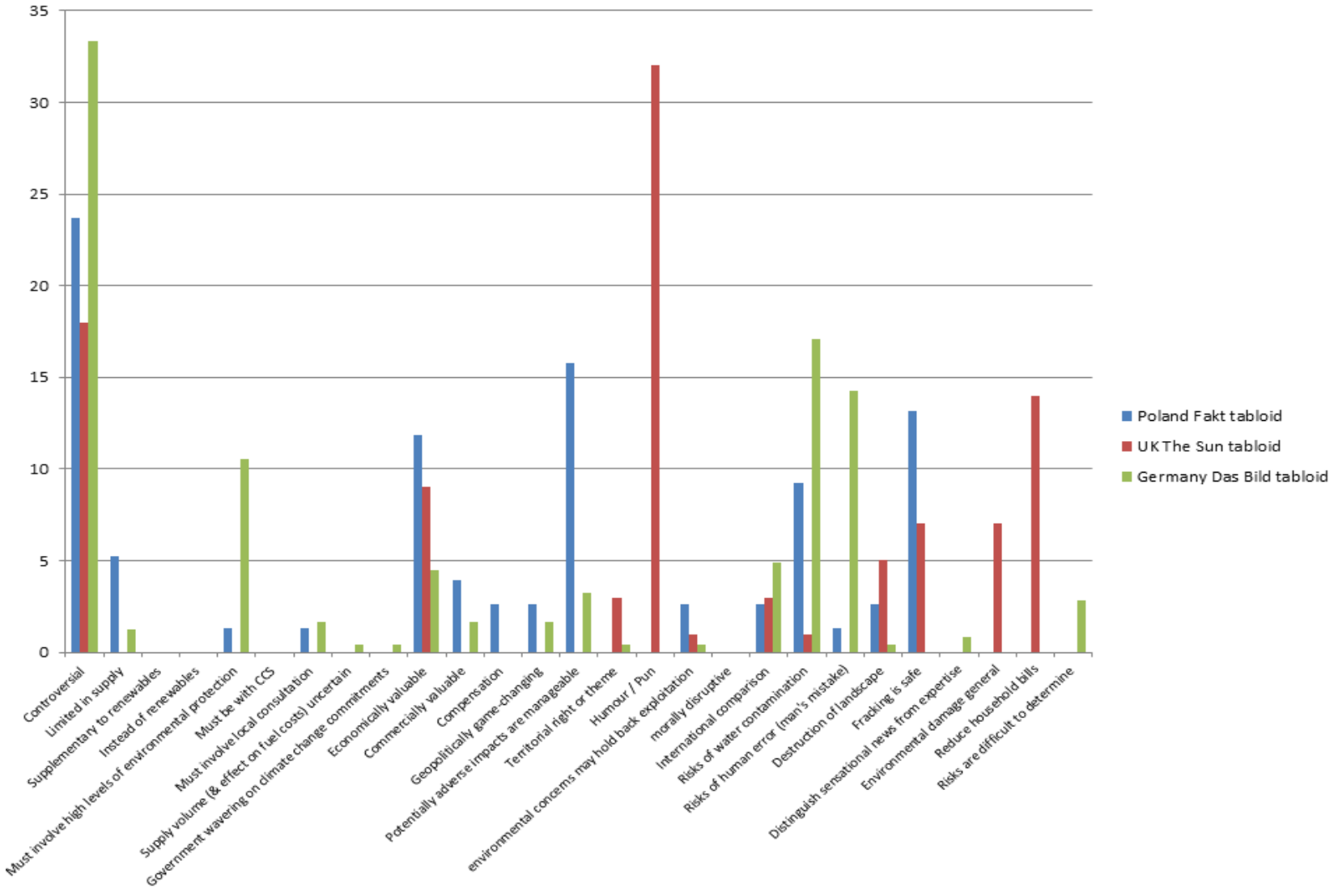


Figure 3 Thematic frequency (%) in the tabloids of the three countries (key, explicit themes only)



Appendix – additional detail on thematic incidence

Figure A1 UK Broadsheet fracking and shale gas themes

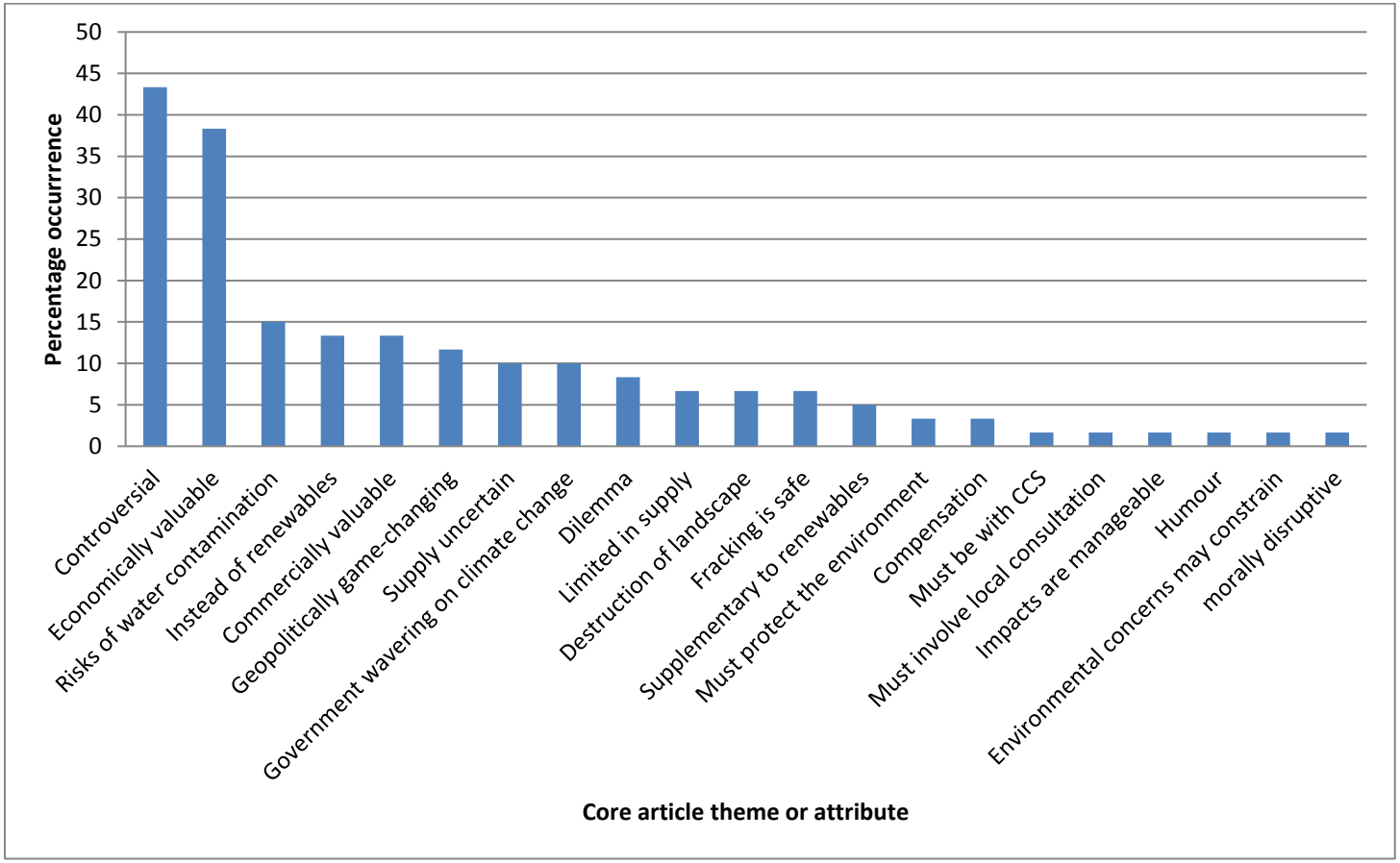


Figure A2 UK tabloid (The Sun) fracking and shale gas themes

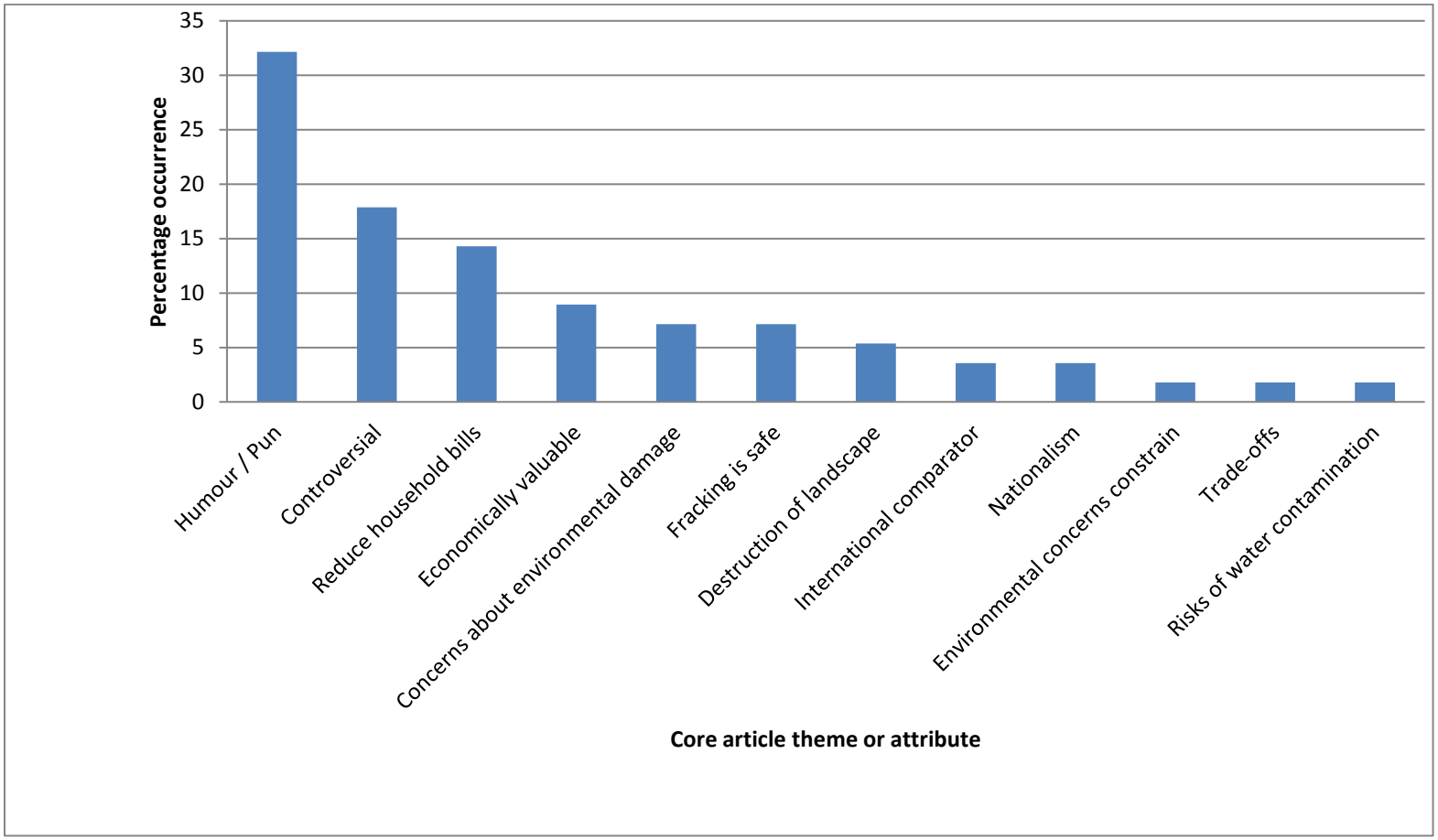


Figure A3a, A3b, A3c Initial concern in The Sun (UK) shifts to humorous representation and approval of shale gas exploitation, with an emphasis on the potential for reduction in household bills.

Figure A3a

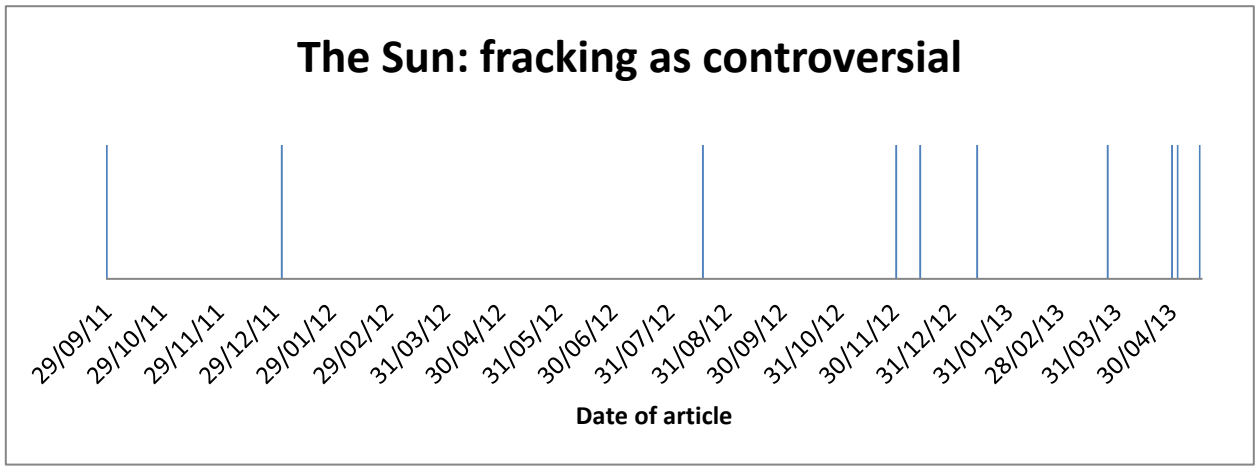
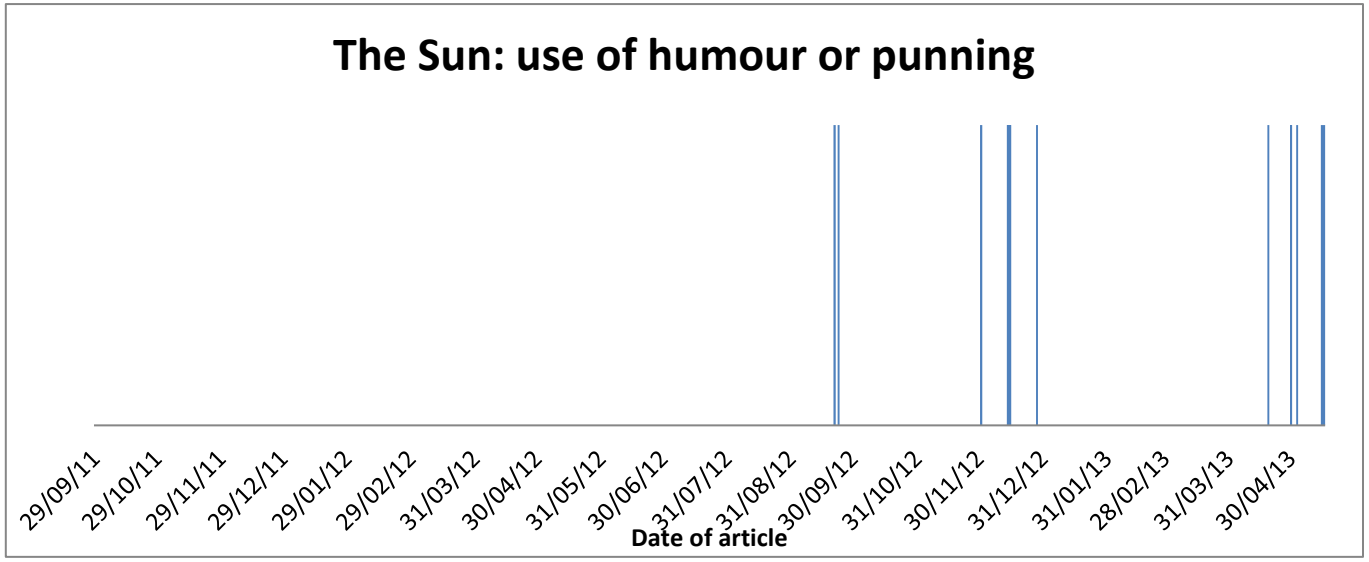


Figure A3b


The Sun: use of humour or punning
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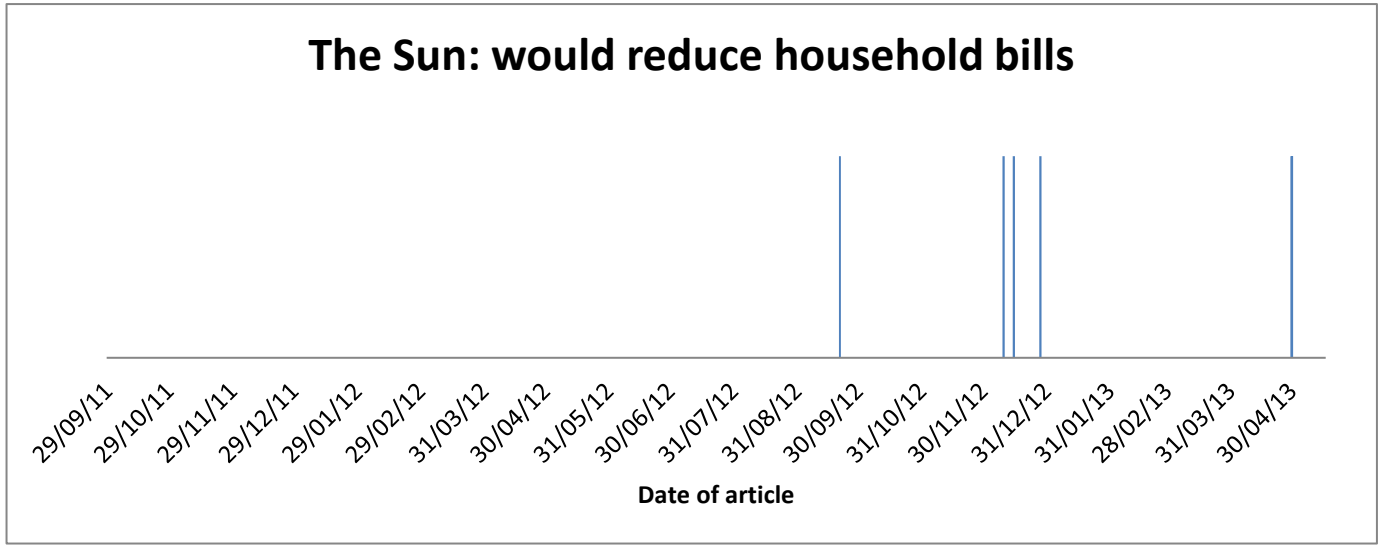
30/04/13
Date of article

Figure A3c


The Sun: would reduce household bills
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Date of article