How do we find out what people think? Conducting social research into geothermal communication.

Essential to the successful adoption of renewable energy technologies is a meaningful and honest consideration of public opinions and their influences on effective communication with communities local to a proposed site. The case studies on St Gallen and Basel presented in Hot Topic 1, illustrate the potential problems associated with a neglect of, or poor communication with the public in creating effective engagement with issues around the development of geothermal energy projects. In the case of Basel, this resulted in the termination of the project due to low public support after seismic activity, as well as a large compensation claim. Gaining a 'social licence to operate' is extremely significant to the successful growth of geothermal energy in the UK.

However, even knowing the value of good communication, it is important to understand more about what matters to people and what affects the way they communicate . To give an example of this, one need only consider the impact of heuristics and biases or what are most commonly considered the 'rule of thumb'. One particularly relevant heuristic (a mental shortcut that we use to judge data) is the affect heuristic, which frequently influences the communication of risky subjects. This is because the affect heuristic describes the way that a strong positive or negative emotion can colour the degree to which a person assesses the associated risks and benefits of any given subject (Slovic et al 2007). A risky subject that is positively viewed, such as driving a car, is subjectively assessed to have a lower risk than a negatively viewed subject which has a lower actuarial (objective) risk, such as flying in a plane (Rottenstreich and Hse, 2001). This can mean that when data that supports the actuarial risk assessment is presented to the person, they reject those data as they conflict with the person's subjective assessment of the risk.

Geothermal energy in the UK is still considered an emerging technology, and as such, the public often have limited technological knowledge about the process, or its benefits and limitations. In such instances, the media, governments and the development company become primary channels for communicating information regarding the geothermal process, or specific information about an unfolding project. Additionally, how communicators frame geothermal projects can have a significant effect on public opinion; this is especially true for journalists. Frame theory states that through the inclusion or omission of selected information, the use of repetition, metaphor, analogy, or the presence of key individuals to provide 'authority of voice', the media can be very influential on public opinion. Simultaneously, digital and social media, community liaison groups, open days and forums provide publics with the opportunity to interact; actively sharing opinions, responding and conversing with others about geothermal power turning communication from a passive, receptive activity to an active, dialogue based one.

In this Hot Topic we will introduce research methods we are using at the United Downs Deep Geothermal Power (UDDGP) project, as well as four methods you can try yourself to explore communication in your local community.

1. Media Framing

Frame analysis originates primarily from the work of sociologist Erving Goffman (1974). Goffman uses the concept of 'frames' to explain the organisation of social experience which structures individual perceptions. Different frames (organising structures), can provide different pictures (content) of the social world. A frame is successful to the degree that it resonates with audiences without recognition, operating as an underlying or implicit account of the world (Hammond, 2007). Frame theory has been adopted by media studies and used extensively to explain how news media reporting may structure social or political issues and shape the construction of perceptions, with the effect of making the world "look natural" (Gamson, 1985: 618). The work of Robert Entman has significantly advanced the media-framing sub-field. While there are different approaches to media framing analysis, Entman provides a useful guiding definition, describing framing as "to select some aspects of a perceived reality and make them more salient [prominent] in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation" (1993: 52). This occurs through the use of frame devices, such as the presence of particular words or images, the selection or omission of particular information, or the use of linguistic tools such as, repetition, stereotyping, catchphrases, metaphor, analogy or emotion. Media framing also often involves elements of sentiment analysis and key actor identification (see section 3), with both contributing to a frame's construction and salience within a text.

Framing analysis involves the researcher immersing themselves within a communicating text. While quantitative analysis may be useful for identifying and counting the frequency of key words, the contextual reading and coding of key themes is often a qualitative and reflexive process. This analysis may take place in a variety of ways. For example, through systematic analysis of newspaper headlines, content, key words, metaphors or the classification of social actors (Anderson, 1997: 127-128). Qualitative frame analysis can be a time intensive method that involves multiple re-readings and content coding. However, it is a valuable way of examining media content within context, and deepening understanding of the formation of public opinion towards political and social issues such as geothermal power production.

2. Sentiment Analysis

Closely linked with media framing analysis, sentiment analysis focusses upon the tone of a text by analysing its polarity, whether that be positive, neutral or negative. Beyond polarity, sentiment analysis may also identify specific emotion present within texts, such as anger or happiness. Sentiment analysis is often (although not always) carried out using computer-assisted software, particularly where this includes data mining from social media platforms. Computer software can collate large datasets, automatically attributing a value to textual content based on a predetermined positive or negative ranking of words. This can be particularly useful for gathering an overall picture of large-scale opinion expressed via social media, and an effective way of illustrating changes in opinion over time. Despite this, there are limitations to computational sentiment analysis, with the primary concern being that sentiment can be 'read' but not always within its intended context. For example, analysis may assign a textual statement a high positive value due to the specific words used, however it would not be able to read if the statement was honest, satirical, or be able to place it within its greater conversational context – which is necessary for deeper understanding. A way to mitigate this limitation is to use sentiment analysis to generate an overall sense of opinion, and then examine this opinion in more detail through qualitative content analysis.

3. The classification of voices in the media

One aspect of frame analysis that is particularly relevant to this study is the classification of social actors within a communicating text. By giving airtime, column space or tweet characters to the voices of particular individuals the media play a role in legitimising or delegitimising those opinions. Furthermore, certain actors may add credibility to both the issue being presented, and the news article itself. This is more likely in the case of social 'elites' such as politicians or experts, due to the level of agency they wield in society. As Anderson notes, "Various social actors including scientists, industry, policymakers and non-governmental organisations (NGOs) battle to influence public perceptions" (2014: 3), with the media a primary stage where that battle takes place. The identification of key actors is done through the qualitative reading and coding of media texts. The primary benefits of examining these key actors, are in identifying potential relationships between
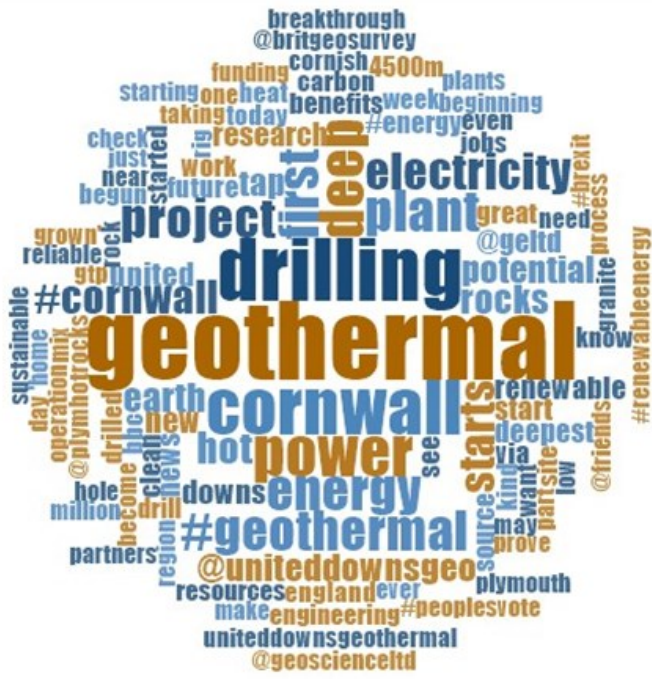
actors, sentiment, and frames. For example, do scientists, politicians or industry experts tend to promote a particular view of the world? Furthermore, it reveals hierarchies of power associated with particular issues, demonstrating who are considered voices of authority and credibility. The limitations of this method are that it provides little scope alone for the analysis of content and message. For this reason, it is best utilised as a facet of greater frame analysis.

4. Semantic feature overlap

When considering communication about controversial topics, we can also focus on specific language choices made by different groups; specifically, how words are used and interpreted. In order to test the ways that people interpret language used in geothermal communications, one very accessible tool is word association. Commonly used by psychologists to assess learning and literacy, word association can be applied in several ways, but is particularly useful when identifying causal conceptions (Fenker et al 2005). Using the theory of semantic overlap, where two words which are used interchangeably in dialogue should have a high degree of feature overlap (Maki et al 2006), researchers can explore the way that certain terms are used and understood by different groups of people. Semantic feature overlap is where the various interpretations of the words match each other. For instance, a shared feature of the words 'ocean' and 'sea' may be 'water'. However not all

features will match, in this instance a feature of the word 'ocean' which does not overlap with 'sea' could be 'pacific'. The degree of overlap, or shared associations, between two terms indicates how closely they are aligned in the participants interpretation (Eysenck and Keane, 2003). Although this approach gives a quick assessment of what associations people have with important concepts used in geothermal communications, there are some limitations – firstly that it is superficial data, which only represents the information conceptions and secondly that this data is flexible and will often be altered by current events.

5. Spatial Impact Perception

To explore how people associate certain meanings with certain terms, it's not only the simple, initial, causal concepts that can be examined, but also a more complex examination of ideas that relate to specific words. This is especially important with language that goes beyond technical use to the general public, such as the language of earthquakes. Our understanding of the associations people have between words such as 'earthquake' and the perceived scale and impact of those events is lacking, despite evidence that the two are connected (Loftus and Palmer, 1974). As such it is important to gain a better understanding of how technical language used in a general context is understood. To explore this idea, the principles of semantic

memory (Collins and Loftus, 1975) which describes our organisation of the general knowledge we have about the world can be used. According to Collins and Loftus (1975) semantic memory can be likened to a network of nodes, which represent concepts or ideas, that are connected to each other by how closely related they are in a person's mind. These relationships are created by the individual's experiences and learning and as such can be changed by new information, but also provide context that the individual uses to interpret the meaning of a specific term. In the case of earthquakes, by asking for detail about the anticipated real-life experiences of an event (where would you feel it, what would you see, etc), we are able to better discover what the contextual ideas people have around earthquake language are, and thus are better prepared for the ways people may interpret messages about seismic activity (Barsalou *et al.* 2008).

6. Mental Models

Although both word association and the use of concept mapping are useful in gaining understanding of how people interpret specific language, both of these approaches are limited in the depth of data they can provide about how people understand and communicate about concepts like geothermal power. For that a very different approach is needed, such as the mental models method (Morgan et al., 2002). The mental models method is a cognitive modelling technique which encourages the description of a comprehensive model of interconnected concepts surrounding an issue, no matter how irrelevant they may appear to the observer (Morgan et al., 2002). The mental models approach allows for the identification of these interconnected ideas whilst still allowing the participant to develop their opinion of a new unfamiliar topic in their own time. This approach was effectively used by Skarlatidou *et al* (2012) to explore conceptions surrounding another unfamiliar and contentious topic – radioactive waste disposal. The value of the mental models approach in examining an unfamiliar concept like radioactive waste disposal is that the participant does not need to have detailed knowledge to produce a mental model and it can be far more useful to discover unexpected connections between schemas (collections of concepts or ideas) that are different to what experts may expect (Goel, 2007; Vari, 2004). Because the mental models method also links an interview style of data collection, with questionnaire data collection, it combines qualitative and quantitative research styles,

providing both rich, deep data from a small sample of the population and statistically resilient data from a larger sample of the population. However, because of this dual style of data collection this is an extremely time-consuming process and the value gained in the depth of the data collected is paid for with the large amounts of time needed for data collection, analysis, modelling, testing and communication. Also due to the style of data collection the focus is often on a very limited population or very specific issue. This can limit the general applicability of findings across larger populations.

Within the UDDGP project we are taking a holistic approach to the conceptualisation of communication. This means we are examining multiple public engagement modalities rather than reducing our analysis to just one medium, such as social media, or newsprint. Our means of data collection are thus very varied, across interviews, online media collection, social media surveying, focus groups and questionnaires. This is a time intensive task, but one that provides real value in illustrating the reach of the current UDDGP project within the community.

In the media analysis both regional and national newsprint are collated using the newspaper archive Lexis, while digital news is collated through Google searches and Google alerts. Broadcast media (including television and radio) is collated less systematically, by recording via Box of Broadcasts or the relevant radio channel when it is known that a discussion of UDDGP may appear. Social media collection is primarily via Twitter, and to a lesser extent Facebook and Instagram, due to issues of accessibility and user

policies. Data from Twitter is collected utilising the Collaborative Online Social Media Observatory (COSMOS), an Economic and Social Research Council (ESRC) data investment run by the Social Data Science Lab at Cardiff University. This software has been developed for academic research, providing ethical access to social media data for the social sciences. The software collects tweets in real time according to key words searched. The resulting dataset can then be analysed with different visualisations, such as word clouds or sentiment graphs, or be exported into Excel for further analysis, including qualitative coding within NVivo. Analysis of the media data will initially involve a small-scale word frequency count in NVivo, before the texts are read in more detail and coded for prominent themes.

For the public perception and communication analysis, three rounds of data collection will be undertaken. Firstly, the semantic feature overlap word association will be done on word pairs that are commonly used by the technical geothermal specialists. This test will be conducted both online and in-person though short surveys designed and hosted by SurveyMonkey. One of the stimulus words from each pair is provided to participants, who give as many responses as possible to those stimulus words (with a minimum of three responses). After this the paired words are united again and the corresponding data are compared and analysed for similarity, frequency of word use and proportion of overlap using the analysis software NVivo. Secondly the spatial impact perception study will use short interviews designed to encourage participants to list their conceptual associations with selected stimulus words, specifically 'earthquake', 'seismic event' and 'tremor'. The results of this analysis will be statistically assessed using SPSS to examine if any of the data presents significant correlations, but also to identify key trends in the data. Finally, the mental models survey will be done using in-person semi-structured interviews. The data will be transcribed then analysed using the constant comparative method (Glaser, 1965). From the comparative analysis a questionnaire will be written to test the ideas expressed about the geothermal project, which were discovered during the interview process and that questionnaire will be used to collect data from a larger proportion of the resident population than could be done with the interviews.

The Ethics of Social Research

In order to do any social study, it is important to consider the potential impact of the work on both the people and

societies that you are studying, and the researcher themselves. Ensuring that any study is planned rigorously and with due care and consideration of the safety of all involved is conducted through the ethical approval process. The ethical approval process asks questions about the physical location and planned activities of the study, the vulnerability of the people involved, if the researcher or the situation is overly impacting on the participant and if the data is being collected, stored and shared safely and in good faith. The ethical approval process is done before a study begins and informs the rest of the study, and can be an iterative process, refining the researchers practice as they conduct the data collection. All researchers on the United Downs Deep Geothermal Power project from the University of Plymouth have been through this process before speaking to the public, and ethical approval forms are available on demand.

While arguably media analysis is not invasive given that news media form part of a public record "prepared for the express purpose of examination by others" (Berg, 2009: 271), there are issues of privacy concerning the use of research data obtained from social media sites. This is due to the nature of the medium, whereby those contributing user-generated content such as tweets may be unaware that their express opinions can be publically accessed and used within research, thus contravening individual rights 'to be forgotten'. Pace and Livingston (2005: 39, in Bryman, 2012: 149) further elaborate on this predicament and offer a set of guidelines for the usage of digital information; 1) The information is publicly archived and readily available; 2) No password is required to access the information; 3) The material is not sensitive in nature; 4) No stated site policy prohibits the use of the material. To avoid obtrusion, social media content should not be remediated within research

reports or publications in a manner that makes the author identifiable without permission. This would include verbatim quotes that can be searched online. Furthermore, social media mining should comply with source regulations when it comes to the collation, storage and publication of data, as well as GDPR regulations.

Conclusion

Previous explorations into geothermal energy production have highlighted the vitality of securing a social license to operate when instigating new energy technologies. Public opinion needs to be accounted for through a project's lifecycle, while communication and engagement needs to be inclusive and effective. Social analysis is extremely beneficial in providing a representation of public opinion, particularly when many people may consider themselves to have limited knowledge of new technologies. It is useful to industry, government and researchers to consider this a necessary step in any new technological development as early engagement not only builds trust with communities (Dowd et al, 2011), but can also provide deeper understanding of how public perception can be influenced by the way in which social issues are communicated.

Recommendations

For a **quick overview of public opinion** towards a particular issue, or to look at changes in opinion over time, sentiment analysis is a useful tool. By examining the sense of positive or negative sentiment, determined by the type of language people are using in their communications, a **simple sentiment analysis** can also provide a starting point for more detailed qualitative text-based analysis.

Social media analytics are a good way of exploring the reach and visibility of content. Analytics allow users to examine which posts have attracted the most traffic in terms of both **visibility and interaction**, and also allows users to look at this across timescales and consider how to improve on their social media influence.

For non-social media, **analysis of headlines** or content can provide a valuable and contextualised analysis of frames. This can be conducted on a more manageable scale by using a systematic representative sample of texts.

Causal conception **word association** can provide a fairly useful data set quickly, but also can also be used as form of **public engagement** and a forum for facilitating discussion. Providing participants with an anonymous way to organise themselves, such as different colours used for residents and non-residents, ages, genders, employment or education status can **provide information that is useful, engaging and enlightening** as well as highlighting the initial reactions that people have to the stimulus word of your choice.

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