The Social Health and Well-being Impacts Associated With Hydraulic Fracturing

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Abstract

In 2014, the UK Government announced they were, ‘going all out for shale gas,’ as part of the UKs need to change the energy landscape to focus on security of supply, economic benefits, (reduction of imports), the need to cut carbon emissions and further establish renewable sources.

Subsequent licencing to explore for Shale Gas resulted in significant publicised protests concerning environmental issues. Published literature in the form of Case Studies and completed Health Impact Assessments, of which there is a paucity, tend to support these concerns. However, clearly absent from this literature, are the Social Health and Well-Being Impacts (Social Determinants of Health) associated with Hydraulic Fracturing.

Data was gathered using an on-line questionnaire which was open for six weeks. The questionnaire included both qualitative and quantitative methods of data collection.

Ninety four respondents completed the questionnaire providing over seven hundred pieces of information and comments. Thematic analysis was used to analyse the data sets. The results of this analysis indicate that the threat to the quality of life, environmental concerns and a lack of confidence in the governance of the decision-making process as key factors in the perceptions of the participants. The complexities of these themes were then visually described using causal loop modelling techniques.

The research concludes that the public have a very negative and mistrustful perception of Government, Statutory Bodies and the Oil and Gas Industry. Frequently cited social impacts include, stress, anxiety, loss of control and negative impacts on communities including environmental pollution.

The implications of this research are that authorities and relevant bodies need to pay far more attention to people and community needs when granting and considering planning consent and licences.

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Abbreviations

‘One -off’ abbreviations are clarified within the main text.

AMA	American Medical Association
BGS	British Geological Survey
CIEH	Chartered Institute of Environmental Health
CIWEM	Chartered Institution of Water and Environmental Management
DBEIS	Department for Business, Energy and Industrial Strategy
DECC	Department of Energy and Climate Change
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency United States
HIA	Health Impact Assessment
HSE	Health and Safety Executive
LEDS	Low Emissions Development Strategies
MHCLG	Ministry of Housing Communities and Local Government (Previously the DCLG)
NEPA	National Environment Policy Act United States
NPPF	National Planning Policy Framework
NPS	National Policy Statements
NSIP	Nationally Significant Infrastructure Projects
OECD	The Organisation for Economic Co-operation and Development
OGA	Oil and Gas Authority
PCPA	Planning and Compulsory Purchase Act
PHC	Primary Health Care
SEA	Strategic Environmental Impact Assessment
UKOOG	UK Onshore Oil and Gas
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organisation

Chapter 1 Introduction

Chapters Synopsis

This research into the Social Health and well-being impacts associated with hydraulic fracturing contains seven chapters.

Chapter 1 details how the research was conceived with Chapter 2 then divided into six sections which provide the necessary historical background and current situation regarding the exploration for onshore Shale Gas.

Chapter 3 is a comprehensive literature review of Case Studies, completed HIAs and other information relevant to the research.

Chapter 4 looks at, Risk and Uncertainty, Complexity Theory, Stakeholder Engagement Theory and finally, Stakeholder Engagement in the Studies and completed Health Impact Assessments relating to hydraulic fracturing.

Chapter 5 identifies the methodology used in the research. Chapter 6 then covers the data collected and its analysis leading into the final chapter which discusses the outcomes of the research, its conclusions and recommendations for further research resulting from this study.

Figure 1.1 Thesis Structure

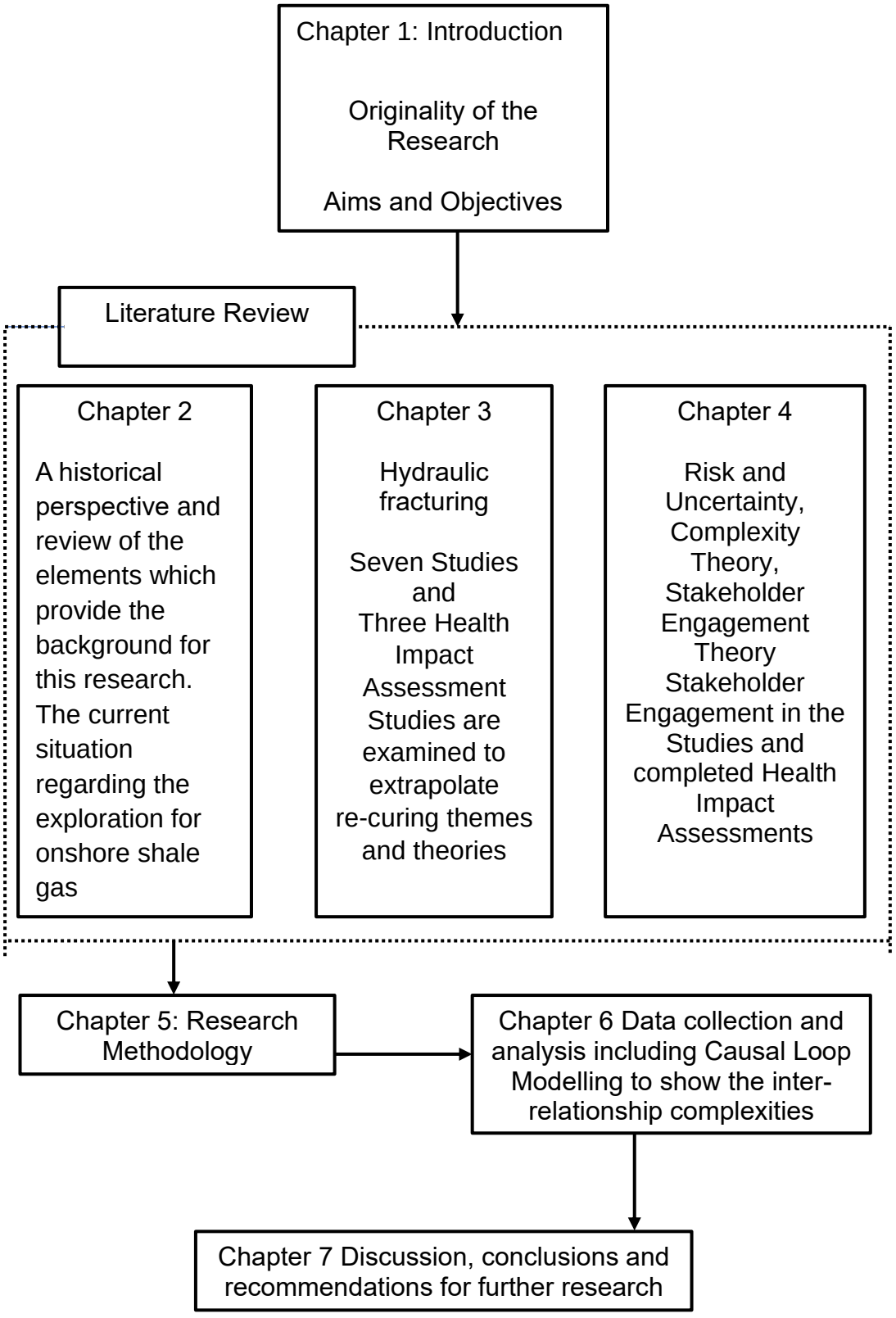
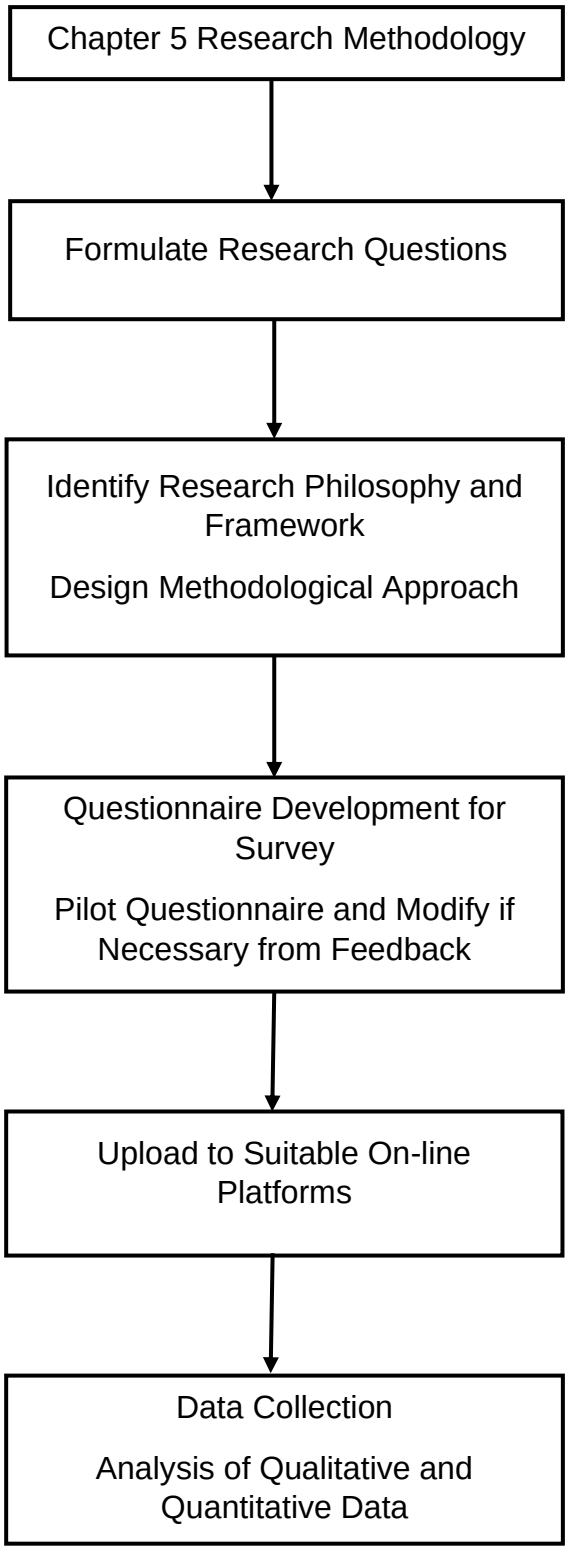


Figure 1.2 Research Methodology



1.1 Thesis Development

Sitting in the jacuzzi, isn't perhaps, the most obvious place for the final piece of the jigsaw to fall into place, for a possible PhD research theme. A month or two beforehand, listening to and watching local media reports about a nearby protest against a proposed hydraulic fracking site, had set the author wondering, what was all this about? The protests were heavily policed, very vocal, aggressive and negative towards the process.

Thinking about those protestors and their placards the author's curiosity was aroused. Why are people protesting about fracking? What did they know, that the author, as a committed environmentalist didn't, particularly as it was a local issue?

The placards were about both damage to the environment and to peoples' health. Indeed, if the process caused so much aggravation and protest, why was hydraulic fracturing even being considered as an energy source?

The author was naturally curious and as an experienced literature researcher, based at University of Liverpool (UoL) within the discipline of Health Impact Assessment (HIA), quickly established that not only was the literature very limited in relation to hydraulic fracturing and peoples' health, but it had predominantly been produced in the United States of America. Much of the published information was, in fact, more to do with the possible detrimental effects upon the environment, rather than the people who lived in either the proposed hydraulic fracturing areas, or where oil and gas extraction using the process, was already taking place

Having recently come to the end, after ten years of the Health Impact Assessment (HIA) Capacity Building Project based in UoL, the author was looking for an avenue in which to use the experience gained during those years. There were offers of HIA consultancy work in the near future, but the author had always thought that, one day, a PhD might be an option, particularly having been offered the opportunity some years before, by Liverpool John

Moores University. However, at that time, due to family commitments, it was not possible to take up the offer.

Health Impact Assessments have, historically, been more commonly used within the arena of the Built Environment, tending to look at the effects of practical projects or policies concerned with building and infrastructure. A simple example of HIA in practice is the author being asked to evaluate a project involving a new housing estate where the occupiers would be encouraged to use bicycles as an alternative form of transport. The HIA highlighted that whilst the project was indeed encouraging a more healthy life-style, there was in fact, no provision for the safe storage of the bicycles.

With experience, it became clear to the author that it was not always easy to determine, particularly by people who only rarely carried out HIAs, if it was appropriate to use the process, or not. As a result, to help facilitate that decision, the author developed an, 'Health Impact Assessment Screening Tool,' now in use internationally, thus removing a stumbling block in the use of HIA.

As the Liverpool project developed, more conceptually based HIAs were increasingly undertaken, examining issues such as Advocacy for those unable to speak up for themselves, when requiring legal or housing advice or dealing with mental health issues.

These conceptual HIAs revealed a number of hidden Social Health Impacts. Recurrent themes were identified including stress, lack of locus of control and social isolation. What emerged most strongly during the HIA project, but which was often ignored during the initial stages of most projects, was that no matter what the project, strategy or development, the social health impacts on people must be taken into account.

The Social Determinants of Health, also referred to as Social Health and Well-being, form the backbone of HIA. Given the apparent public unease concerning hydraulic fracturing, the author began to wonder, in view of her

experience of the HIA process, if in fact, it could and should contribute to the proposed hydraulic fracturing exploration for shale gas, particularly as it was being viewed by Government as a possible significant alternative source of energy for the future.

The introduction of the HIA process into the planning application process, particularly in the early stages, might ameliorate some of the antipathy from the public to the introduction of hydraulic fracturing into the UK. Recognition of the HIA values and principles of democracy and equity offers people the right to express their concerns and opinions and their anxieties both for the here and now and a sustainable future.

1.2 Hydraulic Fracturing

The extraction of shale gas (often referred to as ‘unconventional gas’) uses the process known as, ‘Hydraulic Fracturing’ often shortened to, ‘fracking.’ Whilst new to the United Kingdom, the United States of America has employed the process since the 1940’s.

Briefly, the process uses large quantities of pressurised water mixed with sand and chemicals which are injected into the gas or oil bearing rock, thus causing it to fracture and allow the gas/oil to flow freely to the surface. New drilling technology now means that reservoirs of gas and oil which were previously unreachable other than by drilling multiple wells directly above them, are now able to be tapped from a single drilling pad.

1.3 Originality of this Research

Such is the widespread concern over the lack of evidence of hydraulic fracturing-related health impacts, that several moratoria have been introduced. These include Scotland, in the United Kingdom, areas of Canada, New York in the United States and several of the member states of the EU.

This research is original in seeking to identify the actual public perceptions of the hydraulic fracturing process relative to the Social Determinants of Health and as such, will add to the current limited body of knowledge concerning the effects upon people, of the process.

No arguments, either for or against the process of hydraulic fracturing, are presented by the author during this research, or as a result of the data collected.

1.4 Research Aim

To determine the public perception of the social health and well-being impacts associated with Hydraulic Fracturing.

1.5 Research Objectives

1. Identify any current research, case studies or HIAs associated with the Social Determinants of Health and the impacts of proposed hydraulic fracturing exploration upon people and communities within the United Kingdom.
2. Establish any knowledge gap revealed during Objective 1 and utilise this to develop a research strategy.
3. Devise the research methodology using qualitative and quantitative data collection methods by means of an on-line questionnaire.
4. Carry out a thematic analysis using text analysis, leading to a Causal Loop Modelling Diagram (CLD).
5. Identify recommendations arising from this research.

Chapter 2 examines the history of the elements which provide the foundation for this study.

Chapter 2 An Historical Perspective

Introduction

The author now looks in detail at the six elements, either historic or current, which are essential background to this research.

2.1. The Social Determinants of Health

The Social Determinants of Health are defined by the World Health Organisation (WHO) as:

> *The social determinants of health (SDH) are the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies and political systems* (WHO, 2017).

Before looking in detail at the Determinants, it is necessary to consider the relevant historical Public Health events which led to their development.

2.1.2 Public Health in History

It is useful to consider a brief history of Public Health, its role in understanding and preventing disease and notable early reformers of the insanitary conditions in which many people lived.

Public Health is defined as:

> *"The art and science of preventing disease, prolonging life and promoting health through the organized efforts of society"* (Acheson, 1988).

Although Public Health has a more recent timeline and image, there is recorded evidence that some form of Public Health can be traced back to an archaeological dig at Mohenjo Daro, in Pakistan. It appears to be one of the earliest settlements dating back over 4,000 years, which contained toilets and

drainage systems, as cited in the book, ‘Public Health in History.’ (Berridge, *et al;* 2011).

One of the most notable more recent contributors to the Public Health arena was Edwin Chadwick (1800 – 1890), a lawyer with a belief that science was a way to improve society and who had an interest in politics and social reform. He was appointed in 1832 by Prime Minister Earl Grey, as Assistant Commissioner, to gather data and information for a Royal Commission of England, on the Poor Law, which was the Social Security System used in the United Kingdom since 1602.

Chadwick was a firm believer in the Miasma theory, which proposed that the gases from decomposing material, bodies and sewage, caused noxious air which triggered, well documented epidemics of the time, such as Cholera (Berridge, *et al;* 2011).

The epidemics of the time both, Cholera and Typhoid, led the government to explore the sanitation situation, which Chadwick was requested to undertake. Subsequently, in 1843, he produced the report, ‘The Sanitary Conditions of the Labouring Population.’ This in turn encouraged the first Public Health Act, 1848, and the first Board of Health which was created under the Act (The 1848 Public Health Act). Epidemics are defined as:

> *‘The occurrence of more cases of a disease than would be expected in a community or region during a given time’* (Merriam-Webster, no date).

Historical recordings of disease and epidemics can be found in the writings of Hippocrates in approximately 400 B.C. He records, in his book, ’Of the Epidemics,’ a wide variety of illnesses, but also records the prevailing weather conditions, noting the different illnesses which occurred during the different seasons. From the descriptions of the symptoms, the author, whilst having no detailed medical knowledge, supposes that these epidemics were similar to modern day Cholera, Typhoid and Consumption (TB) (Francis, 2009).

Rudolf Virchow (1821–1902), a German scientist who made several biological discoveries and is known as the, ‘Father of Pathology,’ is also credited for driving forward Public Health as he was a committed supporter of both social and political reform. Virchow wrote:

> *‘Medicine is a social science, and politics is nothing else but medicine on a large scale. Medicine, as a social science, as the science of human beings, has the obligation to point out problems and to attempt their theoretical solution; the politician, the practical anthropologist, must find their means for their actual solution …. The physicians are the natural attorneys of the poor, and social problems fall to a large extent within their jurisdiction.’*
> (Britannica.com, no date).

A translation by the authors Taylor and Rieger, of Virchow’s report on the 1847-1848 typhus epidemics in Upper Silesia, describe how the epidemic was largely ignored in the context of, ‘social medicine,’ – a term he often used and one that become popular. Rather than endorsing medical changes he prescribed and suggested social changes. These included full employment and higher wages. The paper also describes his drive and input into social medicine and the Medical Reform Movement of 1884 (Taylor and Rieger, 1984).

Friedrich Engels (1820 – 1895), was a German philosopher and Social Scientist, often believed to be the, ‘founding father of social medicine,’ and that his work contributed to what are known today as the Social Determinants of Health. One of his most acclaimed works was, ‘The Condition of the Working Class in England,’ first written in German in 1845 and then translated in to English in 1887 (Engels, 1887).

Between them, Virchow and Engels established that it was essentially because of poor living standards that these public health epidemics were able to flourish, with correspondingly high death rates.

2.1.3 Population Growth and Legislation

As recorded by various censuses, the population grew across Europe in the late 1800's from 123 million (1800) to 230 million (1890). Populations grew concurrently with industrial growth and increased numbers of people migrated to the cities. Ironically, as the industrial movement advanced and grew, the infrastructure of these overcrowded towns and cities did not, thus creating insanitary conditions, which encouraged the rapid spread of disease.

The Health of Towns Association was established in 1844 to put pressure on Sir Robert Peel's Government to force them to take action to improve the health of the public. As we have already seen in 1848 the first Public Health Act was published.

Some of the background thinking to producing these policies, was the cyclical element of individuals becoming ill through disease. They became ill, they couldn't work and therefore couldn't, 'generate wealth, or perform military duties.' Thus, given this background, the policies were written to protect the health of the public (Berridge, *et al;* 2011).

To conclude, there is an increasing awareness that the impacts on the health of individuals and communities are affected by both social and environmental factors (OMS, 2010).

2.1.4 Social Health 1945 Onwards

Following the formation of the United Nations in 1945, the organisation discussed setting up a global health organisation. On 7th April 1948, the World Health Organisation (WHO) began its operation based in Geneva, Switzerland.

WHO is a specialised agency of the United Nations which is concerned with International Public Health. The first Principle of its Constitution states:

'Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.'

The organisation's role is to, 'address the social roots of health problems, as well as the challenges of delivering medical care' (Hardy, 2009).

Alec Irwin and Elena Scali of WHO, write in their discussion paper, **'**Action on the Social Determinants of Health: learning from previous experiences,**'** that one of the fundamental objectives of the WHO was to, 'tackle the environmental and social roots of illness.' It is accepted that with the World Health Organisation's constitution and this objective, the way was paved for a Social Model of Health to be considered linked to broad human rights commitments (OMS, 2010).

2.1.5 Social Model of Health

The Social Model of Health, is a conceptual framework which aims to achieve improvement in health and well-being by addressing the economic, Social and Environmental Determinants of Health. The other models most often discussed include:

- Medical (Biomedical) Model of Health.
- Biopsychosocial Model of Health.
- Salutogenic Model of Health and
- Ecosystem Model of Health.

Table 2.1 overleaf illustrates these models in detail.

Table 2.1 Overview of the Models of Health

Model Name	Overview
Medical Model of Health (or Bio-Medical Model of Health)	This model came to the fore during the Age of Enlightenment. The belief was that science was the cure all way of illness and disease. It is accepted that this model presents the view that health is purely about disease.
Biopsychosocial Model of Health	Developed by Engels in 1877, this model recognises that there are a number of factors that can influence health and describes health as, 'a scientific construct and a social phenomena.' The model takes into consideration three factors 1) biological (illness, age and gender, 2) psychological factors (individuals beliefs and perceptions) and 3) the social (community, absence or presence of relationships).
Salutogenic Model	This model was developed by Aaron Antonovsky with a focus on how and why we stay well and explores the relationship between things that stress people, coping and health.
Ecosystem Health	The premise behind this model is about, 'redesigning our relationships with the rest of nature' and recognises the impact on people that changes to the environment can have. Such changes can include land use, climate change, resource depletion.

Adapted from (Community Development and Health Network, no date).

During 1949, the Soviet Union and other communist countries temporarily withdrew from the United Nations. Following this withdrawal, UN agencies including the WHO, came strongly under the influence of the United States. Notwithstanding the key role the US played in shaping the WHO Constitution, US officials were at that time reluctant to emphasise a Social Model of Health.

One of the contributing factors to this was the development of significant major new drugs including antibiotics and vaccines. This inspired both medical personnel and the public to believe that yet again science and technology had the answer to global health problems (Solar and Irwin, 2010).

Concurrent with this period were, 'vertical public health programmes.' These were disease-specific programmes, notably targeting, malaria and small pox which between them killed millions of people annually (Cairncross, *et al;* 1997).

These programmes seemed to have overtaken the idea of the Social Model of Health, as it slipped into the background, as the social context of the diseases tended to be ignored (OMS, 2010).

Thomas McKeown (1912-1988), Professor of Social Medicine at the University of Birmingham and demographic historian was the first person to be acknowledged as coining the phrase, 'Determinants of Health.' He challenged the belief that the increase in the population was due to life-saving medical advancement and argued that this increase was due to improvements in standards of living and nutrition.

McKeown's thesis led to much controversy and debate during the 1970s and 1980s as some of his research was deemed to be flawed, both on the method of his quantitative techniques and apparent misinterpretation of causes of death.

Nevertheless, despite these findings, his ideas regarding the effects of the conditions in which people live having either a detrimental or positive effect on

their health and wellbeing still resonates in the field of public health (Szreter, 2002).

The 1960s and 70s had seen a focus on community-based health promotion given that the current public health models being used were still eluding the poor and other vulnerable population groups. This however, did have one positive effect as the Social Model of Health was raised once again into the political/health agenda. The community-based interventions were viewed as offering community empowerment at a grassroots level, which actively encouraged communities to have a say in their health and well-being (OMS, 2010).

The next major turning point for the Social Model of Health/Social Determinants of Health came at the September 1978 International Conference on Primary Health Care, at Alma-Ata, Kazakhstan sponsored by WHO and UNICEF. This Conference led the way to a, 'rights-based approach to health,' known as the, 'Alma Ata Declaration,' with Primary Health Care as the way to accomplish this.[1]

Primary Health Care (PHC) has at its heart, the premise that the Social Determinants of Health are an important part of the PHC agenda and, as declared at the Conference, that the social and economic roots of disease were just as important (World Health Organization, 1978).

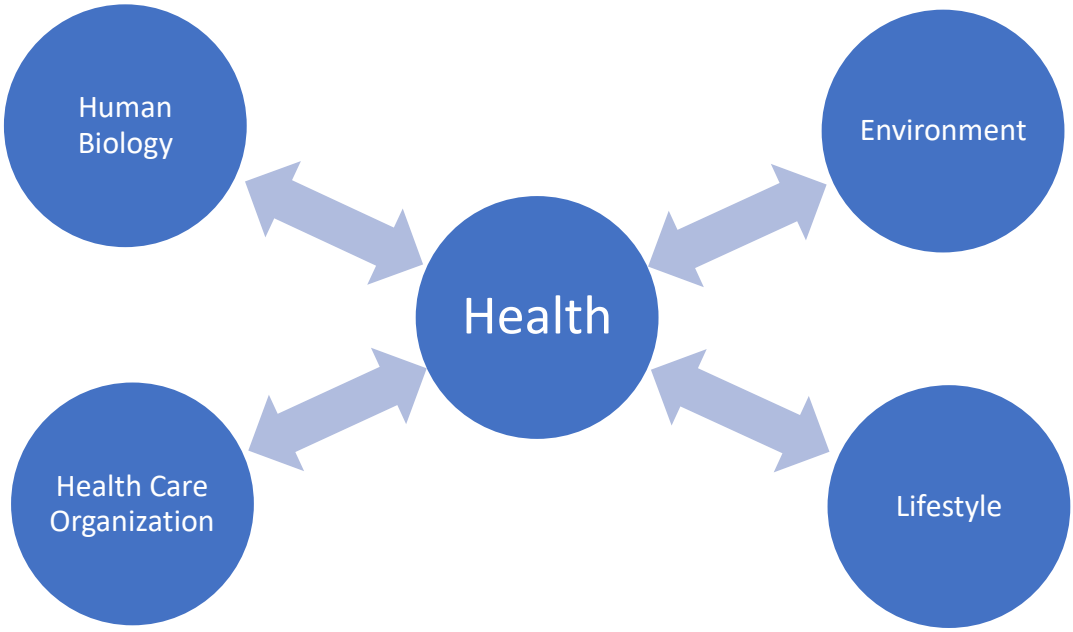
During the 1970s and at the start of 1980, two extremely significant reports were published. The first was the 1974 Lalonde Report, (Canada) and secondly the Black Report, from the UK in 1980.

[1] A human rights-based approach (HRBA) aims to support better and a more sustainable development outcomes by analysing and addressing the inequalities, discriminatory practices (de jure and de facto) and unjust power relations which are often at the heart of development problems (UN Practitioners' Portal on Human Right Based Approaches to Programming, 2016).

The Lalonde Report, named after Marc Lalonde, an Attorney and Canadian Minister of Health and Welfare. Lalonde drove the idea of health promotion and that the Determinants of Health went beyond the traditional purview of public health and argued for the importance of socio-economic factors to be considered. At this time, Canada was leading the way internationally on the research into health inequalities.

Lalonde used the aforementioned McKeown's idea to develop a conceptual framework, 'the health field concept,' which he used to undertake a health demographic profile of the Canadian population. The framework devised by Lalonde, identified four major components as shown in Figure 2.1 adapted from uottawa.ca/sim/data/models.

Figure 2.1 Lalonde Framework



www.med.uottawa.ca/sim/data/models/Model-lalonde.pdf, no date.

As the framework was used, it became clear that, 'Lifestyle,' needed to be divided and was therefore split into physical and social environments.

Alvin Tarlov, Professor of Medicine, University of Chicago writing some twenty years later, lists four categories now classed as Determinants of Health – Genes and Biology, Medical Care, Health Related Behaviours and Social Characteristics, all very similar to Lalonde's original major components.

Tarlov is credited with using the phrase, 'Social Determinants of Health' on a consistent basis. Writing a chapter in the book, 'Health and Social Organization: Towards a Health Policy for the Twenty-first Century,' he states that:

'from antiquity, health has been thought of as a physical or mental state.'
(Blane, *et al;* 1996).

Prior to this, The Black Report, 1980, was the report undertaken by the Working Group on Inequalities in Health, chaired by Sir Douglas Black, whose posts included a Professorship of Medicine at the University of Manchester and Presidency of the Royal College of Physicians. At its heart lay how, even with the inception of the National Health Service (NHS), the inequalities gap was increasing, with the nation's health and ill-health being unequally distributed.

The Black Report documented four main theories as to why there were class differences:

- Measurement artefact.
- Natural or social selection.
- Cultural/behavioural.
- Materialist/structuralist.

The report concluded that this couldn't be blamed on the NHS but more on societal issues such as inadequate housing, poor education, diet and employment. The report was not regarded very highly by the Conservative

Government at the time, with very few copies being printed, thus restricting access (Gray, 1982).

In 1987 Professor Dame Margaret Whitehead, WH Duncan Professor of Public Health at The University of Liverpool, wrote a report, ‘The Health Divide.’ Her report reviewed progress concerning the recommendations contained in The Black Report and to examine possibilities for the future.

As with its predecessor, this report was also not well received by the Conservative Government, but in fact, efforts to suppress it, resulted in widespread publicity (Gray, 1982).

2.1.6 The Social Determinants of Health Rainbow

The Determinants are best illustrated by what is commonly called, ‘The Rainbow.’ Since it was first published, the Rainbow has appeared in many styles, but all are variations upon the original theme.

Figure 2.2 The Rainbow Model Framework

Dahlgren and Whitehead,1991.

Devised in 1991, by Goran Dalhgren and Dame Margaret Whitehead, both based at that time at the University of Liverpool, it offers a framework to help identify the Social Determinants of Health. It is an illustrative diagram broken down by layers that show the influences on health. Each layer indicates sectors of influence, which can either be within, or outside a person’s control.

Breaking the Rainbow down layer by layer enables, the interrelationships between these complex elements to be become clearer.

2.1.7 The Rainbow Model-Layers

General Socio-economic, Cultural and Environmental conditions factors in the, ‘major structural environment,’ are contained within the outer layer.

The second layer titled, ‘The Living and Working Conditions.’ considers the material and social conditions people live and work in.

The third layer, ‘Social and Community Networks,’ represents the networks that people are involved in, what support they can get from friends, family and the wider community.

The penultimate layer, ‘Individual Lifestyle Factors,’ are considered to be the factors that people undertake the responsibility for themselves, for example, what they eat, whether they smoke or not and if they misuse substances such as alcohol.

Finally, the inner most layer represents factors of age, sex and genetics over which people have little influence, but can play a significant part.

Each layer therefore in turn, in a policy context, links to policy areas. So, for example, the outer layer would consider high-level strategic policies or agreements that would create, ‘structural change,’ such as environmental agreements between countries.

Policies addressed to deliver the second layer would include policies that impact on nutrition, housing or health services.

The third layer focuses on improving the communities that people live within, with the ideal that improved networks will support improved health, whilst the fourth layer offers policies focused on an individual’s lifestyle choices.

Although described as layers, in isolation it should be recognised that the principle behind the Rainbow is to offer a conceptual framework which interrelates at each policy layer.

As noted in the report, 'Policies and strategies to promote social equity in health,' the layers discussed above are aimed at bringing about improved, 'material and social conditions' that people live and work in and likely politically driven in essence as the changes are strategic (Dahlgren and Whitehead, 1991).

2.1.8 Commission on the Social Determinants of Health

It was at the Ottawa Conference in 1986, that eight key Determinants of Health were acknowledged. These being, peace, shelter, education, food, income, a stable eco-system, sustainable resources, social justice and equity (OMS, 2010). It was discussed, that in order to address and deal with these factors, a multifaceted approach was required, not just from the health sector but other departments within governments.

The WHO Commission on the Social Determinants of Health (CSDH) was established in 2005 to support countries and global health partners in addressing the social factors that impact on people's health. It seems, from reading the Commission's output, that it became snared by global politics and was disbanded on delivery of its report in 2008. The principal recommendations being:

- To improve daily living.
- Tackle the inequitable distribution of power, money, and resources and,
- Measure and understand the problem and assess the impact of action (Marmot, 2008).

The most notable quote from the Commission report states:

'*what good does it do to treat people's illnesses and send them back to the same conditions that made them sick.*'

Perhaps Gareth Williams, Professor of Sociology at Cardiff University, puts the above period into perspective when he writes:

'*After the political destruction of the Social Determinants of Health, they are back on the political agenda'* (Williams, 2003).

In Section 2.2 the author looks at Health Impact Assessment followed by Environmental Impact Assessment in Section 2.3.

2.2 Health Impact Assessment

2.2.1 What is Health Impact Assessment (HIA)?

The roots of (HIA) are two-fold. The first is its links to Health Promotion from which the Social Determinants arose and secondly, from Environmental Impact Assessment. HIA is an assessment tool based upon the Social Determinants of Health. It is a globally recognised system which is used to systematically assess the health impacts, either positive or negative, of a strategy, policy or programme. Its initial development was intended for use within the built environment arena and as such not within the biomedical field. HIA also supports decision makers through the decision-making process with its ability to produce evidence-based recommendations.

In terms of its application, HIA is not designed to be used as a long-term epidemiological study tool as are longitudinal studies which look at the same population or factors over time and gather historical evidence which allows the extrapolation of trends. Forecasting within the HIA methodology for health outcomes can be somewhat difficult for two primary reasons. Firstly, as already indicated, HIAs tend to be more immediate and are usually commissioned to be undertaken on policies and strategies. Secondly, the

evidence used is derived from published literature or snapshots in time, for example focus groups which present primary data.

There are several definitions of HIA, but the most commonly used is from the Gothenburg Consensus Paper, 1999. The paper was the product of an international HIA conference, 'Theory to Practice,' organised by the European Centre for Health Policy (ECHP), the World Health Organisation and the Nordic School of Public Health.

The definition captures the essence of HIA by describing the flexibility of the method, which allows and ensures that the effects on different population groups are identified.

> *'A combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population'* (European Centre for Health Policy, 1999).

In the 1946 Constitution of the World Health Organisation, 'Health' is defined as:

> *'Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'* (WHO, 1946).

The World Health Organisation definition is the one most commonly used in the HIA process. As well-being and health promotion have evolved over the past 70 years, HIA models and definitions have also been developing.

Linda Mcintyre and Mark Petticrew in their 1999 paper, 'Methods of Health Impact Assessment: a literature review,' list five other definitions of HIA, these are:

> "*…a methodology which enables the identification, prediction and evaluation of the likely change in health risk, both positive and negative, (single or collective) of a policy, programme, plan or development action on a defined population…To be effective, HIA must provide a mechanism for identifying the full spectrum of potential 'health hazards', evaluating their potential for causing harm and assessing their risk of occurrence to any particular group/target at any particular time/place*" - British Medical Association 1998.

"Identification of the health impacts of policy involves establishing all the potential effects on the health of the nation, tangible and intangible, direct and indirect, that could occur at each stage of the implementation of a policy initiative." Department of Health - Policy Appraisal and Health report 1996 amended 2004.

"Method of evaluating the likely effects of policies, initiatives and activities on health at a population level and helping to develop recommendations to maximise health gain and minimise health risks" - Towards a Healthier Scotland, 1999:

"Any combination of procedures or methods by which a proposed policy or program may be judged as to the effects it may have on the health of a population" - Ratner et al. 1996:

"The estimation of the effects of a specified action on the health of a defined Population" - Scott-Samuel, 1998 (Mcintyre and Petticrew, 1999).

An example of such a health impact, as identified through undertaking an HIA, is 'Social Isolation,' which affects different groups of people and is not restricted to either a specific group or location (Grinnell, 2013).

2.2.2 HIA Values

The Gothenburg Consensus paper attributed several values to be used during the HIA process. These values have ensured the open, democratic and valuable tool HIA has become.

- Democracy: the right for people to participate in a transparent process.
- Equity: in particular whilst assessing the impact on a population group but importantly the distribution of those effects within a population, for example gender, ethnic background and age.
- Sustainable Development: although somewhat vague, in the author's opinion, HIA should take into consideration the short and possible long-term impacts as well as the more/less direct impacts.
- Ethical use of evidence: encouraging rigorous use of both quantitative and qualitative evidence, based on different scientific

disciplines and methodologies which will ensure as comprehensive assessment as possible (European Centre for Health, 1999).

The Treaty of Amsterdam, 1999, made substantial changes to the 1992 Treaty of Maastricht, which devolved various powers from national Governments to the European Parliament. The relevance of this treaty to this research, is Article 152, which required, 'that a high level of human health protection shall be ensured in the definition and implementation of all Community policies and actions' (European Communities, 1997).

2.2.3 HIA Methodology

There is no International Standard for HIA methodology, but it is a respected, academically proven tool able to identify within proposed policies, strategies and programmes, health impacts both positive and negative, which might otherwise be unrecognised, unknown or unexpected. It is a flexible tool with a range of approaches as illustrated in Figure 2.3 and Table 2.2.

Figure 2.3 Generic HIA Methodology

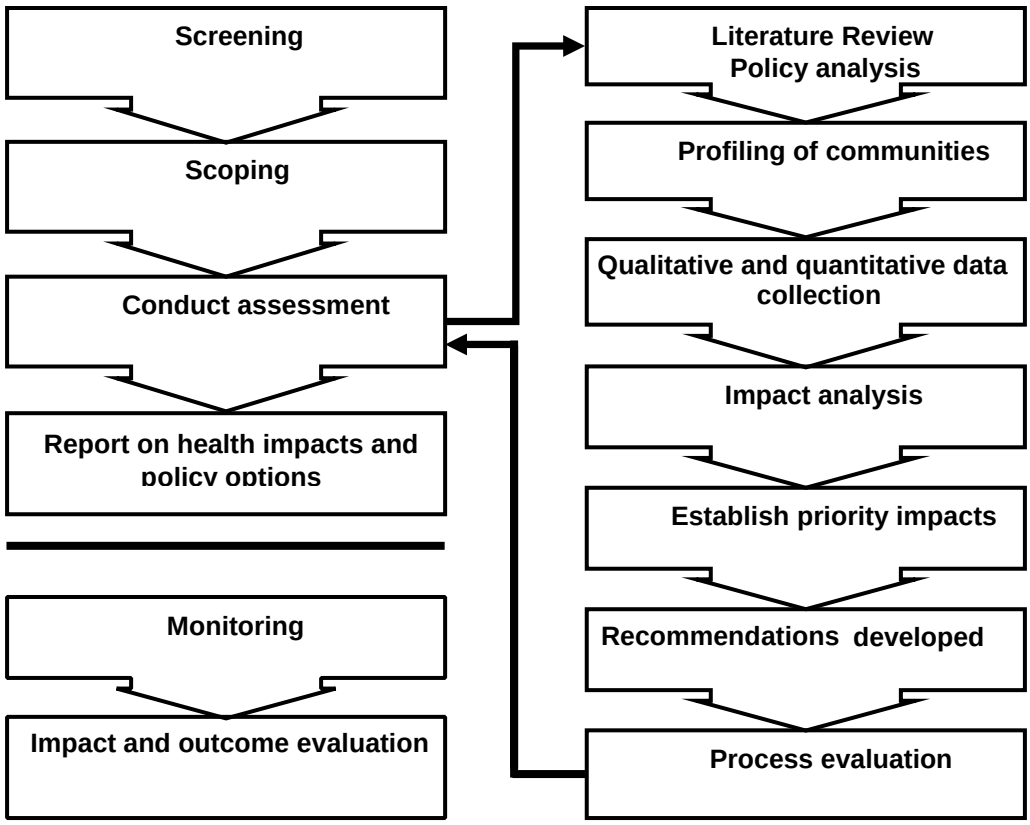


Table 2.2 Stages of HIA Methodology

Stages of HIA Methodology	Purpose	How
Screening	Assess if HIA required.	Select HIA Screening Toolkit. Establish HIA Steering Group. Undertake HIA Screening.
Scoping	Develops the Blueprint of The HIA. This will ensure the HIA is kept on schedule.	Decide and Agree: Type and breadth of HIA, Timescales, Limitations, Resources required and Type of Stakeholder Engagement (if needed).
Evidence Gathering	Gathers and identifies health impacts, from a range of sources, which impact positively or negatively on population groups.	Literature Reviews (collates body of knowledge). Community Profiles (localised picture of the demographics). Policy Analysis. Stakeholder Engagement – (workshops focus groups, Delphi Studies, Questionnaires, expert consultations).
Theme Analysis	Collates all health impacts identified.	Identifies priority/most common health impacts.

Table 2.2 cont Stages of HIA Methodology

Stages of HIA Methodology	Purpose	How
Impact Analysis	Characterise Priority Impacts	Direction of Change (+ or -). Likelihood of the impact (definite, probable, possible or speculative based on the strength of the evidence and the number of sources). Scale (The severity (mortality, morbidity and well-being) and magnitude, where possible (size/proportion of the population affected). Latency (when the impact could occur).
Recommendations	Develop set of recommendations	Using identified health impacts from the evidence gathering stages.
Implementation and Monitoring	Implementation an Monitoring Recommendations	Agree a plan to ensure recommendations are implemented and monitored.
Process Evaluation	Evaluate the HIA Process.	Undertake evaluation.

(Harris, 2007), transcribed from the original.

2.2.4 Impact Analysis

Impact analysis is the final stage of the assessment phase. Having first identified the potential health impacts this stage assesses and characterises the effects of the identified health impacts. This includes assessing the level of evidence and characterisation of each health impact.

Using the, ‘hierarchy of evidence’ (as described below), each health impact identified is analysed for its impact based on the strength of evidence.

A pre-described hierarchy of evidence is examined against each piece of research explored to provide consistency.

Hierarchy of Evidence:

- Level I - Reviews of (systematic) reviews or meta analyses.
- Level II - Systematic reviews; reviews of several HIAs.
- Level III - Single studies or HIAs.
- Level IV - Expert witnesses (key informants).
- Level V – Stakeholders.

With regards to characterisation, the following criteria is used and is shown below in Table 2.3 and is used to ensure a structured approach to the characterisation of the impacts.

Table 2.3 Impacts Characterisation Criteria

Health impacts	The health determinants affected and the subsequent effect on health outcomes.
Direction of change	Health gain (+) or health loss (-).
Scale	The severity (mortality, morbidity and well-being) and magnitude, where possible (size/proportion of the population affected).
Likelihood of impact*	This refers to the chance of the effect occurring - definite, probable, possible or speculative (based on the strength of the evidence and the number of sources of evidence used).
Latency	When the impact may occur. At what point in the policy, programme or project may the effect occur, how long will it last and are the changes reversible.

- **Speculative** = may or may not happen; no direct evidence to support.
- **Possible** = more likely to happen than not; direct evidence but from limited sources.
- **Probable** = very likely to happen; direct strong evidence from a range of data sources collected using different methods.
- **Definite** = will happen; overwhelming, strong evidence from a range of data sources collected using different methods.

Often these characterisations are shown in the form of a matrix, although it should be noted that this may not always state how the results were achieved as each health outcome conclusion should be explained.

2.2.5 The Dahlgren-Whitehead Rainbow – Its Links to HIA

This multi-level model highlights the complex interactions between a range of factors – biological, lifestyle, environmental, social and economic, as detailed previously in Figure 2.2 page 27. The, 'Rainbow' offers a framework to help identify the Social Determinants of Health which supports the identification of potential health impacts within each layer. Identifying these health impacts can support the most suitable interventions, be it in a policy, plan or programme. Depending upon in which layer the impact falls, it helps explore the different interactions between the layers and the determinants and to understand all the interrelationships.

People's health is affected by a variety of influences, factors such as environment, income, employment, transport, housing, crime and the social and physical condition of local neighbourhoods, all contribute to both good and poor health. It is all these factors which HIA links and examines.

2.2.6 Influences on the Use of HIA

There are a range of options of the type and depths of HIA. The decision of which type and to what depth will be influenced by a number of Scoping questions such as:

- Time – considerations should be given to the timescales available to undertake an HIA based on the type of HIA (see below), time available to complete an HIA and the timescale of decision-makers of a proposal.

- Resources – primarily resources will focus on funding and how much is available, but consideration for people's time should also be considered.
- HIA skills – crucial to undertaking an HIA will be the HIA skills of those involved. Will there be an HIA facilitator to guide the process. Will there be some HIA up-skilling required?
- Along with the, 'type' and the 'when' to undertake an HIA – these are described below.

2.2.7 Types of HIA

- Desk-top HIA - Undertaken with limited resources, unlikely to include any community participation.
- Rapid HIA - Includes a broader evidence search and some community participation. Still undertaken with some constraints (such as limited resources and time).
- Comprehensive HIA - More in-depth and carried out over a longer period of time.

2.2.8 When to Undertake an HIA

The, 'when' is an important factor to consider and will be determined by what stage the strategy, proposal or programme is at.

- Prospective HIA - Conducted before a proposal is implemented.
- Retrospective HIA - Conducted after proposal implementation.
- Concurrent HIA - Conducted during proposal implementation.

As described in Krieger's paper, 'Assessing health impact assessment: multidisciplinary and international perspectives,' 2003, several key points or what are termed as, 'promises,' (of HIA) are noted. Summarised, these include:

- HIA can enhance the recognition of the social determinants of health, within a wider audience, beyond those in public health.
- It can engage and support, through structured discussions with communities, policy proponents and policy analysts as well as those involved in the wider health fields.
- Encourage interdisciplinary working.
- Improve the Environmental Impact Statement, although this appears to be restricted to the United States, to engage with, and include the health impacts on populations.
- Support the growth of Human Rights Impact Assessment.
- Encourage greater transparency and accountability (Krieger *et al.*, 2003).

2.3 Environmental Impact Assessment

2.3.1 The Initial Development of Environment Impact Assessment

Environmental Impact Assessment (EIA) which was first introduced in the United States in 1969 through the National Environment Policy Act (NEPA). It was the first legalised system to be actioned to consider the environmental impacts from large scale projects and is defined as:

> *'The process by which the anticipated effects on the environment of a proposed development or project are measured'* (Canter, 1982).

EIA is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse (Dorward, 2009).

It is recognised and widely accepted, that it was the publication in 1962 of Marine biologist Rachel Carson's book, *'Silent Spring,'* that had significant influence on the rising social awareness of the impact on the environment, in this instance of the indiscriminate use of pesticides, which drove the wider issues pertaining to sustainable development.

As with HIA, there is more than one definition of EIA:

"Environmental Impact Assessment – EIA is a process that examines the environmental consequences of development action in advance."
(Glasson, *et al;* 2005).

'The process by which the anticipated effects on the environment of a proposed development or project are measured' (Canter, 1982).

"The term environmental assessment describes a technique and a process by which information about the environmental effects of a project is collected, by both the developer and from other sources, and taken into account by the planning authority in forming their judgements on whether the development should go ahead" (ODPM, 2000).

Following the introduction in the United States of the first legalised system to be actioned to consider the environmental impacts from large scale projects, in 1969, many countries followed suit – Australia (1974), France (1976), Pakistan (1983). Scotland was the first country in the United Kingdom to implement EIA's during the 1970's in relation to North Sea oil and gas installations on the Firth of Forth.

It was not a statutory requirement in the United Kingdom until 1985 when a report, originally commissioned in 1976/77 and much delayed, was overtaken by the EU directive 85/EE7/EEC requiring member States to introduce domestic legislation (Scottish Natural Heritage, 2013). It should be noted, that the EIA Directive is not expected to be recalled due to Brexit.

EIAs of large scale projects are now being undertaken in over 190 countries and have been recognised as having an important role in ensuring the consideration of potential impacts on human health (Glasson *et al*; 2005).

In 1972 the United Nations Environment Programme (UNEP) was formed and is the leading global environment authority that sets the global environment agenda. Its mission statement reads:

"To provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and people to improve their quality of life without compromising that of future generations" (UN, 1972).

2.3.2 Stages of Environmental Impact Assessment

There are predominately five stages in the EIA process shown in Table 2.4 below. Adapted from isurv (Environmental impact assessment & social impact assessment, 2010).

Table 2.4 Stages of the EIA Process

Stage of EIA	Requirements
Screening - this determines whether a project is required or not.	Is the project listed in either Schedule I or II? If the project falls within Schedule I then an EIA is required. If the project falls within Schedule II and exceeds relevant thresholds, then the project will require screening to ascertain if there are any significant environmental impacts. Part 4 of the Planning Act identifies the projects that would require development consent but there are some projects that will require screening to determine whether an NSIP would have significant impacts and whether an Environmental Statement is required.
Scoping – determining the issues to be included within the EIA and reported in the Environmental Statement.	Scoping is not a mandatory stage, yet is seen as best practice. • The Local Authority must consult with the Statutory Consultees: • Natural England. • Environment Agency. • Historic England Marine Management Organisation. For an NSIP a scoping opinion, the Secretary of State must also consult with the Statutory Consultees.

Table 2.4 cont Stages of the EIA Process

Stage of EIA	Requirements
Preparation of an Environmental Statement – documenting the assessment and mitigation of significant environmental effects.	Environmental Statement (ES) is a brief document where alternatives are considered, aspects of the environment including: • population, fauna, flora, soil, • water, air, climatic factors, • material assets, landscape and the interrelationship between the factors. It should describe likely significant effects of the development, measures to mitigate these effects and a non-technical summary. The non-technical summary is crucial as it is the only section the public and decision makers will read.
Consent application and consultation	The application for consent and the supporting Environmental Statement should be submitted to the relevant decision-making body. The application is then required to be consulted on with the statutory bodies and the public.
Decision-making	Once a decision has been made it is published in local newspaper and on the Local Authority planning website. Any planning conditions must be discharged before development can begin. With an NSIP[2] the Planning Inspectorate prepares a report to the Secretary of State including a recommendation. Timescale, the examination of the application must be completed within 6 months, the Secretary of State then has a further 3 months in which to grant or refuse development consent. Once this decision has been reached and published there is a 6-week period where the decision can be challenged in High Court.

[2] Nationally Significant Infrastructure Projects.

2.3.3 EIA Protocols

It should be noted, that most of the following publications referred to, contain a substantial number of rules, guidelines and provisions, but only the most significant are quoted, to include them all would add little to this research other than provide a mountain of reading.

The Organisation for Economic Co-operation and Development (OECD), publication, *'Declaration on Environmental Policy'* 1974, was the first international document to include EIA and was the follow up to the UN Conference on the Human Environment in 1972. Article 9 of the Declaration states that:

> *'it was critical that environmental impact of significant public or private activities be assessed prior to implementation'* (UN, 1972).

In addition to this Declaration, the OECD also declared a further recommendation, *'Council Recommendation on Assessment of Projects which may have Significant Effects on the Environment,'* which introduced eight articles for EIA procedures for member countries.

1982 saw the adoption of the, '*World Charter for Nature*,' which specified that:

> '*Environmental Impact Assessment should be ensured to minimize adverse effects on nature, nature assessments should be included in the fundamental elements of all planning and should be publicly disclosed and deliberated'* (UN, 1982).

On the back of this charter, the UNEP created an expert committee and developed a set of guidelines to support the use of EIA from which in 1987 these guidelines, *'Goals and Principles of Environmental Impact Assessment,'* were adopted (UNEP, 1987).

The EU Environmental Impact Assessment Directive (85/337/EEC) came into force in 1985 which created a mandatory requirement for EIAs to be undertaken before the inception of defined projects which had likely environmental impacts. This directive has been amended three times since its

implementation. The UK transposed the most recent amended version of the Environmental Impact Assessment Directive 2011/92/EU, in May 2017. One of the important amendments was to strengthen existing legislation in order to ensure a higher level of protection to the environment and human health (Deloitte, 2016).

Within the Directive, projects are divided into two Annexes, I and II. Annex I projects, for which an EIA is mandatory, include long-distance railway lines, motorways and express roads and large installations for the disposal of hazardous waste. Annex II projects can include such works as flood relief works and must be screened by national authorities for a possible EIA.

As can be seen, there are significant differences between HIA and EIA, such as timeframe, resources, both financial and skill based, language, legislative backdrop and frameworks. Importantly there are also significant differences between the level of analysis, project or policy and impacts that are considered.

The impacts considered are a crucial factor in the differences with EIA focused primarily to the biophysical and the environment and HIA focusing on human health and the social determinants of health.

The above points and notably the impacts considered, illustrate the complex inter-relationships between humans and the environment particularly when adding in large infrastructure projects, all this presents as a potentially confusing and complicated picture. Given this highlighted complexity, it is prudent to explore complexity in more detail in Chapter 4.

2.3.4 Strategic Environmental Impact Assessment (SEA)

The differences between SEA and EIA are the level at which they are undertaken. SEA is used at the strategic level on strategies, plans and programmes, whilst EIA is undertaken at project level. Strategic Environmental

Assessment (SEA) which was not implemented until 2001 was designed to support decision makers to develop:

> *'sustainable spatial and sector policies, plans and programmes, aiming to ensure an appropriate consideration of the environment'* (Fischer, 2003).

In the paper by Fischer, 2002, 'Strategic Environmental Assessment in Post-modern times,' it describes SEA as the, 'big-brother of Environmental Impact Assessment' (Fischer, 2003).

Strategic Environmental Assessment or to give it its official title the, 'Directive on the Assessment of Certain Plans and Programmes in the Environment,' 2001/42/EC. It is implemented in the UK through the, 'Environmental Assessment of Plans and Programmes Regulations 2004. 'The aim of this Directive is:

> *'to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development, by ensuing that, in accordance with this Directive, an Environmental Assessment is carried out of certain plans and programmes which are likely to have significant effects on the environment'* (European Parliament, 2001).

Following on from the previous subjects of the Social Determinants of Health and HIA and EIA, the author now looks at the reasons the Government is, 'going all out for shale' and will them look at the Licencing and Planning process necessary for any exploration to take place.

2.4 Hydraulic Fracturing for Shale Gas

2.4.1 Why Hydraulic Fracturing for Shale Gas?

Whilst this research primarily concerns the UK, hydraulic fracturing is being suggested as being able to play a significant part in solving the world's energy crisis and some argue that it is, 'expected to be the fastest growing component of the world's energy consumption by 2020' (Law and Curtis, 2002). Global

population growth is predicted to rise to 9 billion people by 2050, thus the need for energy resources has become of paramount importance (DESA, 2015).

Government policy is to explore for onshore oil and gas resources. Given the estimated existing resources of sixty to seventy years of known oil and gas reserves, Deutsche Bank make the point that much of the easily extracted oil has already been produced and new extraction technologies have been developed and are being used in some oil fields. These factors are driving the desire to explore the possibilities of extracting what is referred to as tight oil and gas – reserves found in shale rock (Deutsche Bank, 2013).

The exploration for Shale Gas, as a future fuel in the UK, is going to happen, with former Prime Minister, David Cameron, declaring on 13th January 2014,

'A key part of our long-term economic plan to secure Britain's future is to back business with better infrastructure. That's why we're going all out for shale. It will mean more jobs and opportunities for people, and economic security for *our country.'*

Energy Minister Michael Fallon, added in a joint statement,

'We already knew that the development of shale gas could bring growth, jobs and energy security to the country, and now local councils and people will benefit from millions of pounds of additional investment.'

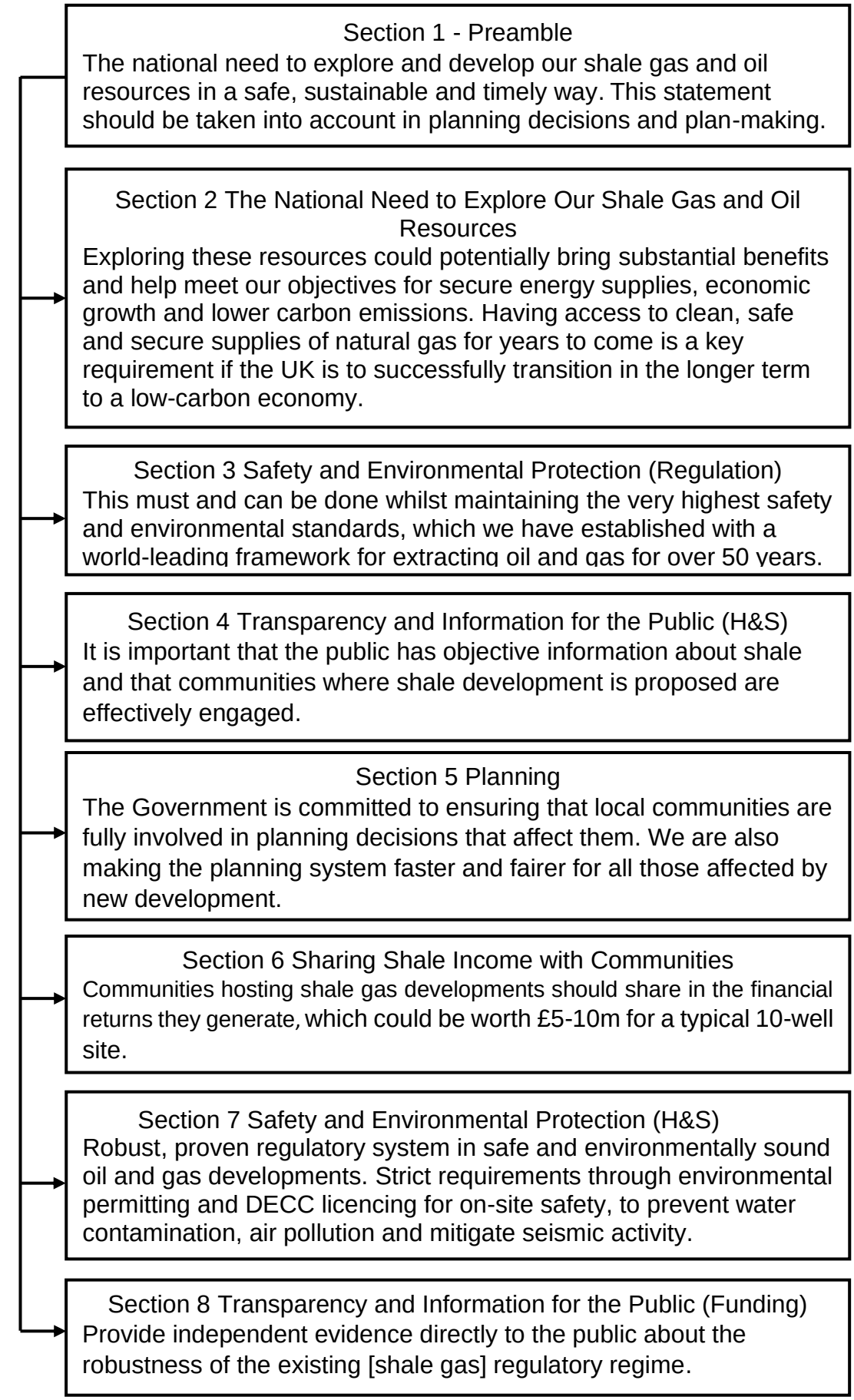
This statement refers to the Government's decision to allow Councils to retain 100% of business rates on shale gas and oil sites.

A joint statement dated 13th August 2015, presented to Parliament on the 16th September 2015, by the DECC and DCLG sets out the Government's view:

'that there is a national need to explore and develop our shale gas and oil resources in a safe, sustainable and timely way, and the steps it is taking to support this. This statement should be taken into account in planning decisions and plan- making.'

The statement covers the topics shown in Figure 2.5 overleaf. See Appendix B for the unabridged paper.

Figure 2.5 DECC and DCLG Oil and Gas Policy Statement



2.4.2 UK Shale Gas: Where is it?

Figure 2.5 Location of Shale Gas Reserves Within the UK

2.4.3 Shale Gas within the UK

The potential for shale gas within the UK is not yet clear. Professor Mike Stephenson of the British Geological Survey (BGS) in association with the OGA calculated the shale gas resource figures for Northern England in the Bowland Shale Gas Study. This is an estimate for the resource (gas-in-place) of shale gas in part of central Britain in an area between Wrexham and Blackpool in the west, and Nottingham and Scarborough in the east. The estimate is in the form of a range to reflect geological uncertainty. The lower limit of the range is 822 Tcf (Trillion Cubic feet) and the upper limit is 2281 Tcf, but the central estimate for the resource is 1329 Tcf.

Professor Stephenson comments, “This shale gas estimate is a resource figure (gas-in-place) and so represents the gas that (we) think is present, but not the gas that might be possible to extract. The proportion of gas that it may

be possible to extract is unknown as it depends on the economic, geological and social factors that will prevail at each operation."

*"*Shale gas clearly has potential in Britain but it will require geological and engineering expertise, investment and protection of the environment. It will also need organisations like the BGS to play their part in providing up-to-date and accurate information on resources and the environment to the public, industry and Government" (British Geological Survey, 2013).

2.4.4 How Long Would this UK Resource Last?

There are varied opinions on the longevity of the gas in the Bowland Shale formation but these differing opinions are all based upon the BGS figure of 1329 Tcf. They range from 15 years to 51, but taking the figure of current consumption of three trillion cubic feet per year and the extraction of 10% of the resource by hydraulic fracturing, it could meet the UK's gas needs for more than four decades (Gosden, 2016).

The Midland Valley of Scotland has a median estimated figure of 80.3 Tcf (British Geological Survey, 2014) but is subjected to a moratorium on its extraction. The Jurassic Shale Basin of the Weald is unlikely to hold any significant resource having not reached the geological maturity to generate gas (British Geological Survey, 2014).

(Author's note; Globally, it is estimated that there are 7,299 Tcf of shale gas spread across 41 counties of the world (U.S. Energy Information Administration*,* 2013)).

2.4.5 Hydraulic Fracturing

The extraction of shale gas (often referred to as 'unconventional gas') uses the process known as, 'Hydraulic Fracturing' frequently shortened to, 'fracking.' Although hydraulic fracturing began commercially in the 1930s it is accepted that it was the 1940s that really saw what is classed as, 'modern day hydraulic fracturing,' when Floyd Farris of Stanolind Oil Company, investigated

the relationship between oil and gas output and the amount of pressure being used in each well (Manfreda, 2015).

History records that the initial oil/gas wells, were all drilled vertically. Whilst these wells were comparatively easy to drill, their disadvantage was that they only produced what was directly beneath them thus, wells, would be literally shoulder to shoulder in order not to miss tapping into the reservoirs below.

Since a vertical well can only be drilled in the one direction, the exploration company must estimate the most productive portion of the reserve from the very beginning of the extraction process. Thus, directional and horizontal drilling has been developed to tap into oil and gas reserves not directly under the well. A well could be drilled just outside a populated area or park and then steered directionally to hit the target (geology.com, no date). An example of this is UK MPs voting in December 2015, to allow Hydraulic Fracturing below 1200m under National Parks, from wells sited outside their boundaries.

The Figure 2.6 Directional and Horizontal Drilling, originally presented here cannot be made freely available via LJMU E-Theses Collection because of a possible copyright issue.

The image was sourced at *Geology and Earth Science News, Articles, Photos, Maps and More* (no date). Available at: https://geology.com/ (Accessed: 3 March 2018).

Directional drilling can also minimise the footprint of drilling operations as one drilling pad can be used to drill a number of wells. In 2010 the University of Texas at Arlington drilled 22 wells on a single platform which are draining about 1100 acres of oil/gas from beneath the campus. The alternative would have been to drill many wells, each requiring a drilling pad, pond, access road and gathering line.

Current hydraulic fracturing process combines the two drilling techniques. Fracking fluid is then pumped down the well under such pressure that it

fractures the rock which creates fissures and cracks releasing the oil or gas which is then pumped to the surface.

The fracking fluid is often referred to as, ‘slick-water,’ which, whilst it mainly consists of water also contains chemicals and additives which can include detergents, salts, acids and lubricants. Additionally, included in this mixture are, ‘proppants’ most commonly sand and/or ceramic particles which, ‘prop’ open the fissure, even when the pumping pressure is finished (United States Environmental Protection Agency, 2012).

Approximately 20%/40% of the fracking fluid pumped down the well is pumped back to the surface and is known as, ‘flowback’ water. In addition to the original chemicals pumped down the well, the flowback water can also contain, ‘formation water.’ This is ancient water found naturally in the pore spaces of the rock. It can often be very salty and contain higher levels than normal of Radon gas which occurs naturally as an intermediate step in the normal radioactive decay chains through which thorium and uranium slowly decay into lead.

In the early days of fracking much of this flowback water was crudely disposed of, giving rise to a variety of concerns. Current day technology is increasingly being used to treat the liquid to return the water to the environment.

2.4.6 UK Imports of Gas

The following data relating to 2015, is taken from the Office for National Statistics report dated August 2016, ‘UK energy: how much, what type and where from?’ (ONS Digital, 2015).

Most of the gas we import comes through pipelines laid underneath the sea bed. We have established pipelines with Norway and the Netherlands which accounted for 61% and 7% of our 2015 gas imports respectively. There are also established pipelines with Belgium, but gas imports from Belgium only

accounted for 0.4% of our 2015 gas imports. The balance is imported as Liquified Natural Gas with 29% of this coming from Qatar.

2.4.7 Energy Security

The International Energy Agency, defines energy security as:

> *'The uninterrupted availability of energy sources at an affordable price. Energy security has many aspects: long-term energy security mainly deals with timely investments to supply energy in line with economic developments and environmental needs. On the other hand, short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance'* (EC Commissioner, 2006).

Energy Security in the UK is defined as:

> *'making sure consumers can access the energy they need at prices that are not excessively volatile'* (Department of Energy and Climate Change and Ofgem, 2013).

The Government's view in the Policy paper, 2010 to 2015 government policy: UK energy security,' (updated 8 May 2015) is that UK energy security remains positive, yet has its challenges. These challenges are listed as:

- Severe weather.
- Terrorist attacks.
- Technical failure and
- Industrial action.

Additionally, the UK's energy system faces a great deal of change as existing infrastructure closes, domestic fuel reserves decline and the system adapts to meet our low-carbon objectives. These changes will create new challenges for the UK energy security in the years ahead. There are a number of Action Points within the policy to ensure the UK has adequate capacity and that this is diverse and reliable. These are as follows:

- Reformation of the electricity market – this aims to attract £110 billion investment required to replace and upgrade the UKs

electricity infrastructure. Increasing energy efficiency – developed an Energy Efficiency Strategy.

- Remove barriers to competitive markets – to do this they are reforming the planning system for the nationally significant infrastructure projects such as Windfarms.
- Preparing for energy emergencies – to work with industry and regulators to strengthen the resilience of the UKs energy networks and assets. Maintaining a reliable network and reducing carbon emissions from UK energy supplies.
- Maximising cost-effective recovery of UK resources – to provide energy supplies that are not exposed to international energy supply risks. Issue licences for domestic oil and gas exploration and production and support development of the oil and gas industry through UK Promote, PILOT (formerly the Oil and Gas Taskforce) and Project Pathfinder (Since October 2016, The Oil and Gas Authority).
- Working internationally – includes the EU security of supply regulations and implementation of the Third package on Electricity and Gas markets.[3] EU energy security is examined later in this chapter.

2.4.8 Shale Gas and EU Energy Security (Briefing Paper Dec 2014)

The EU issued a briefing paper in December 2014 concerning energy security which it defines as, 'the uninterrupted availability of energy sources at an affordable price.' The International Energy Agency distinguishes short-term energy security (the ability of the energy system to react to sudden changes in the supply-demand balance) and long-term energy security (timely investments to supply energy in line with economic and environmental needs). See Appendix C for the unabridged paper.

[3] This is the latest round of EU energy market legislation, the third package, which has been enacted in 2009, to improve the, 'functioning of the internal energy market and resolve structural problems' (European Commission).

The key points are:

- The EU imports 53% of its energy needs.
- 66% of its natural gas consumption is imported, 39% from Russia, 33% from Norway and 22% from Algeria and Libya.
- Russia exports 71% of its output to the EU.
- Technically recoverable shale gas in the EU amounts to 14 trillion cubic metres (tcm) whilst conventional gas reserves are 5.2 tcm. (Conventional Gas refers to natural gas that can be produced from reservoirs using traditional drilling, pumping and compression techniques).
- Only a few exploratory wells have been drilled - between 33,500 – 67.000 wells required if shale gas boomed by 2050.
- Shale gas will not be as profitable in the US market due to the more complicated geological structure and higher environmental standards (Erbach, 2014).

2.4.9 Development in EU Member States (Briefing Paper Dec 2014)

Bulgaria, France, Netherlands have banned fracking. Denmark, Germany Spain, Poland, Romania and the UK are proceeding, if somewhat cautiously. Lithuania has an uncertain legal framework despite being initially in favour of the process (Erbach, 2014).

2.4.10 EU Outlook (Briefing Paper Dec 2014)

- Shale production will not be short term, ‘Evolution rather than revolution,’ (John Watson CEO Chevron).
- More exploratory drilling required to assess the extent of commercially recoverable resources.
- Lessons should be learned from developments in the US in order to avoid environmental problems such as methane leaks (Erbach, 2014).

2.4.11 Energy Supply and Energy Security (EU Briefing Paper 2016)

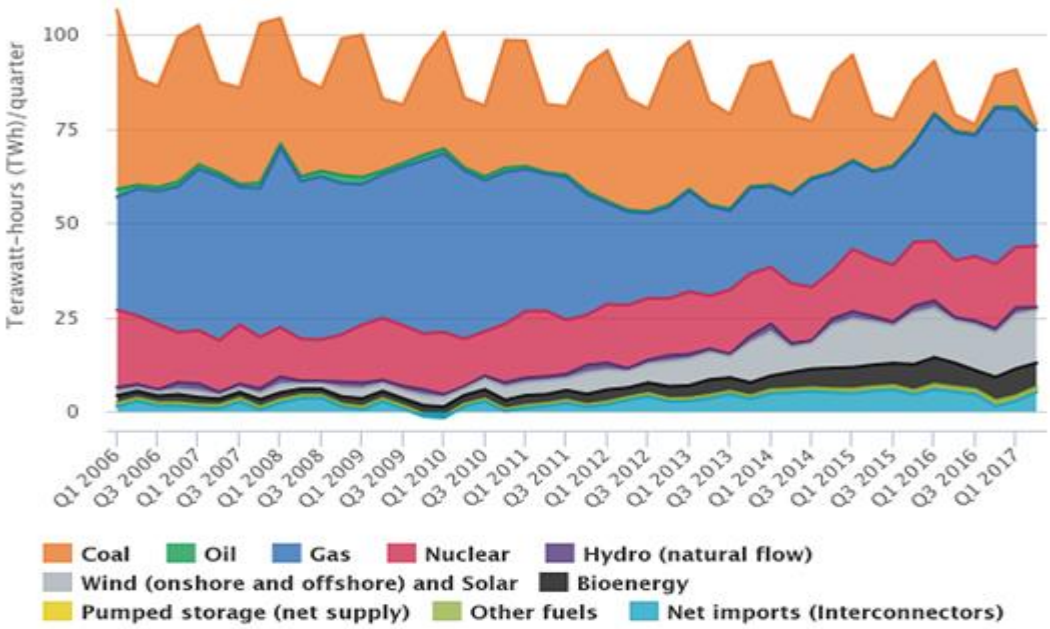
The main objectives of EU energy policy are sustainability, affordability and security of supply. The key points are:

- More than half of EU citizens would like to see the EU play a bigger role in energy supply and energy security.
- The main objectives of EU energy policy are sustainability, affordability and security of supply.
- Energy policy is a shared competence between the EU and its Member States. Member States remain free to choose their energy sources and the structure of their energy supply (Erbach, Svasek and Dobreva, 2016). See Appendix D for the unabridged paper.

2.4.12 UK Government’s Climate Control Agreement

Legislation concerning reducing carbon emissions is having a major impact on finding alternative secure sources of sustainable/renewable fuel. Figure 2.7 overleaf shows the energy trends from Quarter1 2006 to Quarter 1 2017 inc.

Figure 2.7 Energy Sources Used to Generate Electricity in the UK



Source: BEIS Energy trends section 5: Electricity (ET 5.1). Information correct as of: October 2017

It is clear from the above data that the use of coal to generate electricity is in sharp decline.

UK Government policy is to move from the use of fossil fuels to generate electricity, due to their high carbon footprint in view of their commitment to cut carbon emissions by 80% by 2050. Shale gas with its lower carbon footprint is therefore seen as an option.

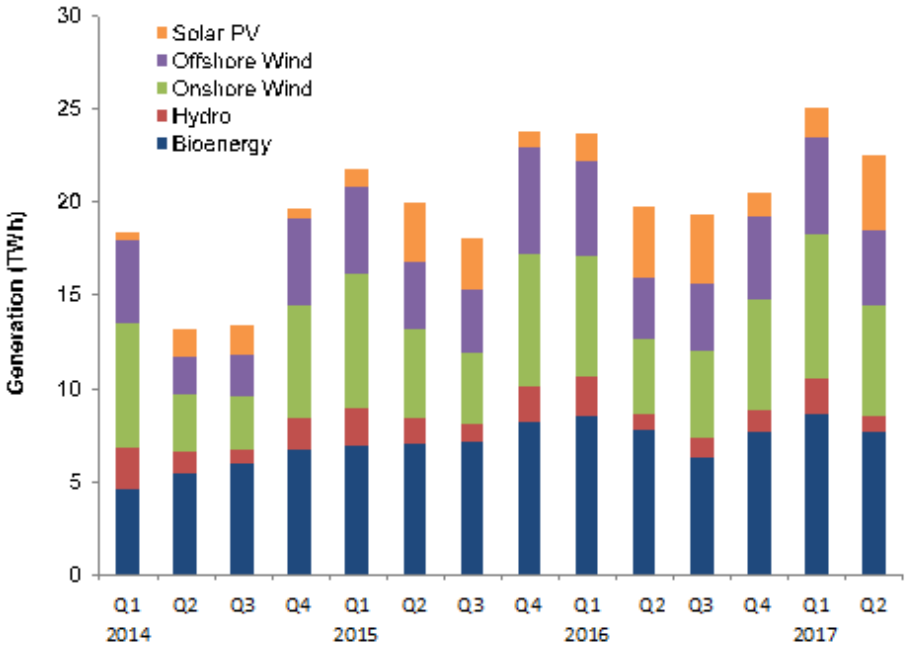
Prof David MacKay and Dr Tim Stone in their study report, 'Potential Greenhouse Gas Emissions Associated with Shale Gas Production and Use' DECC 9th September 2013 conclude: 'The carbon footprint (emissions intensity) of shale gas extraction and use is likely to be in the range 200 – 253 g CO2e per kWh[4] of chemical energy, which makes shale gas's overall carbon footprint comparable to gas extracted from conventional sources (199 – 207 g CO2e/kWh(th)), and lower than the carbon footprint of Liquefied Natural Gas (233 - 270g CO2e/kWh(th)).'

[4] gCO2eg/kWh are grams of carbon dioxide equivalent per kilowatt-hour of electricity generated.

‘When shale gas is used for electricity generation, its carbon footprint is likely to be in the range 423 – 535 g CO2e/kWh(e), which is significantly lower than the carbon footprint of coal, 837 – 1130 g CO2e/kWh(e).’

The Government is also committed to the use of renewables (although they have recently withdrawn the renewable subsidy) and in conjunction with shale these are being viewed as sustainable and secure sources of energy, less prone to external political influences.

Figure 2.8 Renewable Electricity Generation Quarter 2 2017



Source, UK Energy Statistics Q2 2017 published by the Department of Business, Energy & Industrial Strategy.

2.4.13 Climate Change

Due to the complex nature of climate change, with the conflicting interpretation of the data concerning global warming, the author will not be drawn into the discussion about the nature of, or the consequences of climate change.

The Climate Change Act, 2008, requires the Secretary of State to ensure that by 2050 there will be an 80% reduction in of greenhouse gases in the UK, as agreed by the Kyoto agreement, based on the 1990 baseline. To

accommodate this agreement, shale gas is now being seen as the way forward as a, ‘transition energy,’ as the UK moves towards more sustainable energy sources.

The 2015 United Nations Climate Change Conference, also referred to as COP 21 – Conference of the Parties, meaning those who signed up to the UNFCCC[5] was held in Paris. The Paris conference negotiated the Paris Agreement, which relates to the agreement for dealing with greenhouse emissions, mitigation, adaptation and finance, beginning in 2020 (UN Climate Change Conference Paris, 2015).

2.4.14 Shale Gas and Climate Change

A briefing paper, Shale gas and climate change, by the Grantham Institute for Climate Change, examines the potential impacts on climate change from shale gas production.

The paper summarises that the main focus of governments is likely to be on the economic drivers for shale gas production but warns that complications such as geological differences and regulatory regimes do not necessarily mean they can emulate the US in exploiting any UK reserves, many of which are yet unproven.

The paper examines the positives, negatives, and unknowns of potential shale gas production which are looked at very briefly as follows:

The positives recognise that within the US the internal markets have seen reduced energy costs, improving energy security and increased employment. Carbon emissions, as indicated by the US statistics, have been reduced due to the reduction in coal usage to generate electricity but with the caveat that much of their coal is now exported.

[5] United Nations Framework Convention on Climate Change.

The negative and unknown elements include methane emission from well venting which could me more harmful to the environment than CO_2. The long term effects are discussed but are recognised as needing more research (Grantham Institute for Climate Change, 2013).

2.4.15 The UK: Transitional Energy

Transitional energy is defined within the United Kingdom's as:

> *'a movement to a secure, low-carbon future with a target of 80% reduction in CO_2 by 2050'* (DECC, 2009a).

A paper, 'Geographies of energy transition: space place and the low-carbon economy,' (2013) and published as part of a, Geographies of Energy Transition Seminar Series, funded by the Economic Social Research Council (ERSC) makes the following points: -

- The Paper refers to *'energy transition'* as a concept, accepted and used within energy policies in some countries but there is*, 'no consensus on a desired end state'* (Bridge *et al.*, 2013).
- The paper uses the UK as a case study because of our low-carbon transition which has been driven by the Climate Change Act 2008 – the first of its kind.
- Historically, the major shifts in different fuels and energy conversion technologies have underpinned broad social and geographical change, such as those seen from the move from coal to oil in the 20th Century.
- The paper states that climate change, energy security, and the depletion of conventional oil reserves, are re-working established patterns and scales of energy supply, distribution and consumption.
- The energy challenge for the 21st Century is the move towards a more sustainable energy system characterised by universal access to energy services, and security and reliability of supply from efficient, low-carbon sources.

2.4.16 Low-Carbon Development

The concept has its origins within the United Nations Framework Convention on Climate Change (UNFCCC) which was adopted in Rio 1992 and is described essentially as, ‘low emissions development strategies,’ LEDS, or low carbon growth plans. There is no formally agreed definition as such but LEDS are generally used to describe forward-looking national economic development plans or strategies that encompass low-emission and/or climate resilient economic growth (Clapp, *et al;* 2010).

Developing a low-carbon economy is based on low carbon sources that have a minimal output of greenhouse gases, in particular carbon dioxide. Many countries are developing LEDS.

The UKs LEDS was produced in 2008/9, ‘UK Low Carbon Transition Plan: National Strategy for Climate and Energy. This document sets out the UKs approach to deliver emission cuts by 2020 (Clapp, *et al;* 2010).

However, a paper, by Kuzemko, 2013, defines low carbon transition as a, ‘long-term process that includes a wide variety of different analytical areas.’ These areas include: technology, industry, culture and belief systems (Kuzemko, 2013).

2.4.17 Carbon Capture

The Carbon Capture and Storage Association (CCSA) explains carbon capture and storage (CCS) as a technology that is able to capture up to 90% of carbon dioxide emissions from the use of fossil fuels within the electricity generating process. Capturing this carbon dioxide prevents it from being released into the atmosphere. Carbon capture consists of three stages:

- Capture of the carbon dioxide.
- Transportation of the carbon dioxide and
- Storage of the captured carbon dioxide, for example, in underground depleted oil and gas fields.

Specific carbon capture technologies are used which separate the gas which is produced by electricity generation or industrial processes, then transported via pipeline or ship with a final destination of underground storage (The Carbon Capture and Storage Association, no date).

2.5 Licencing and Planning

2.5.1 The Infrastructure Act 2015 and Hydraulic Fracturing

A Seminar paper written by Richard Turney in October 2013, a Barrister specialising in planning, environmental and public law, examines, 'Fracking and the National Policy Planning Framework.' Turney identifies a number of potential policy challenges for fracking.

1. Unconventional gas production is relatively new to the UK, and is being welcomed with a predictable mix of apprehension, excitement and occasional hysteria. Given the immutable truth that the policy maker spends his life at least two steps behind the entrepreneur, the planning policy framework is still emerging. The purpose of this paper is to map out how the National Planning Policy Framework NPPF addresses fracking; but also to explore how the national and local policy framework is likely to develop; and to identify some of the challenges ahead.

2. Fracking creates a number of problems in planning policy terms:

a. It is controversial, in terms of its economics and its environmental effects;
b. It is untested;
c. There are a range of different consent regimes, falling under three different government departments, several agencies, and mineral planning authorities, meaning that the risk for inconsistent policy on the subject is considerable;
d. The scale of fracking operations may be significant, and their impacts widespread;

e. There are typically several different project stages (exploration, testing, production, and remediation/aftercare) which may demand different policy responses;
f. As part of the immutable truth mentioned above, it is likely that the technology will move faster than the policy maker, so there will be a continuing challenge to catch up;
g. There is a risk of shooting first, and asking questions later: adopting policies without properly informed consideration and consultation.

3. In that context the risk of creating a labyrinthine and internally contradictory policy regime is considerable (Turney, 2013).

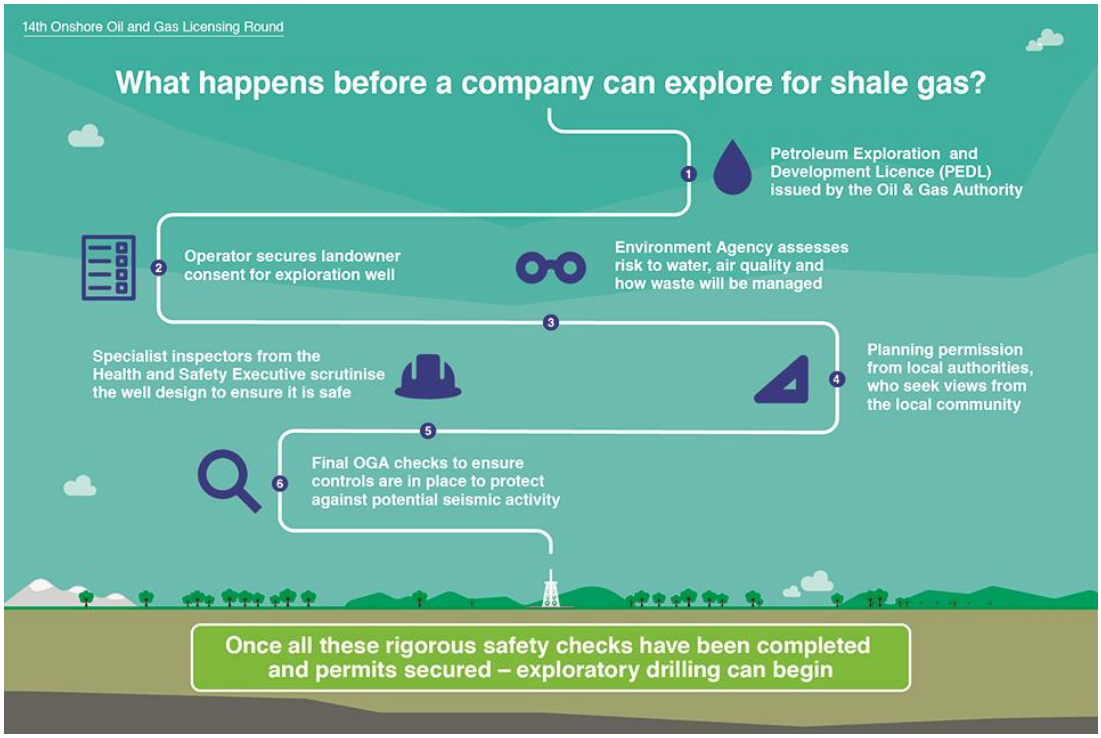
The Act provides for a new right to use land to exploit petrol or deep geothermal energy without notifying owners, which includes the right for fracking (hydraulic fracturing) under land. Previously, access to these resources was by agreement. Voluntary commitments have been made by the energy industry to notify communities of the exercise of these rights, but if the Secretary of State is not satisfied, he may introduce regulations setting up a statutory notice scheme.

There are also a number of pre-conditions that must be satisfied before a well consent for fracking can be issued. The provisions allow for the drilling, boring, fracturing and alteration of deep-level land, installation of infrastructure, feasibility assessments, energy preparation and decommissioning. There is a right to leave the land in a different condition and the right to leave infrastructure or substances in the land. Infrastructure Act 2015 expressly removes landowners' liability for any loss or damage attributable to the exercise of these rights by another person (Berwin, Leighton & Paisner, no date).

2.5.2 Licencing

Before any shale operation can begin in the UK, operators must pass rigorous health and safety, environmental and planning permission processes. The Department for Business, Energy & Industrial Strategy, issued on the 13 January 2017, an update paper, 'Guidance on fracking: developing shale gas in the UK,' which includes the diagram in Figure 2.9.

Figure 2.9 Licencing Map



(Oil and Gas Authority, no date).

The Oil and Gas Authority (OGA) is the regulatory body for the UKs offshore and onshore oil and gas resources. The legislative context which provides OGA with the powers to, 'maximise the economic recovery of UK oil and gas resources' include:

- Energy Act 2016 – provides a legislative framework which formally established the OGA as a government company. It also offers OGA a range of powers including, participating in meetings with

operators, access to data, and enforcement powers (Oil and Gas Authority, no date).

Licencing for shale gas exploration is the responsibility of OGA, who award licences to, ‘successful applicants’ i.e. Oil and Gas companies in licensing round. Every company, within the UK, who wants to pursue exploration activity must apply for a Petroleum Exploration Development Licence, (PEDL), which is subject to the appropriate regulatory consents and planning permissions (UKOOG, no date).

A UK PEDL allows an operator to undertake the exploration for oil and gas. A number of criteria have to be considered including, applicant’s competency, financial viability, environmental awareness and geotechnical analysis and coverage of relevant insurances (UKOOG, no date).

Once a block has been permitted and the operator has decided the most appropriate location to drill, consultations and applications for all consents and permits are applied for, by the operator. A drill site is described as being up to 2 hectares, about the size of two football pitches. These wells are temporary but maybe in use for a number of months (UKOOG, no date).

There are three broad stages of development activity but not all sites will go through all these stages, which are:

1. Exploration,
2. Appraisal and
3. Production.

2.5.3 Stage 1 – Exploration

This normally begins with an operator seeking the planning consent to drill a well. These wells are designed to be data gathering wells which will take samples of rock in order to collect vital geological information about the potential oil and gas layers of interest. Typically, operational activity at an

exploration site spans two to four months. The site is normally vacated after that.

2.5.4 Stage 2 – Appraisal

After examining the data taken during the exploration phase, operators will usually decide to test the well before making a decision about whether or not it will be commercially viable. Depending on the geology, this stage may involve carrying out one or more hydraulic fracturing (fracking) procedures. This will usually involve an additional planning consent and a full environmental impact assessment.

Operations on the surface typically last between four and six months, but with on-site activity lessening the longer the testing goes on.

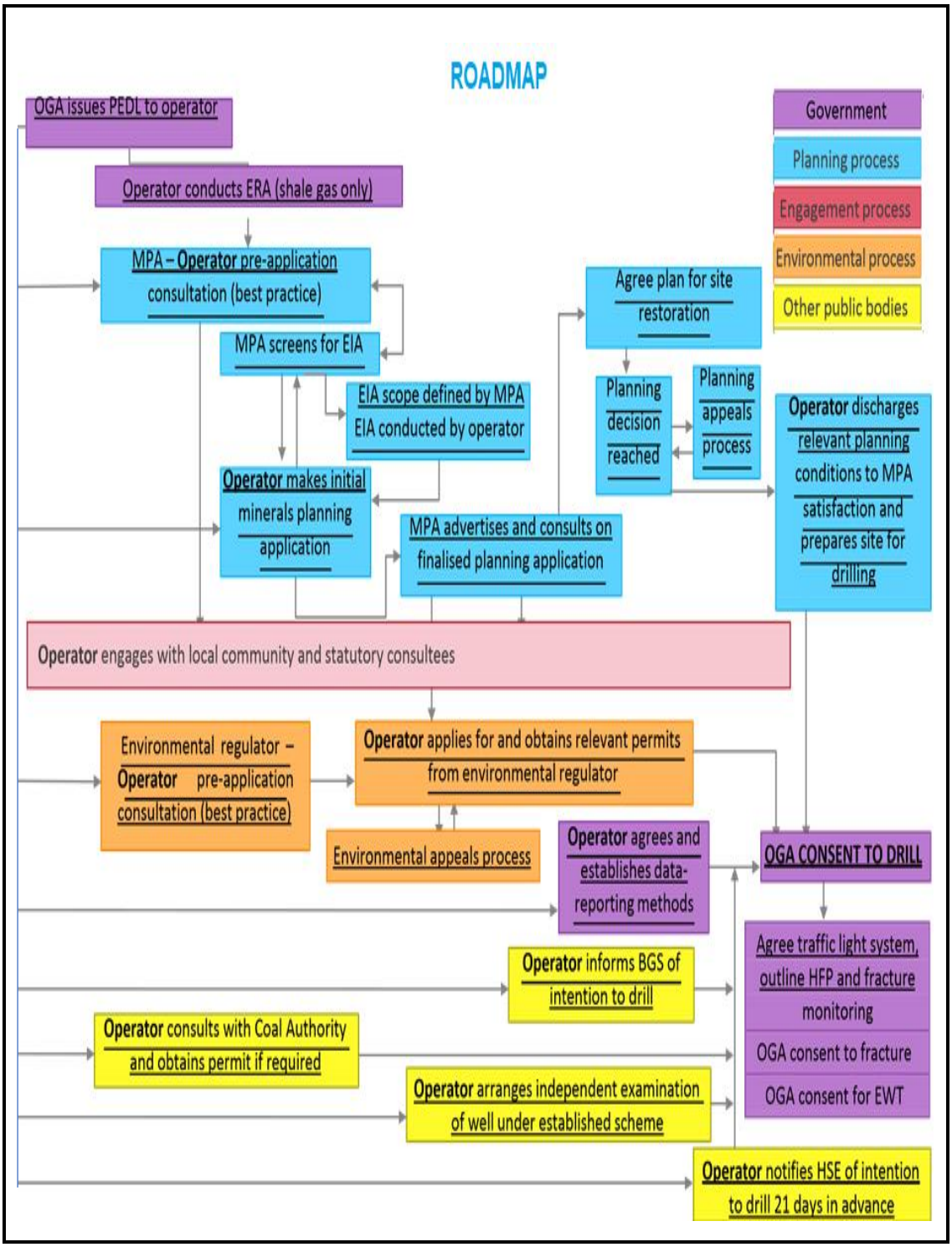
2.5.5 Stage 3 – Production

Once the operator has worked out whether or not the development is commercially viable, the operator will apply for planning consent for a full production site and a pad development plan (PDP) will be submitted to the Department for Business, Energy and Industrial Strategy (BEIS).

At this stage, the additional infrastructure will be constructed. For example, this includes any pipelines which are needed, subject to further planning applications. Once drilling has been completed, activity on the surface will lessen greatly as wells start to produce natural gas (UKOOG, no date).

The pathway an operator has to follow, to gain the various consents and permissions required to begin the exploratory process (and possible subsequent production) of drilling for shale gas is complex. This is shown in Figure 2.10 overleaf. It should be noted that whilst there are a number of references to conducting EIAs, there is no reference to HIA.

Figure 2.10 Roadmap - Consents and Permissions



(DECC, 2015).

(There is a further stage, which is the Decommissioning stage with conditions which should be itemised in the planning application).

2.5.6 Planning

The planning system in the UK is a complex and complicated beast which has grown and developed over the years. The author has referred for the purposes of this research primarily to the website www.planninghelp.org.uk as it is well written, logical and understandable.

The UKs planning system has an overall aim to, 'ensure a balance between enabling development to take place and conserving and protecting the environment and local amenities' (www.planninghelp.org.uk).

There are variations to the planning system in, Scotland, Wales and Northern Ireland, but decisions concerning planning applications for hydraulic fracturing apply to the whole of the UK irrespective of devolved powers. The Welsh Senedd announced in May 2017, that HIA will become a statutory requirement for Public Bodies in Wales. The specific circumstances and regulations have yet to be determined, but when drawn up will be consulted on in late 2017 and early 2018.

However, most planning powers and decisions are left with Planning Departments in Local Authorities, with powers of appeal to Government if considered necessary. (Author's note: recent decisions from Westminster, regarding hydraulic fracturing, appear to overrule the set procedure with Ministers, 'forcing' through decisions. In Scotland Ministers can, 'call-in' planning applications which allows them to make planning decisions rather than the planning authority).

2.5.7 Planning Considerations of Major Infrastructure Projects

Two Acts – the Planning Act, 2008, and the Localism Act, 2011, prepare the planning ground work for decisions on major infrastructure projects or what are defined as, 'Nationally Significant Infrastructure Projects' (NSIPs) i.e. they require a type of consent known as, 'development consent.'

The 2008 Planning Act brought in a new process for NSIPs for certain projects, including, energy, transport, water and waste, which are over a certain threshold. A recent example is Terminal Five at Heathrow, but water and oil pipelines are also included if over a certain capacity. (Author's note: it is not clear if Hydraulic Fracturing sites would fall into this category).

A further change was the Major Infrastructure Planning Unit within the Planning Inspectorate. Through this Act, the relevant Ministers are now responsible for making these decisions on advice received from the Planning Inspectorate.

2013 saw the introduction of the National Infrastructure Plan. Through this Plan, forty priority investment designations were emphasised and as such any proposed development or infrastructure projects, not meeting the 2008 Act criteria would automatically be designated as an NSIP.

2.5.8 Consultation Process NSIPs

Prior to any submission of a planning application, a consultation must be carried out. A further consultation will be undertaken by the Planning Inspectorate upon submission of the planning application. At the pre-application stage, the applicant is required to:

- Consult with the local authority and any other interested party although statutory parties and local authorities are no longer automatically interested parties.
- Prepare a statement in consultation with the local authority on how they intend to consult with, 'people living in the vicinity of the land' (Planning Help, no date).

After submission, consultations are undertaken by the Planning Inspectorate, with local authorities submitting a, 'local impact report.' Local people are encouraged to get involved in consultations but it should be noted that the Inspectorate can ignore any community representation especially if they are

considered, ‘vexatious or frivolous’ or any that relate to compulsory purchase (Planning Help, no date).

2.5.9 National Policy Statements

National Policy Statements (NPS) are Government produced and include how a policy intends to mitigate against climate change coupled with a description of the Government’s objectives in relation to infrastructure development in certain sectors and ensure the following are covered:

- How this will contribute to sustainable development.
- How these objectives have been integrated with other Government policies.
- How actual and projected capacity and demand have been taken into account.
- Consider relevant issues in relation to safety or technology.
- Circumstances where it would be particularly important to address the adverse impacts of development.
- Specific locations, where appropriate, in order to provide a clear framework for investment and planning decisions (National Policy Statements, no date).

The main sectors covered by NPS include:

- Energy (including oil and gas supply and storage).
- Transport.
- Water, waste water and waste (National Policy Statements, no date).

2.5.10 NPPF Minerals Policy

NPPF Minerals Policy of which there are a number of paragraphs directly related to unconventional gas of which:

- Paragraph 142 states, 'the need for a sufficient supply of material to provide….the energy…that the country needs.'
- Paragraph 143 states that environmental criteria should be assessed to ensure permitted operations do not have adverse effects on the environment (natural and historic), human health, mining subsidence and impacts on flow and quality of surface and groundwater and migration of contamination for the site.
- Paragraph 144 - states that, 'local authorities should give great weight to the benefits of the mineral extraction, including to the economy.'
- Further documentation is discussed in this seminar paper including a Technical Guidance, published by the NPPF in 2012, of which there is reference to the developer having to produce a programme of works which shows the impact on a community over the life of the development (Turney, 2013).

The author now looks at the final segment of this chapter, an increasingly topical subject, particularly for the years to come, 'Sustainable Development and Sustainability.'

2.6 Sustainability and Sustainable Development

2.6.1 Sustainability in History

The term, 'Sustainable Development,' has its own unique evolution. Often regarded in modern days as a, 'buzz word' and used frequently across many organisations since the 1980's, it has in fact, as literature reveals, an incredibly long, complex and interesting ancestry which can be traced back to the pre-Greco-Roman Period (Paul, 2008).

Although the idea of Sustainability initially had a significant theological and philosophical approach, historical evidence indicates that concerns, which may once have been thought to have originated during the Industrial Revolution - environmental destruction and degradation - were in fact prominent as far back as the Ancient Egyptian, Greek and Roman civilisations. Environmental problems, such as deforestation and soil fertility loss occurred in areas now known as Iraq, Kuwait, eastern parts of Syria and south-eastern Turkey.

Writings by the Greek philosopher, Plato 429/8-347 B.C. and Pliny the Elder 023 A.D.079 A.D. a Roman naturalist and natural philosopher, both evidenced environmental destruction from human activities such as logging and mining. They not only recognised the devastation this was causing but also the importance of how these resources should be preserved.

2.6.2 Definition of Sustainable Development

Sustainable Development is defined as:

'Development that meet the needs of the present, without compromising the ability of future generations to meet their own needs'
(Brundtland, 1987).

2.6.3 Definition of Sustainability

The word, 'sustainability,' when applied to natural resources, is reputed to have come from German forestry circles sometime during 1713.

It was originated by Hans Carl von Carlowitz, using the German word *nachhaltende Nutzung* meaning, 'sustainable use.' The context related to the replanting of young trees after felling had taken place (Du Pisani 2006).

2.6.4 Sustainability and the Industrial Revolution

Britain is viewed as the birthplace of the Industrial Revolution, which Historians more or less agree, began in 1760 and lasted for the ensuing seventy years.

There were substantial reserves of coal, iron ore and limestone, all significant raw materials necessary to develop industry and to invent new machines to improve production.

Human progress, moved at a faster pace during this period, further supporting the idea that man had dominance over nature.

Du Pisani described this as, ‘leading people to think that it is right for them to dominate the natural order and radically transform it into consumer goods, that it is necessary and acceptable to ravage the landscape…and that only things produced by industry and placed on the market for sale have value.’

2.6.5 Sustainable Development 1972 Onwards

In 1972 the United Nations (UN) convened the first Conference on the Human Environment, held in Stockholm, which Sweden had first suggested in 1968. It was facilitated by Maurice Strong, a Canadian diplomat who in 1971 had commissioned a report, ‘Only One Earth: The Care and Maintenance of a Small Planet,’ co-authored by Barbara Ward and Rene Dubos (Ward and Dubos, 1972).

The General Assembly of the UN suggested the conference focus on, ‘stimulating and providing guidelines for action by national government and international organisations facing environmental issues.’

The conference subsequently agreed a Declaration containing 26 principles concerning the environment and development. Of these principles three are particularly relevant to this research:

- Number 2. Natural resources must be safeguarded.
- Number 6. Pollution must not exceed the environment's capacity to clean itself.
- Number 11. Environment policy must not hamper development.

However, there is no reference in the 26 principles to what are now known as the, ‘Social Determinants of Health.’ Thomas McKeown, Professor of Social Medicine at Birmingham University had begun to highlight the importance of these in 1965 in his book, ‘Medicine in Modern Society’ (McKeown, 1998).

Other principles agreed by the conference recognised the first real relationships between development and the environment and the conflicts between the two.

Arising from this conference was the United Nations Environmental Programme (UNEP) which had a mission to, ‘provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations’ (Paul, 2008).

In 1983, the United Nations General Assembly (UNGA) formed the, ‘World Commission on Environmental and Development.’ In turn Gro Harlem Brundtland the Norwegian Prime Minister known for her strong background in the sciences and Public Health was tasked by the United Nations to encourage countries to work together to pursue Sustainable Development. What became known as the Brundtland Commission published a report in 1987 known as, ‘Our Common Future’ (Brundtland, 1987).

Brundtland’s report focused on the impact of human activity was having on the earth and that population growth and development was unsustainable if continuing at such a pace and without forethought (Brundtland, 1987).

This report led the way at the 1992 United Nations Conference on Environment and Development (UNCED) held in Rio de Janerio (also known as the Earth Summit). This was the first-time efforts were made on an international scale to develop, ‘action plans and strategies for moving towards a more sustainable pattern of development’ (UN-Rio Declaration, 1992).

The conference was deemed, ‘unprecedented,’ due to its sheer size, the range of countries involved and numbers attending with a focus on facilitating governments globally to end the depletion of natural resources and polluting the earth. The principal themes discussed were the, ‘Environment and Sustainable Development.’

The conference recognised the difficulties faced by poverty versus, ‘excessive consumption by affluent populations,’ which is destroying the earth. Additionally, the conference emphasised that the environmental impacts of, ‘economic decisions,’ should/need to be considered.

The four main outcomes from the Rio Conference were:

1. United Nations Framework Convention on Climate Change.
2. The formation of the United Nations Commission for Sustainable Development (UNCSD).
3. The Rio Declaration on Environment and Development.
4. Agenda 21.

The United Nations Framework Convention on Climate Change was an internationally signed agreement which had an overall aim to, ‘prevent dangerous human interference with the climate system.’

It was the responsibility of the newly formed United Nations Commission on Sustainable Development, to monitor and implement the decisions and outcomes of this conference.

The Rio Declaration on Environment and Development built on the 1972 Conference and developed a further 27 Principles of which the most relevant ones to the author’s research are refer to below:

Principle 1. Human Beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle 3. The right to development must be fulfilled so as to equitably meet development and environmental needs of present and future generations.

Principle 4. In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Principle 8. To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote demographic policies.

Principle 10. Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle 11. States shall enact effective environmental legislation. Environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply. Standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries.

Principle 15. In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Principle 17. Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority (UN Rio Declaration, 1992).

Agenda 21 was a substantial document which is a voluntary worldwide action plan of the United Nations regarding sustainable development. It was signed by over 178 Governments at the Rio Conference. Its premise was to prepare the world for the next century/generation and had actions in a number of areas including; social and economic areas, managing natural resources and promoting sustainable agriculture. It has four sections as shown in Table 2.5.

Table 2.5 Agenda 21

1	Social and Economic Dimensions (examining the underlying human factors and problems of development).
2	Conservation and Management of Resources for Development (details the issues, such as resources and ecosystems, which must be examined in detail if sustainable development is to go ahead).
3	Strengthening the Role of Major Groups (explores the social partnerships required if sustainable development is to be a reality).
4	Means of Implementation (explores the resources that may be required in support of sustainable futures).

(United Nations, 1992).

The World Summit on Sustainable Development (WSSD), 2002, was held in Johannesburg, its aim being, 'To Improve Lives while Preserving Earth's Resources.' A number of commitments were made, on an international basis which included sustainable consumption and production, water and sanitation, improving people's lives and conserving natural resources especially with ever increasing populations in mind (United Nations, 2002).

In June 2012, the United Nations held a Conference on Sustainable Development in Rio de Janeiro, (RIO+20.) Dr. W Kreisel, Director WHO Centre for Health Development and WHO Kobe Centre, Japan, wrote a paper, 'RIO+20 and Health Roads Leading from the RIO Earth Summit 1992 to 2012,' in which he writes:

'Since the adoption of Agenda 21 at the Rio Earth Summit 1992, sustainable development has been on the world agenda. Prior to the Rio Earth Summit, human health was omitted and certainly did not hold any significant concern, thereby sustainability and health remained detached.'

Sustainability requires focus on both the, 'here and now' and the future ensuring a good quality of life. This requires everyone to take responsibility from Government to communities and individuals' (Kreisel, 2012).

Having dealt briefly with the historical elements which provide the backbone of the research, the author examines in the following chapter current published literature relevent to this research.

Chapter 3 Literature Search

Introduction

The author, as a former Health Impact Assessment Researcher at the University of Liverpool, has spent a considerable time effecting literature searches on a wide range of policies and procedures. With reference to the subject of this thesis, using, 'normal' parameters or, key words, threw up a great deal of literature, which, in fact, upon review, was not relevant to, or linked to, hydraulic fracturing.

Also excluded from the key word search was the term, 'environmental health,' as this research does not focus on this element, as was, 'human health risk,' as this is defined as, 'the process to estimate the nature and probability of adverse health effects in humans who may be exposed to chemicals in contaminated media, now or in the future' (US EPA, no date).

The search revealed an abundance of papers, articles', documents and reports, many with a narrative towards the traditional public health elements for example, air pollution, water contamination, traffic noise and the potential impacts on human health from these environmental issues.

3.1 Clarification of 'Public Health' in the Literature Search.

In addition to the definition of public health as in Chapter 2:

"The art and science of preventing disease, prolonging life and promoting health through the organized efforts of society" (Acheson, 1988).

The Oxford English Dictionary defines it as:

*The health of the population as a whole, especially as monitored, regulated, and promoted by the state (*A practical example of this is the addition of chlorine to disinfect water supplies to protect public health).

In 2014 the Centre of Excellence in Environmental Toxicology (CEET), disseminated the results from a joint working party, with a number of recommendations from their findings in the paper, 'Environmental Health Research Recommendations from the Inter-Environmental Health Sciences Core Centre Working Group on Unconventional Natural Gas Drilling Operations (UNGDO).' The paper had a remit to review the literature focusing on the public health elements in relation to UNGDO.

The outcome of this review determined that contamination/pollution to air and water is a potential danger as is the damage to the, 'social fabric of communities' (Penning *et al.*, 2014).

Emerging new evidence of a more long term public health aspect of the impacts of hydraulic fracturing on human health, a paper, 'Hydraulic fracturing and infant health: New evidence from Pennsylvania,' (2017), details the interrogation of birth data of 1.1 million births in Pennsylvania from 2004 to 2013, based upon proximity to hydraulic fracturing sites (Currie; *et al*; 2017).

The results indicate that if a mother lives within a 1km of a site there is the largest health impacts as compared to those living up to 3km, where there were still negative health impacts found. The research suggests up to a 3 km radius, a range of birth defects with, *'a higher risk of poor birth outcomes'* (Currie; *et al*; 2017).

However, according to another paper by Beranbe *et al* (2004), which reviewed low birth weight, state there are a number of other reasons why a baby could be born with a low birth rate. These variables include; uterine malnutrition (associated with placenta problems), socio-economic factors and the lifestyle of the mother and any other medical conditions.

It is interesting to note the research outcomes from the low-birth weight paper and proximity to hydraulic fracturing sites which appears to exclude the other

variables for low birth weight in infants as described by Beranbe *et al* (De Bernabé *et al.*, 2004).[6]

The above two papers illustrate what are firmly regarded as public health issues. To clarify further, using air pollution as an example, there are a number of medical health impacts which are referred to as perceived threats within the generic literature search. These impacts include respiratory problems, impacts to the nervous system, birth defects, blood disorders and cancers.

Whilst it is recognised these are important elements to people and communities, they have been further excluded from the literature search as this focuses on the social health and well-being impacts.

It should be noted that using the words, 'hydraulic fracturing' or 'fracking,' and variations of the words occasionally used such as 'fraccing,' as single independent terms, made no difference to the search results, which eventually identified seven studies relevant to this research and three completed HIAs.

3.1.1 The Seven Studies

The seven studies relevant to this research, each of which was published in a different journal are:

1. Is Shale Gas an Energy Solution or Public Health Crisis? 2013. Location: Colorado. Journal of Public Health Nursing.

2. 'Fracking in BC: A public health concern.' 2013. Location: British Columbia. British Columbia Medical Journal. (Note this paper states it is not peer reviewed).

3. Unconventional natural gas development and public health: toward a community-informed research agenda.' 2014.

[6] The author is not implying that the research in relation to proximity is not valid or real but not all facets appear to be included.

Locations: New York North Carolina and Ohio. Journal: Review of Environmental Health.

4. Stakeholder Perceptions of Socio-environmental Impacts from Unconventional Natural Gas Development and Hydraulic Fracturing in Haynesville Shale. 2015.
   Location: Haynesville Shale, Louisiana. Journal of Rural Social Sciences.

5. Popular Epidemiology and 'Fracking': Citizens' Concerns Regarding the Economic, Environmental, Health and Social Impacts of Unconventional Natural Gas Drilling Operations. 2015.
   Location: Bradford County, Pennsylvania. Journal of Community Health.

6. Place-based perceptions of the impacts of fracking along the Marcellus Shale. 2015.
   Location: Marcellus Shale Appalachian Basin, New York, Pennsylvania, West Virginia and parts of Ohio. Journal of Social Science & Medicine.

7. A review of the biophysical and socio-economic effects of unconventional oil and gas extraction: Implications for South Africa. 2016.
   Location: Country-wide. Journal of Environmental Management.

The studies all took a different methodological approach but all were location specific, either where hydraulic fracturing was already underway, or where hydraulic fracturing was a possibility. Three of the studies have, 'public health' in the title, thus focusing upon the public health aspects of the process (Benusic, 2013; Korfmacher *et al.*, 2014; Sangaramoorthy *et al.*, 2016).

The remaining four studies concentrate more on the effects upon people of the hydraulic fracturing process.

3.1.2 Analysis of the Main Points of the Studies

Study 1. Is Shale Gas an Energy Solution or Public Health Crisis? 2013
Location: Colorado. Journal of Public Health Nursing.

Rafferty and Limonik used a case study approach which involved following a nurse who became seriously ill after treating a patient who was admitted to hospital covered in chemicals who had been in close proximity to a hydraulic fracturing site in Colorado.

The study examined several aspects of the hydraulic fracturing process, from, 'fracturing fluid,' water usage and air pollution. The study identifies a number of socio-economic factors among communities, including, negative impact on tourism, falling property prices, rising crime figures, sexually transmitted diseases due to transient working populations and increased rents as the population increases which appears to be having a knock-on effect of a rise in homelessness.

The study touches on the impact on communities, which due to landowner and royalty payments, can lead to significant divide between landowners within communities which in turn can affect their quality of life. The study also references the impact on residents within local communities and dealing with the wealthy extraction industry which is described within the study as, 'time-consuming' and, 'intimidating.'

The study concludes, with concern, that the medical profession are being excluded from the debate and that Health Impact Assessments need to be undertaken (Rafferty and Limonik, 2013).

Study 2. 'Fracking in BC: A public health concern.' 2013
Location: British Columbia. British Columbia Medical Journal. (Note this paper states it is not peer reviewed).

The study by Benusic, was presented as a review of the process and comments of anecdotal evidence of hydraulic fracturing already underway in British Columbia, on the western coast of Canada.

As an exploratory study, it mentions socio-economic factors, but gives no detail regarding them. However, considering the area has already been classed as a boom area, the points raised are the demographic changes that can occur when boomtowns emerge. The study describes this in the manner that these demographic changes can have on the local health service infrastructure as transient populations bring an influx of groups of men in particular, which in turn creates an increase in both alcohol consumption and crime rates.

The study concludes that there is a need for a bias free, evidence based provincial review (Benusic, 2013).

Study 3. Unconventional natural gas development and public health: toward a community-informed research agenda. 2014. Locations: New York North Carolina and Ohio. Journal: Review of Environmental Health.

The study focused on a community needs assessment, examined three states – New York, North Carolina and Ohio - and took a, 'prospective approach'[7] undertaking 43 interviews with community leaders, of which individuals positioned themselves on whether they supported, opposed or were neutral to hydraulic fracturing. It should be noted that at the time of the interviews between 2012 and 2013, hydraulic fracturing had not been initiated in either New York or North Carolina but drilling was well underway in Ohio.

The questions encompassed the broad health impacts of drilling, sources of information, priorities for further research and changes to communities. The

[7] The **prospective approach** – a research method in which study subjects are studied over a period of time (StatsDirect, no date).

overriding concerns from the interviewees focussed on the Social Determinates of Health rather than the disease element.

Consideration of varying geographic, political and economic elements were factored into the analysis for each state as well as factoring in whether or not the process had started.

The socio-economic factors that became apparent comprised of quality of life, economic well-being, the pressure on public health services, traffic, community character and conflict, stress and the effects of boom and bust towns, further to those already mentioned, communication and transparency, particularly in respect of future research and funding and also the need for information.

This study concluded that with regards to an environmental health research agenda for unconventional gas development, community input and involvement is necessary, if not complex and that communities should be involved throughout each stage of the process, and that for communities to be involved within the suggested research agenda all stakeholders, from government, to industry to non-governmental groups should develop systems for integrating community input through the unconventional natural gas drilling (UNGD) process (Korfmacher *et al.*, 2014).

Study 4. Stakeholder Perceptions of Socio-environmental Impacts from Unconventional Natural Gas Development and Hydraulic Fracturing in Haynesville Shale. 2015. Location: Haynesville Shale, Louisiana. Journal of Rural Social Sciences.

Further research exploring socio-economic factors was undertaken in an area known as Haynesville Shale (shale gas extracted since 2008) which explored stakeholder perceptions through two different sources. Firstly by examining current research from studies, industry reports, pro/anti-fracking literature, and media articles and secondly, undertaking 35 semi-structured interviews with

residents, community activists, industry spokespeople, professionals, business owners, state regulators and state geologists/scientists.

As the above study suggests there is growing concern over the push for drilling for unconventional gas and on-going calls for research to be undertaken on the impacts at different locations to identify local-level impacts on communities.

A significant number of socio-economic impacts were identified through the research in Haynesville Shale area and included, traffic and damage to road infrastructure, inadequate oversight of the industry, lack of citizen control, inequitable landowner leasing, increased crime and other associated health impacts (prostitution and drugs, for example), benefits to certain factions of communities and industry, decreased property values, boom and bust economy, increased potential for political corruption and issues surrounding race relations.

Positive factors suggested were about improved local economy and job opportunities.

The study states the need for the full range of socio-environmental (a phrase often interlinked with socio-economic) factors to be explored and the potential significance for humans. As Ladd suggests, '…(if we) fail to address the broadest range of impacts associated with energy technologies like fracking, then we will merely end up shifting the burdens away from the principal beneficiaries of development, imposing them instead on the often rural communities and residents nearby' (Ladd, 2013).

Study 5. Popular Epidemiology and 'Fracking'; Citizens' Concerns Regarding the Economic, Environmental, Health and Social Impacts of Unconventional Natural Gas Drilling Operations.2015. Location: Bradford County, Pennsylvania. Journal of Community Health.

A different approach to identifying citizens' concerns was used in a research project undertaken in the Marcellus Shale Gas Field in Pennsylvania, where natural gas exploration started in 2004. The research employed a methodology known as Popular Epidemiology (a process by which citizens investigate risks with a perceived environmental threat) and using the Social Determinant of Health Framework, 215 letters to a local newspaper, 'The Daily Review.' between January 1st 2008 and 8th June, 2013 in Bradford County, were reviewed. Bradford County was the area used for this research, due to it being the county with the highest natural gas production. The qualitative data analysis tool, NVivo 10 was used to code and analyse the results.

Analysis of the data identifies residents calling for stronger evidence-based research along with a balance between economic interest and protecting health.

Socio-economic factors identified through the letters indicate engagement with communities at the early stages of the process as well as early engagement with the medical profession. There was a strong recognition that, 'science is struggling to keep up with the dangers of fracking.' Analysis of the letters revealed much needed job creation could occur although some writers were not convinced of the proposed level of job creation and whether local people would be appropriately skilled or if indeed, workers would be brought in.

Writers expressed concern over how complex the royalty payment process was and whether they were getting a fair price. However, there were some writers who questioned the funds paid to local communities, 'Impact Fee' and if it would be targeted appropriately and if local communities actually affected by hydraulic fracturing would receive payments or if payments would be distributed within the wider community context, thus generating feelings of mistrust.

There is some indication through this study regarding landscape change, loss of agricultural land, negative impacts as farms were no longer viable as well as the impact on wildlife and biodiversity (Powers *et al.*, 2015).

Study 6. Place-based perceptions of the impacts of fracking along the Marcellus Shale. 2015. Location: Marcellus Shale Appalachian Basin, New York, Pennsylvania, West Virginia and parts of Ohio. Journal of Social Science & Medicine.

The study again explores the health impacts on communities of an area, Doddridge County, within the Marcellus Shale formation, by undertaking two focus groups of local residents. This study also employed the Grounded Theory methodology and elements of the traditional HIA methodology. The focus groups were undertaken to identify and open discussions of health impacts and consisted of 13 participants, predominately female and all over the age of 18.

A multi-day trip was also carried out by some of the researchers visiting local hydraulic fracturing sites and residences, observing and taking notes.

The analysis firstly consisted of coding the focus group transcripts on a themed basis. A further data analysis was undertaken and sub-themes developed using grounded theory. The emerging themes consist of, ‘meanings of place and identity,’ transforming relationships’ and, ‘perceptions of environmental and health impacts.’

Summarising the impacts, these include the negative impact on land, geography and history of place, the destruction of the environment, quality of life, distress and grieving.

Further impacts show traffic, negative financial implications, regulation and mineral right concerns, fear, anxiety and stress (brought about by uncertainty), property values, feeling legally powerless and mistrust. Two positive socio-economic factors were stated, the local economy may improve and local jobs could be created.

At the time of this study being published legislation had been passed by Maryland Congress that included a moratorium on hydraulic fracturing until 2017, until further research on health and economic impacts has been undertaken.

The study concludes as with others, that future planning and research is crucial including research that captures the, ‘full spectrum of stress’ which can then support community leaders and policy makers as and when communities may well find themselves facing hydraulic fracturing in their communities.

Study 7. A review of the biophysical and socio-economic effects of unconventional oil and gas extraction: Implications for South Africa. 2016 Location: Country-wide. Journal of Environmental Management.

One major concern is the impact this process could have on the country’s water supply. Whilst the use of water for the hydraulic fracturing process is not an uncommon concern globally, South Africa is classed as a, ‘water-stressed country’. The potential impact of increased water usage is described by Esterhuyse as having the potential to impact on communities and create community divide.

South Africa, is not new to mineral extractive industry and has seen exploration for oil and gas since the 1960’s when shale gas was explored. This was, ‘low permeable gas deposits’ which were unable to be extracted due to lack of technology. The advances in new technology now have the potential to offer this exploration.

This study reviewed the literature of both biophysical and socio-economic elements related to the exploration and extraction phases of hydraulic fracturing. Within each element a number of strands were considered, both positive and negative.

Focusing only on the socio-economic factors the strands the paper considers include: air quality, astronomy, social well-being and living conditions, agriculture and food security, demographic impacts, health and economic well-being. It should be noted that some of these strands may be more country specific, such as astronomy as this includes factors such as radio telecommunications, environmental impacts on optical telescopes but does include light pollution from the potential use of artificial lighting.

The study describes very few positives, but these do include (please note, all potential), job creation, improved access to health care, food security and population increase. The negatives far outweighed the positives, although it should be recognised that there were elements, which could not be identified in the literature, for example, no positive aspects could be identified with regard to air quality.

Some of the negatives aspects included, decline in tourism, jobs and opportunities taking years to, ‘materialise,’ population increase could create problems including both a gender imbalance and, ‘distorted age structure.’ In respect of the health strand considered within the paper, it focused on the potential health impacts from environmental and medical perspectives.

Within the social health and well-being strand, the negatives take into account such considerations as, fear of health risks, loss of community, anxiety, impacts on the social cohesion of communities, particularly if there are transient populations and as such possible associated increase in crime and substance misuse.

One of the significant considerations, and the context in which the study was published, scrutinised the need for appropriate legal and regulatory framework to support hydraulic fracturing within South Africa, in order to protect both the environment and humans and that a, ‘holistic approach’ needs to be assumed.

The study concludes that in order to protect both the environment and humans that the precautionary approach is taken, that consideration of social,

economic and environmental factors be considered. Furthermore, the study states, that government and industry need to recognise the, ‘complexity of the challenges,’ and if oil and gas operators are to gain a, ‘social licence to operate,’ then transparency and, ‘effective regulatory systems’ need to be in place (Esterhuyse et al., 2016).

3.1.3 Synthesis of Cases

Six of the studies were carried out in the United States of America and one in South Africa, non were completed in the UK. There is no commonality in the methodologies employed and there was a variety of stakeholder involvement but two have no stakeholder consultation.

Considering the Social Determinants of Health, those which predominately feature throughout the studies include stress, anxiety, powerlessness, grieving and distress. Environmental concerns include, as expected, water and air pollution.

Community concerns which occur throughout the studies are the impact on the health service infrastructure caused by transient populations with potentially risky lifestyle behaviour such substance misuse and other addictive behaviours. Also, a potential for an increase in crime and sexually transmitted diseases, all of which fall within the public health domain.

3.1.4 Completed Hydraulic Fracturing HIAs

During the literature search, using the key words, ‘Health Impact Assessment, Hydraulic Fracturing and Fracking,’ revealed just three HIAs which have been completed. These are:

Battlement Mesa, in the US (2010) commissioned by Garfield Board of County Commissioners (BOCC) with the aim of addressing:

Community concerns regarding future land use decisions and to provide specific health information in relation to the developer's plans for natural gas extraction. Also to provide a qualitative and quantitative analysis of existing environmental, exposure, health and safety data relating to the local community.

Lancashire in the Northwest of England commissioned by Lancashire County Council titled; 'Potential Health Impacts of the Proposed Shale Gas Exploration Sites in Lancashire' (2014 report issued 2016).

Two structured stakeholder workshops facilitated by Ben Cave Associates to, 'solicit local views on issues associated with shale gas exploration and extraction and health and wellbeing.'

Scotland. Commissioned by the Scottish Government (SG) in 2015 report issued in 2016 An HIA of Unconventional oil and gas in Scotland.

Three questions were asked by SG:

1. What are the potential risks to health?
2. What are the wider health implications of deploying the technology necessary for the exploration and exploitation?
3. What options could there be to mitigate any potential adverse impacts that are identified.

3.1.5 Summary of the HIAs.

All three had the same end point to essentially establish what the health impacts were from hydraulic fracturing and the possible effects on communities. A full dissemination of these HIAs can be found in Appendix E.

Interestingly, the Battlement Mesa HIA wanted the HIA to provide what appears to be quite a quantitative approach by considering exposure, and health and safety data. The Scotland HIA was not so prescriptive about community issues.

In terms of the Scope of the HIAs Lancashire did not appear to have one although it must be noted that what is presented from the Lancashire HIA is the stakeholder engagement element.

The scope for the other two focused on a range of areas with both having a strong emphasis towards environmental factors such as air emissions and noise. The Scotland HIA Scoped a somewhat apparent focus to medical health impacts as it states, '….evidence in health status directly associated with exposure to specific (environmental) hazards.'

In terms of assessing the health impacts identified, the two U.K. HIAs determined a set of assessment criteria very much in-line with the Impact Analysis section of the generic HIA methodology. Shown in Figure 2.2 on page 27.

3.2 Literature Search - Other Information

Despite the lack of HIAs being used to specifically assess the effects of hydraulic fracturing on people, the literature search reveals, from a number of professional bodies, a growing concern, although these are bodies mainly based in the United States. There is an increasing call for HIAs to be carried out, in addition to Environment Impact Assessments, prior to the commencement of any stage of the hydraulic fracturing process.

The Health and Environment Alliance issued a joint statement in a coalition of environment and health Non-Government Organisations (NGOs) in 2012 on hydraulic fracturing. The statement raised concerns over the impacts from a number of aspects, such as socio-economic, air pollution, land use and stated, 'all these effects have direct and indirect impacts on individual and public health' (Health and Environment Alliance, 2011).

A comprehensive report by the organisation, Concerned Health Professionals of New York, published a, 'Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking (Unconventional Gas

and Oil Extraction), Fourth Edition,' in November 2016. This report collated all the calls and support for the use of HIA relating to hydraulic fracturing. They are summarised below.

- April 2013, what is thought to be the one of the first peer-reviewed nursing articles, 'Is Shale Gas Drilling an Energy Solution or Public Health Crisis?' by Professor Margaret Rafferty, concluded that, '…gas drilling must be preceded by a comprehensive Health Impact Assessment.'
- June 2014, a discussion paper by the Nova Scotia Deputy Chief Medical Officer, reported the need for Health Impact Assessments, particularly if proposed hydraulic fracturing sites are close to communities.
- September 2014, New York's Rockland County legislature adopted a resolution calling for a comprehensive HIA. This call was proposed because of the proximity of a high-pressure pipeline to a nuclear facility and other associated natural gas infrastructure.
- September 2014, the University of Rochester's Environmental Health Sciences Center, undertook a series of interviews which recognised further research was required including Health Impact Assessments.
- July 2015, Renssalaer County Lawmakers, passed a resolution asking the state of New York to freeze the approval process for the Northeast Energy Direct pipeline until a comprehensive HIA was carried out for natural gas pipelines.
- June 2015 the American Medical Association (AMA) adopts a resolution, 'Protecting Public Health from Natural Gas.'
- Infrastructure, again calling for a comprehensive Health Impact Assessment.
- July 2015, New York State, Schoharie County supervisors and medical professionals, 'demanded comprehensive Health Impact Assessments as a precondition for permitting natural gas pipelines.'
- December 2015, the Niagara County Legislature upon recommendations of the Medical Society of the State of New York

called for an HIA on the natural gas infrastructure as well as co-hosting a conference in Albany on the Medical Society's findings, (it is not clear whether this included the HIA.)

- October 2016, a group of health care professionals in Massachusetts called for a moratorium on, 'major new natural gas infrastructure,' until the health impacts on communities could be determined through a comprehensive Health Impact Assessment.
- January 2016, the Institute for Wisconsin's Health Inc conveyed the results of an HIA undertaken on fracking sand mining operations in western Wisconsin. Whilst it is recognised this is not directly related to the hydraulic fracturing process per se, it plays a significant part of the downstream process as the sand is often used as the proppant, i.e. holds the fissures open once the rock is fractured.
- June 2016 the Environmental Protection Agency (EPA) Region 2 (in the United States), commented to the Federal Energy Regulatory Commission (FERC) on the Eastern System Upgrade Project, which included a natural gas compressor station in an area of New York. As part of these comments they suggested an HIA but, the company agreed to fund a health study but wished to retain the ability to determine the study parameters (Dermansky, 2013).

Doctors for the Environment (DEA) in Australia, advise they are, 'a non-profit, non-politically aligned, independent, national organisation of medical doctors which advocates on health issues due to environmental factors,' submitted a, 'Submission to the Inquiry into Unconventional Gas (Fracking) – South Australia,' in January 2015. This submission refers to the approach in Australia which, 'evaluates the environmental impacts of developments under the Health Impact Assessment (HIA) Guidelines, September 2001.' This statement implies the need to undertake HIAs of, 'fracking,' developments (Doctors for the Environment, 2015).

In the United Kingdom the Chartered Institute of Environmental Health (CIEH), whilst, in a Policy Position on Hydraulic Fracturing, September 2014, does not

specifically refer to the use of Health Impact Assessment, it states the need to consider the wider implications including social considerations. It also goes on to say that with regard to, ‘public health or wider social impacts, government must ensure that there is an effective and adequately resourced regulatory monitoring regime in place to build public confidence’ *(Harrison, et al;* 2014).

Additionally, the Chartered Institution of Water and Environmental Management (CIWEM) published a report, ‘Shale Gas and Water, An Independent review of shale gas extraction in the U.K. and the implications for the water environment,’ in 2016. It recommends, as part of the application process, by shale gas operators, that they undertake a pre-application consultation with relevant Mineral Planning Authorities, which may result in screening for an EIA.

The CIWEM report goes onto say that where it is believed there may be significant impacts on health and well-being to local population groups, that requests to the relevant Directors of Public Health, to undertake an HIA should be made (Cantwell, *et al;* 2016).

With Hydraulic Fracturing a paper in 2015, by Watterson and Dinan of Stirling University, Scotland, explored the use of HIA and the use of unconventional gas extraction development. This paper takes a different approach and whilst it still advocates for the use of HIA, brokers discussion surrounding the use of HIA, who commissions them and questions whether communities are able to afford to have an HIA undertaken. Thus, do they always fall to the developers to commission them, and does this make HIA in this way inequitable?

Watterson and Dinan ask what and who makes a specialist HIA practitioner and, are they governed or regulated to ensure HIA specialists are professional in their approach? Their concluding statement asks, ‘how will HIA professionals rise to this challenge?’ (Watterson and Dinan, 2015).

3.3 Summary Chapter 3

Despite an extensive literature search of the Social Health and Well-Being Impacts Associated with Hydraulic Fracturing, the results are very few and predominately originate from the United States of America. The literature search identified seven studies which the author has analysed to show the methodology used and the outcomes. Only three HIAs, one in the United States and two in the United Kingdom were identified.

Although the literature is limited there are some emerging themes which emphasise the need for stakeholder inclusion, transparency, adherence to regulations and consideration to the communities that may be affected. There is also evidence that, whilst there is a growing call for the use of Health Impact Assessment, there is concern about the commissioning and the regulation of those undertaking the HIAs.

The following chapter outlines three theoretical perspectives that have emerged from the previous two literature review chapters. The theories identified are; the Theory of Risk, Complexity Theory and Stakeholder Engagement Theory.

Chapter 4 Theoretical Perspectives

Introduction

As described in the previous two chapters, an uncertain and complex picture is unfolding with the proposed introduction of hydraulic fracturing into the U.K. energy resource. The literature search reveals a lack of uniformity in the analysed outcomes, presenting a somewhat complex picture.

The inter-relationships and overlap between humans, the environment and public health, particularly when adding in large infrastructure projects can present a potentially confusing and complicated picture. Given this highlighted complexity, it is prudent to explore the theories of complexity, risk or uncertainty and stakeholder engagement in more detail.

4.1 Risk and Uncertainty

Risk, as a term, has its roots in medieval times when people and communities were faced with environmental disasters not so dissimilar to today's concerns, how they perceived those risks, often described as hazards or dangers and how they responded to them (Zachmann, 2014).

With the development and increasing use of technology, the concept of risk or uncertainty, terms often used interchangeably, was developed from a mathematical approach, driven by the interest in probability and gambling.

As the concept of risk evolved from a more mathematical standpoint, Cultural Theory was proposed in an effort to explore risk from a more sociological perspective. This theory explored the groupings people belonged to and these perceptions of risk through a, 'shared worldview.'

Other factors then came into play, including the increased use of technology, social urbanisation and the growing insurance sector causing the beginning of

framing risk and uncertainty, including the growing use of risk assessment in industry (Zachmann, 2014).

The Health and Safety Executive (HSE) published a report, 'Review of the Public Perception of Risk, and Stakeholder Engagement,' who had conducted a review of literature on, 'public' perception of risk, especially in relation to hazardous industries that are subject to permissioning and licensing regimes.

The review explored perceptions of risk and subsequent engagement with stakeholders, or more precisely, the public. It is maybe not unsurprising that the paper indicates a correlation between an environmental risk and social ties to where people live, work and play.

The HSE review has also given consideration for the inclusion of factors including, gender and tolerance to risk, socio-demographic and geographical location of a proposed hazard, which may have an impact on a person or community's identity of their, 'place.'

As described by the Royal Society, 1992 and cited in the above paper, one of the main movements of the time, was the importance of social, cultural and political processes which can have an impact on an individual's perception of risk and what is socially acceptable.

Research undertaken by Pidgeon; *et al*, 2003, offered a conceptual framework, which brought together psychological, sociological and cultural perspectives of risk perception.

Key findings include:

- Public responses may be more rational than believed.
- A number of factors are likely to be needed to amplify risk, for example media coverage.

- Trust and perceptions are important when considering institutional risk management and
- Discrepancies between perceived risk at a national level amplified at local level (Pidgeon; *et al*, 2003).

Further factors, as described by Breakwell et al, 2001 include: self-interest, moral outrage and fear, when the public are concerned and those concerns reach a, 'critical point' (Breakwell, 2001). Also noted in work undertaken by Petts et al, and cited in the, HSE review, is increased concern if it is perceived there is secrecy and distrust in organisations, particularly if there is a vested interest (Williamson and Weyman, 2005).

One further element of risk to be discussed focuses on the link between risk, communication and trust. This link is considered to be important with regard to public engagement, particularly in relation to communication from regulatory bodies. Research undertaken by Weyman and Kelly, cited in the HSE review, considers the source of the information for its provenance (Williamson and Weyman, 2005).

The HSE review, has established a number of variables which can influence the perception of risk. These are outlined below:

- Perceived control – which considers individual control or loss of control and vulnerability.
- Psychological time and risk – this considers the time scale between an incident occurring and the on-set of harm from any toxins.
- Familiarity – the familiarity of a risk and the unknown risk and
- Trust and distrust – this variable deliberates that often people's perceptions of risk are not based on direct experience but more through information from a variety of sources.

The literature indicates in the seven studies and three HIAs, that uncertainty most describes the concerns of the stakeholders. These include:

environmental concerns of pollution, traffic nuisance/accidents, environmental damage, explosions and seismic activity. Concerns linked to social well-being are stress, loss of control, changes in community character, effects upon the health service infrastructure and demographic changes potentially bringing unsocial behaviour, crime and substance abuse. As the terms of risk and uncertainty tend to be used inter-changeably table 4.1 is included to clarify the difference.

Table 4.1 Comparison Chart: Risk and Uncertainty

Basis for Comparison	Risk	Uncertainty
Meaning	The probability of winning or losing something worthy is known as risk.	Uncertainty implies a situation where the future events are not known.
Ascertainment	It can be measured.	It cannot be measured.
Outcome	Chances of outcomes are known.	The outcome is unknown.
Control	Controllable.	Uncontrollable.
Minimization	Yes.	No.
Probabilities	Assigned.	Not assigned.

(Surbhi 2016).

Applying the factors from the table above to the situation of the introduction of hydraulic fracturing into the U.K. it can be seen that whilst, there is knowledge and experience within the US, this does not apply in the U.K. and therefore the situation in the U.K. is based on uncertainty.

4.2 Complexity Theory

Complexity theory concerns itself with environment, organisations, or systems that are complex in the sense that very large numbers of constituent elements or agents are connected to and inter-acting with each other in many different ways (Mason, 2016).

Large scale infrastructure projects, such as hydraulic fracturing, are associated with technical, organisational and environmental complexity. These will have a number of uncertainties attributed to them such as

timeframe, organisations financial competency and project performance. These are internal elements and government/regulatory change and economic instabilities are external elements. Traditionally these factors are associated with project management, but over recent years there has seen a demand for, ‘relational,’ ‘human’ and, ‘social’ aspects to be considered (Pryke *et al.*, 2018).

Whilst there are health concerns which arise from environmental factors on one hand and health concerns that lie within the social well-being arena, the picture is more complex than this apparent clear cut division.

These are likely to be public health issues and an example might be the incident of asthma which is often linked to increasing air pollution leading to a rise in GP visits and hospitalisation. But, studies have also shown that, ‘there is a link between strong emotion, including stress and asthma symptoms getting worse’ (Asthma UK no date).

Complex Adaptive Systems (CAS) is a school of thought said to have risen out of the Santa Fe Institute in the mid-1980s and, as described by the Health Foundation as, ‘a way of thinking about and analysing things by recognising complexity, patterns and interrelationships rather than focusing on cause and effect’ (The Health Foundation, 2010).

The paper, ‘The Challenge of complexity in health care,’ by Plsek, as the title implies, explores the challenges faced when using Complex Adaptive Systems and the issues which are facing the health arena in today’s world, and proposes that public health is now shifting from dealing with epidemics and diseases to include environmental issues and lifestyle choices (Plsek and Greenhalgh, 2001).

However, an emerging area of use is within the field of social sciences. Byrne in his book, ‘Complexity Theory and the Social Sciences, An Introduction,’ comments that, ‘the issues is that in the social world, and in much of reality including biological reality, causation is complex,’ that often there are multiple causes which don’t have a numerical value (Byrne, 2001).

Joel Moses, defines the theory as:

"a complex system is composed of many parts that interconnect in intricate ways' (Ferreira, 2001).

(Authors note: while researching Complexity Theory, it became clear that, whilst it is a very effective project management tool, much of it would not apply directly to both the subject and Social Science category of this research. Appendix A contains a broader look at the theory).

4.3 Stakeholder Engagement Theory

In both the seven studies and HIAs, stakeholder engagement was either undertaken differently or non-existent. Given the HIA values and principles it seems fitting to explore Stakeholder Theory in more detail.

Stakeholders are described as:

'…..people who are affected by or can affect a decision'
(Talley, *et al,* 2016).

According to the paper, 'A Simplified approach to stakeholder engagement in natural resource management: the Five-Feature Framework,' 2016, its opening sentence states that, 'natural resource management and public policy literature recommends the inclusion of stakeholders and their interests in decision-making and planning processes,' which implies that undertaking some stakeholder engagement can improve the decision-making process.

The paper also goes onto state that through stakeholder engagement there becomes another of associated outcomes including, 'social learning and, community support for project outcomes (Talley, *et al,* 2016).

Stakeholder Engagement Theory, places itself within the business and management world. Seen as socially responsible for corporations, the literature states that principally the more stakeholder engagement that takes

place within an organisation, the more the organisation is viewed as being responsible. Implicit is that much stakeholder engagement is held within organisations and predominately stakeholders are employees this gives the impression of the link to corporate responsibility (Greenwood, 2007).

Stakeholder theory came to the fore in the mid-80's notably with the publication of Richard Freeman's book, 'Strategic Management,' published in 1984. Freeman argued that the stakeholder concept was undertaken from a company's perspective. Freeman defined a stakeholder as, 'any group or individual who can or is affected by the achievement of the organization's objectives' (Fontaine; *et al*, 2006).

Based on Freeman's definition, it seems appropriate to ask the question, who are stakeholders and according to the document, 'Stakeholder Theory,' (as above reference) it states, 'stakeholder groups mainly consist of customers, employees, local communities and shareholders. Further groups could include, media, general public, government and future/past generations.'

Understanding what a, 'stakeholder' is, is crucial with the earliest definition being cited in Freemans book. The Standford Research Institute (SRI) define a stakeholder as, 'those groups without whose support the organisation would cease to exist.' This definition appears to focus on the organisation as opposed to Freeman's definition which seems to be much broader (Fontaine; *et al*, 2006).

Theoretical development of stakeholder theory was developed from Donaldson and Prestons' work in 1995, titled, 'The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications.' This work proposes three branches: Descriptive, Instrumental Approach and Normative.

Descriptive theory is often used to describe an organisations characteristics and behaviours. The instrumental approach studies what the consequences are of engaging with stakeholders, whilst the normative approach considers, the moral rights related the organisations activities (Fontaine; *et al*, 2006).

Further to this, as described in the paper, 'Visualising and Mapping Stakeholder Influence,' stakeholder theory offers a number of perspectives and expectations that they may hold and is used as a method of identifying stakeholders and the influence different types of stakeholder can confer (Bourne and Walker, 2005).

These are divided into three theories:

- Social science stakeholder theory.
- Instrumental stakeholder theory.
- Convergent stakeholder theory.

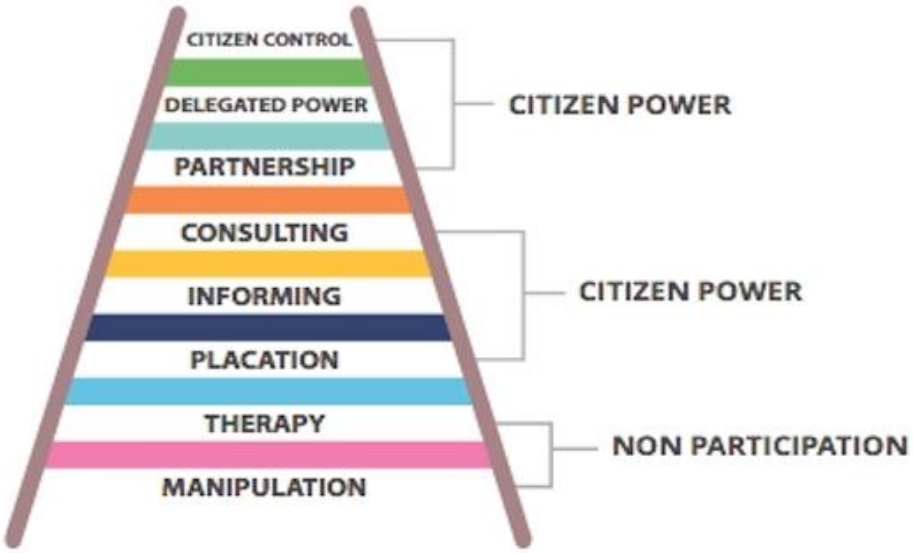
Social science stakeholder theory, as determined by Gibson, 2000, consists of factors including: justice, equity and social rights of the stakeholders' ability to moral persuasion over a project. It is noted that this view is deemed broad and unmanageable due to the impacts on significant number of people, examples of which range from affecting business to quality of life.

Instrumental stakeholder theory, as stated initially in Donaldson and Prestons' work, is dependent on the quality of the interactions.

Finally, convergent stakeholder theory which suggests that stakeholder actions and how they may respond to change is crucial to understanding as a, 'mutual trust and cooperative relationship' will be necessary.

Much of the published work on stakeholder theory concerns commercial organisations and it is difficult to transpose this into a social science research project. However, a brief look at Arnstein's, 'Ladder of Citizen Participation,' developed in 1969 concerning citizens' involvement in the planning process in the U.S., likens participation to a ladder with eight rungs. This is illustrated in Figure 4.1 below.

Figure 4.1 Arnstein's Ladder of Citizen Participation



(Arnstein, 1969).

4.4 Stakeholder Engagement in the Studies and HIAs

Stakeholder engagement can play a crucial part in Health Impact Assessment, although somewhat dependent on which type of HIA is being undertaken. In the main, if a Rapid or Comprehensive HIA is being carried out then it is likely some form of stakeholder will be included.

In terms of the stakeholder engagement which has taken place in the case studies and HIAs, much of it would appear to fall on Rung 4, although Arnstein describes this as, 'window dressing' (Arnstein, 1969).

As the approach to stakeholder engagement was different for each HIA, it is felt appropriate to consider this element in further detail.

The Battlement Mesa stakeholder engagement appears to have recruited a wide range of people but with no clear indication of how the stakeholder engagement was carried out. It appears from the HIA report that previous community meeting minutes were used to identify health impacts, along with a literature review and White paper which had been produced in 2008 outlining potential environmental hazards, vulnerable populations and health outcomes.

The Lancashire HIA undertook two structured workshops with attendees being invited by the Local Authority. However, what is not known is the criteria, if any, for those invited.

The Scotland HIA, held no direct stakeholder engagement but impacts were identified from a number of sources from community group views to industry. It also concluded, ‘ambivalent views’ in an evidentiary context.

The literature review presents a picture of a lack of a common approach to stakeholder engagement thus making comparisons difficult. Korfmacher, in Study 3, states that stakeholder involvement is necessary if not complex and that communities should be involved through each stage of the process.

4.5 Summary Chapter 4

The three theories present an accurate picture of the complexity issues which will include both environmental and personal concerns likely to be faced with the introduction of hydraulic fracturing into the U.K.

The following chapter details the research methodology and design leading to the development and publication of the research questionnaire.

Chapter 5 Research Methodology

Introduction

Oil and Gas companies exploring for shale gas in the UK will be expected to submit an Environmental Impact Assessment (EIA) as part of the planning application process. EIAs do not specifically include human health components and certainly not the Social Health and Well-Being Impacts. The pre-research evidence available in the media presents a confusing case, depending upon the politics of those involved with horror stories emanating in the United States

5.1 Establishing the Research Questions

The literature search in Chapter 3 reveals that little work has been conducted globally, which looks specifically at the effects of hydraulic fracturing upon people, as opposed to the environment. The environment also figures large in history but only in relation to public health, not people's health and well-being.

5.2 Research Considerations

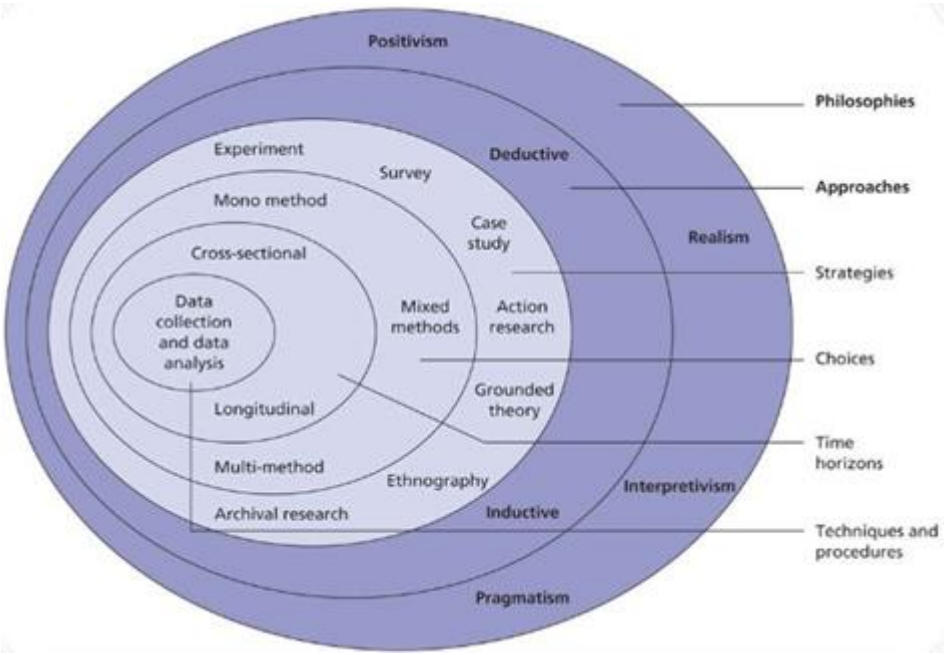
There are three types of research to be considered:

- Exploratory research which often involves a literature search or undertaking focus groups with an aim to explore a new phenomenon in order to test an idea/feasibility for further research.
- Descriptive research explores the description of observations of a phenomenon.
- Explanatory research searches for, 'explanations of the nature of certain relationships' (Jankowicz, 2005).

5.3 Research Methodology

For the purposes of this research it was decided by the author to use the, research, 'Onion' as a framework to develop the research philosophy. The Onion was developed by Professor Mark Saunders, et.al, 2007, to depict the layers describing the techniques of methodology which can be employed for the research design.

Figure 5.1 The Research 'Onion'



(Saunders, Lewis and Thornhill, 2009).

However, before the layers of the, 'onion' are peeled to determine the research design, there is a further layer which sits outside the onion defined as, 'Paradigms.'

5.3.1 Paradigms

A paradigm is defined as,

'a perspective based on a set of assumptions, concepts and values that are held by a community or researchers.'

(Johnson and Larry, 2003).

For most of the 20th century the principal paradigm was Quantitative. This type of research relies on the collection of data which is primarily numerically orientated.

However, two further paradigms have emerged, Qualitative during the 1980s, often seen as the opposite to quantitative, and Mixed Research, which uses both. Firstly, Qualitative Research relies on the collection of data which is primarily non-numeric and focuses on words (Saunders, Lewis and Thornhill, 2009). Secondly, Mixed Research – research which combines both quantitative and qualitative methods. Literature suggests mixed research goes back to the 1950s, but it appears not to have been truly recognised till 2003 (Creswell, 2003).

5.3.2 Research Paradigms

As cited in Pickards paper, 'Paradigms and fairytales' Kuhn, 1962, describes a research paradigm as,

"the set of common beliefs and agreements shared between scientists about how problems should be understood and addressed" (Pickard, 2013).

Kuhn, coined the word paradigm in 1962 to mean, 'a philosophical way of thinking,' and comes from the Greek linguistic roots to imply, 'pattern.' Within a research context, paradigm is used to describe a researcher's belief about the world (Kivunja and Kuyini, 2017).

It, in principle, allows the researcher to decide the methodological approach to their research and how the data will be analysed.

According to Lincoln and Guba (1985) and cited in Kivujna there are four elements (or branches) of a paradigm, these are: ontology, epistemology, axiology and methodology. These are explained in further detail below:

The four research paradigms are:

- The branch ontology is concerned with the assumptions that the researcher makes about the nature of the reality of the social phenomenon to be researched. In other words, it is the beliefs a person (or researcher) has about the reality of the world (Scotland, 2012).
- The branch epistemology has its roots in the Greek language meaning, ‘the study of knowledge.’ This is how a researcher knows something and whether or not it constitutes as acceptable knowledge.
- The branch axiology, refers to the ethical values that the researcher follows when developing and planning the research methodology.
- The final branch, methodology refers to the research strategy, methods and procedures employed to gather the knowledge required to answer the researcher’s research question (Kivunja and Kuyini, 2017).

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Table 5.1 Matrix Illustrating the Four Branches of the Paradigm Aligned with Each Philosophical Approach (Saunders, Lewis and Thornhill, 2009).

Paradigms	Positivism	Realism	Interpretivism	Pragmatism
Ontology: The researcher's View of the Nature of Reality or being.	External, objective and independent of social actors.	Is objective. Exists independently of human thoughts and beliefs or knowledge of their existence (realist), but is interpreted through social conditioning (critical realist).	Socially constructed, subjective, may change, multiple.	External, multiple, view chosen to best enable answering of research question.
Epistemology: The researcher's view regarding what constitutes acceptable knowledge.	Only observable phenomena can provide credible data, facts. Focus on causality and law like generalisations reducing phenomena to simplest elements.	Observable phenomena provide credible data, facts. Insufficient data means inaccuracies in sensations (direct realism). Alternatively, phenomena create sensations which are open to misinterpretation (critical realism), Focus on explaining within a context or contexts.	Subjective meanings and sociable phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions.	Either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the research question. Focus on practical applied research integrating different perspectives to help interpret the data.

Table 5.1 continued on following page.

Table 5.1 cont Matrix Illustrating the Four Branches of the Paradigm Aligned with Each Philosophical Approach.

Paradigms	Positivism	Realism	Interpretivism	Pragmatism
Axiology: The researcher's view of the role of values in research.	Research is undertaken in a value-free way; the researcher is independent of the data and maintains an objective stance.	Research is value laden: the researcher is biased by world views, cultural experiences and upbringing. These will impact upon the research.	Research is value bound, the researcher is part of what is being researched, cannot be separated and so will be subjective.	Values play a large role in interpreting results, the researcher adopting both objective and subjective points of view.
Data collection techniques most often used.	Highly structured, large samples, measurement, quantitative, but can use qualitative.	Methods chosen must fit the subject matter, quantitative or qualitative.	Small samples, in-depth investigations, qualitative.	Mixed or multiple method designs, quantitative and qualitative.

(Saunders, Lewis and Thornhill, 2009).

5.4. The Onion Peeled

5.4.1 First Layer - Philosophies

Research philosophy is an over-arching term relating to the development of knowledge and the nature of knowledge. The four philosophies stated in the outer layer are:

- Positivism
- Realism
- Interpretivism
- Pragmatism

Positivism – is a philosophical stance that was developed by Auguste Comte in 1822, based on the belief that social reality can be explained only through

science and that society's behaviour can be determined and governed by natural law' (Dudoviskiy, 2015).

Realism – is a philosophical stance which accords, 'things that are known or perceived an existence or nature which is independent of whether anyone is thinking about it perceiving them' (Britannica.com, no date).

The approach is of, 'independence of reality from the human mind.' Realism is divided into two groups, direct and critical.

- Direct is explained as, 'what you see, is what you get' thus stating realism, 'portrays the world through human senses.'
- Critical – this realism states that humans experience sensations and images of the real world, which can be deceptive, which therefore argues the opposite to direct realism.

Interpretivism – with this philosophical stance the researcher – it says – is expected to interpret elements of the study, thus integrating human interest into a study. It appears that, 'interpretive researchers assume that access to reality is only through social constructions such as language, consciousness, shared meanings and instruments' (Research Methodology, no date).

Pragmatism – as described by Ozman and Craver, 2008, pragmatism is a traditional philosophy founded in the 1800s in America by C.S. Pierce and William James. It is seen as a philosophy of personal experience. Pragmatism is defined as, 'seeking out the processes and do the things that work best to help us achieve desirable ends' (Smith, 2015).

This philosophical approach only accepts concepts to be relevant if they support action and that there are many viewpoints and that one single viewpoint can never give an entire picture.

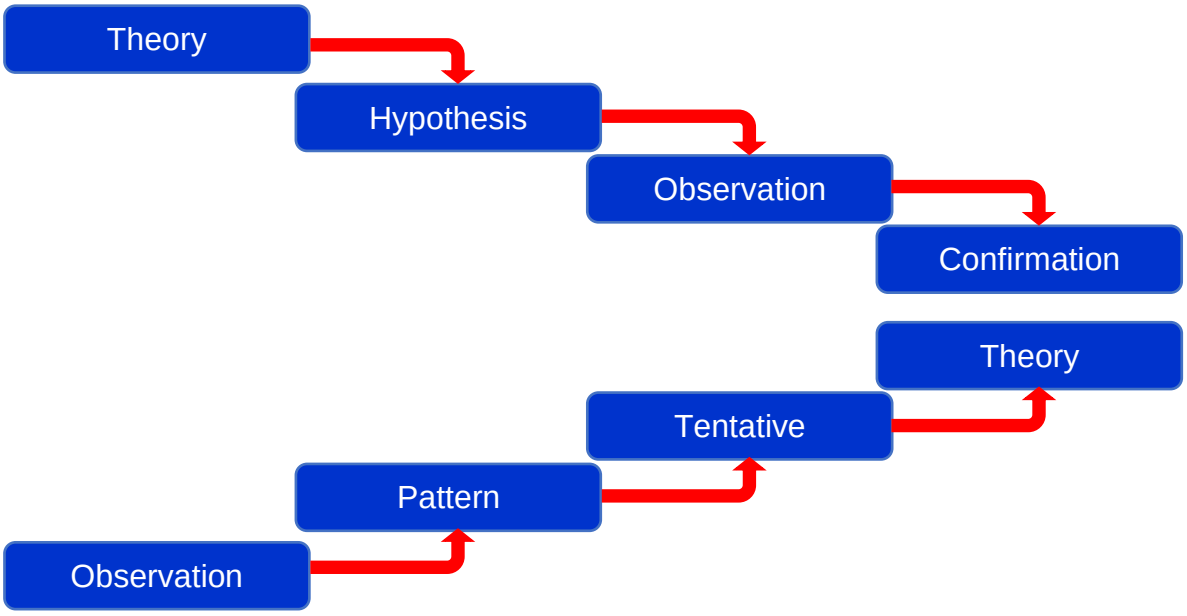
5.4.2 Second Layer - Approaches

- Deductive and Inductive.

The deductive approach focuses on the development of a theory, whereas the inductive approach is explained as being from the bottom up, meaning that data is first collected and the theory is developed as a result of the data analysis. These approaches, adapted from Trochim are illustrated in Figure 5.2.

Figure 5.2 Deductive and Inductive Approach

Deductive Approach



Inductive Approach

(Trochim, 2006).

5.4.3 Third layer – Strategy

Contained within the third layer of the Onion there are a number of research strategies that could be applied in any research project dependent on the philosophical and choices approach. These strategies include:

- Experiment – this research is historically seen as being attributed to the natural sciences and examines the causal links, often with a control group and a measurable result.
- Survey –an investigation about the characteristics of a given population by means of collecting data from a sample of that population (OECD, no date).
- Case Study – where the researcher explores in depth a programme, event or activity or process of one or more individuals, over a given time period where the researcher collects data through a range of methods (Creswell, 2003).
- Action Research – often performed by a group of participants, the process involves investigating through activities rather than theoretical response.
- Grounded Theory – this research requires the researcher to develop a theory by undertaking several stages of data collection and refine the data until it emerges into concepts or categories.
- Ethnography – this research involves the researcher studying by observation an intact cultural group in their natural setting over an extended time period.
- Archival Research – this research is undertaken using administrative records and/or documents, not necessarily historical, as the principal source of data (Saunders, Lewis and Thornhill, 2009).

5.4.4 Fourth Layer – Choices

This refers to the method for data collection used, whether, mono, mixed or multi. Mono – a single method of both data collection and analysis used. Mixed - is described as the term used when both quantitative and qualitative data collection and analysis techniques are used. Multi-method – is more than one method of data collection from one paradigm usually qualitative.

5.4.5 Fifth Layer - Time Horizon

The time frame which for any research is crucial. As can be seen there are essentially two time horizon options, cross-sectional and longitudinal.

Longitudinal is described by Saunders as, ‘a series of snapshots and be a representation of events over a given period.’ This is in contrast with cross-sectional, which is a, ‘snapshot’ in time (Saunders, Lewis and Thornhill, 2009).

5.4.6 Sixth Layer - Data Collection and Data Analysis

The innermost internal layer of the onion explores the practicalities of the research, of what type and data collection methods will be employed. Both Primary and Secondary data are likely to be collected and analysed using any relevant tools and techniques. Primary data is that which is derived from first hand sources. Secondary data is that which is derived from the work or opinions of other researchers.

5.5 Methodological Design

Having studied the research paradigms in conjunction with the four philosophies in management research and then peeled the, ‘Onion,’ the author has concluded that the most appropriate methodological design for this research has an overarching philosophy of pragmatism which is defined as a, ‘study of personal experience,’ as it is the closest fit with the four paradigms. Ontologically it reflects external multiple views and would best enable answering the research question about public perceptions of hydraulic fracturing. The observed phenomena will provide acceptable knowledge.

The pragmatist approach will support the author’s commitment to the HIA value of the Ethical Use of Evidence and of non-bias in the collection of the data and interpretation of the results. As that data will be of both qualitative and quantitative nature, a mixed method of data collection is deemed appropriate.

An inductive approach will be taken, whereby the data will form the basis of a tentative hypothesis and theory. The research strategy will be by the means of a survey.

The time horizon will be cross-sectional as is most appropriate to the use of surveys. A longitudinal timeframe is not applicable to this research in view of the uncertainty of the timescale of the introduction of hydraulic fracturing into the UK.

Data collection will employ the following techniques:

- An on-line questionnaire designed to capture an appropriate data-set, free from bias and with minimal impact on accessibility to research participants (Rowley, 2002).
- The use of case studies that are relevant to this research especially in a, 'real life context' (Rowley, 2002).
- Participant Observation is described as a tool for, 'collecting data about people…..' As described by Marshall and Rossman, 1989, cited in Kawulich, 2005, as, 'providing a written photograph.' A unique method allowing the researcher to observe people in a number of various settings and how they behave and develop an understanding of their attitudes (Kawulich, 2005).

Participant observation is a data collection methodology initially used by Frank Cushing to observe the Zuni Pueblo people in 1879. As a data collection method, participant observation is divided into three phases, participation, observation and interrogation (Kawulich, 2005). According to Schmuck, this method of data collection is useful in a number of ways, including, non-verbal expressions, interactions between people and the nature of their communication, all of which offer researchers potential information which participants may be reluctant to share with researchers under different data collection methods, such as interviews.

DeWalt and DeWalt, 2002, as cited by Kawulich, suggest that using participant observation can help with a broader, more holistic understanding of the research being undertaken. They also propose that using this form of data collection can offer greater validity to the study. Participant observation can offer a greater understanding of the context of the research. In terms of validity, it is also stated by DeWalt and DeWalt, 'validity is stronger with the use of additional strategies, such as…….questionnaires' (Kawulich, 2005).

Broadly speaking, participant observation often involves a researcher interacting with the public and becoming embedded in a situation. The information collected in this way can contribute in the early stages of research design. More often than not this type of research is carried out over a period of time and not restricted to one time/session (Usability Body of Knowledge, no date).

By undertaking participant observation, a commentary should be able to be provided of the situation being studied by recording what is seen, what the researcher can make sense off, what doesn't make sense and any behaviours that occur commonly allowing for reflective conclusions to be developed.

Observational data from any events attended will be recorded to provide additional documented information. Participant observation is very high on ecological validity as it involves studying social phenomena in their natural contexts (Saunders, Lewis and Thornhill, 2009).

5.5.1 Data Analysis

The data collected will be analysed (manually and NVivo) to identify the emergent themes. Observational data from any events attended will be recorded to provide additional documented information. A Causal Loop Diagram (CLD) will be used to provide an understanding of the relationships of the themes identified through the data analysis. Using CLD will allow potentially seemingly unrelated concerns and issues to be mapped and to establish any patterns and/or causal relationships.

The data will be analysed by two discrete methods, firstly by comprehensive analysis of the text and secondly a Causal Loop Diagram will be developed.

A summative content text analysis will be used which will be gathered from the questionnaire. As stated by Moore and McCabe, ‘where the gathered data is categorised into themes and sub-themes’ (Langkos, 2014).

As this will be undertaken manually, human error could occur. To ensure that this will be minimised the analysis will be carried out by the author and an independent Chartered Psychologist. NVivo Pro, a computer programme which supports qualitative data analysis, will also be run on samples of the data to ensure result robustness.

A summative content analysis will be undertaken to interpret the data from the questionnaires. Using this technique involves counting all the keywords with the underlying context interpreted (Hsieh and Shannon, 2005).

If applicable a synonym table will be developed to support the analysis and to enable patterns and relationships to emerge. This is to allow for the possibility that respondents might use different words to express similar feelings and frames of mind.

Initially, codes will be attached to manifest words or text. Latent coding, or groupings, of similar concerns, will be then applied to start, ‘chunking’ codes together. Finally, main themes will be identified and the data used to build a CLD.

5.5.2 Causal Loop Modelling

Causal Loop Modelling is a valuable tool which helps to visually illustrate the complexities of themes and their inter-relationships with each other. They were first used in the early 1970’s and are now commonly used in project management. In February 2015, the World Health Organisation in collaboration with Columbia University, published the paper, ‘System Tools for

Complex Health Systems: A Guide to Creating Causal Loop Diagrams,' (de Pinto, 2015).

A Causal Loop Diagram (CLD) is defined as follows:

> *'A causal loop diagram (CLD) is a qualitative method for visualizing how different variables in a system are interrelated and how they influence each other to create system dynamics. This approach is used to build a simplified model of the factors and dynamics that influence a phenomenon of interest'* (The Earth Institute, no date).

The process of producing a CLD has three stages:

1. Develop a, 'Rich picture' from the research data.
2. Identify the main Outcomes and Drivers from the Rich picture in an Inter-relationship digraph.
3. Build the CLD.

Firstly, a Rich Picture will be developed, although for the purposes of this research it will be a, 'verbal rich picture.' This is a mechanism where the information from the data analysis is captured as complex scenarios evolve. (de Pinto, 2015). Using data from the Rich Picture, an Inter-relationship Digraph (IRD) will be created.

The construction of the IRD begins by placing all the elements (variables) derived from the analysed data in a circle. A single variable is selected and the relationship is shown to other variables with a line between them with the arrowhead showing the direction of the relationship. This process is continued with the other variable until the IRD emerges. The main Outcomes will be those with most incoming arrows and the Drivers those with the most outgoing lines (de Pinto, 2015).

Once the Outcomes and Drivers have been identified, the CLD can be developed. This should allow the main concerns and issues raised by the research to be identified.

5.6 Credibility and Validity of Research Findings

Discussed by Saunders et al, the reliability and validity of the research is key and asks the basic question, ‘will the research stand up to the closest scrutiny?’

Saunders explains that reliability is, ‘the extent to which your data collection techniques or analysis procedures will yield consistent findings.’ He goes on to state that, validity is a method when the procedure or procedures used to collect the data accurately measure what they are intended to measure (Saunders, Lewis and Thornhill, 2009).

5.7 Questionnaires

There appears to be some ambiguity over the word ‘questionnaire’ as it is often linked to the word ‘survey.’

5.7.1 Definition of a Questionnaire

> *A questionnaire is a set of carefully prepared questions designed with the aim of collecting reliable data from selected participants*’
> (Remenyi *et al.*, 1998).

Oppenheim defines a questionnaire as:

> *‘a tool for collecting and recording information about a particular issue of interest’* (Oppenheim, 1992).

Questionnaires are often used as a data collection tool as they allow a significant amount of data to be collected from large sections of populations and often in a relatively economic way. They tend to be used for exploratory research which, ‘aims to seek new insights into phenomena, to ask questions, and to assess the phenomena in a new light’ (Saunders, Lewis and Thornhill, 2009).

5.7.2 Questionnaire and Longitudinal Forecasting

The design of a questionnaire focusses on from whom data will be collected and how often it will be collected. Data can be collected by means of a census or sample survey.

A census, such as the UK Decennial Population Census, asks the same questions across the nation whereas a sample survey can be a one off snap shot of either a selected or random sample of respondents at a given moment in time, or is carried out on more than one occasion. Such surveys are referred to as serial surveys. Serial surveys can be used to carry out repeated cross-sectional sample surveys by using different samples or longitudinal studies where the same questions are asked of the same respondents at planned time intervals.

The only variable in most longitudinal surveys is the time element. They are often used to identify relationships and interactions between variables and therefore may give some basis for determining possible causality.

An example of such a study is The Million Women, started in 1996. It has followed the same sample of women using the same health questionnaire requested every two to three years, aiming to determine the relationship between Hormone Replacement Therapy (HRT) and certain conditions including breast cancer.

Survey data can help improve forecasting by detecting changes when they are happening, ‘instead of waiting for the information to be incorporated into formal relationships’ (Dunkelberg, 1986).

The type of questionnaire to be used in this research will provide a snapshot in a moment of time of how an unselected sample of the population perceives the proposed introduction of hydraulic fracturing into the UK. As a one off, time limited sample, in which respondents will be anonymous, neither a longitudinal survey or forecasting is possible.

5.7.3 Types of Questionnaire

There are three types of questionnaire:

- Self-administered, where they are completed by the respondent. These are often undertaken electronically, posted or hand-delivered – all, 'handed' back to the researcher.
- Interviewer administered questionnaires where the questionnaires are recorded by the researcher, such as a telephone questionnaire.
- A structured interview where the interviewer meets the respondent face-to-face.

But, the three methods were all likely to present the same problems as already experienced with the focus groups and the intended face to face interviews. Therefore, the only safe method of collecting data would be through a suitable on-line platform.

Whilst designing the questionnaire it was also necessary to consider the following the issues of Validity, Reliability, Contamination, Bias, Sources of error and Sampling.

Validity is defined as: 'The concept of validity is that a test is valid if it measures what it claims to measure' (Kelley, 1927).

Reliability is defined as: The term reliability in research is the consistency of the research study (Simply Psychology, no date).

Contamination: Spurious associations and inaccurate estimates mainly arise due to chance, bias, confounding and/or contamination.

Bias occurs when there is a systematic difference between study measurement and the true population values (Levin, 2005). Bias could be evident in the coverage error, as some parts of the population would not have access to the internet. Additionally, the questionnaire could only be published

in English due to cost constraints. There might also be bias in the sense that only those interested in the subject of hydraulic fracturing would reply.

Errors in questionnaires, can occur from a number of reasons, of which the four main ones are explained by Groves, 1989, and reiterated by Fricker.

- Coverage error – when some part of the population cannot be included.
- Sampling error – when a sample of the target population is surveyed – different samples will generate different results.
- Non-response error – when no data is collected.
- Measurement error – when responses are different from the, 'true' response (Fricker, 2008).

With regards to the last bullet point, as this research is original there can be no response which is different from the true response.

Sampling: A sample is a group of people who take part in the investigation. The people who take part are referred to as participants (Mcleod, 2014). Sampling within the context of a questionnaire is described as, 'the selection of a subset of a larger population to survey,' (Fricker, 2008) and used as already stated to gather information about a population group.

Sampling methods can be grouped into two, probability-sampling is one in which each person in the population has an equal or at least known chance of being selected, whilst in a non-probability sample, some people have a greater but unknown chance of selection. This research undertook a non-probability sampling approach.

As with elements of the Onion, the author concluded that these issues would not be relevant as there would in fact be no control of participants who responded to the questionnaire.

5.8 The Questionnaire

A paper-based pilot of the questionnaire was undertaken, with a small number of people, mainly friends and professional acquaintances. The purpose of the pilot study was to determine if the questions were clear and unambiguous, as this would then make the process of the subsequent data analysis more accurate.

The main comments concerning the pilot were in relation to the clarity of the language of the questions, which were then amended accordingly. Most of the pilot study respondents were positive about the flow of the questionnaire which was said to be easy to fill in and the time to complete, approximately 10 minutes, was acceptable.

Following on from the paper pilot, the decision was taken to up-load the questionnaire onto an on-line survey portal for ease of distribution.

The most appropriate on-line hosting was identified from a number of options including Survey Monkey, E-Surv and Bristol On-Line Survey (BOS). Bristol On-Line Survey was chosen as it was already under licence to Liverpool John Moores University. The other two were excluded due to a combination of cost and technical incompatibility.

Once the survey was up-loaded it was distributed across various platforms to drive exposure and wider coverage and as there would be no control over who completes the questionnaire it was to be considered both equitable and democratic. The platforms identified included the website, ‘Drill or Drop’, a website that is the ‘go-to’ place for anything related to hydraulic fracturing. A community website, Stapleford Community Group, a local business, the Natural Veg Men with a wide on-line network and LinkedIn. These sites were linked to the Bristol On-Line Survey.

All locations were chosen to prevent, where possible, undue bias, although there appeared to be very few sites that were of a neutral nature towards the

hydraulic fracturing process. As the platforms for the questionnaire were not all identified at the same time, the author decided to leave the questionnaire open to the public for six weeks to allow for an adequate number of replies in order to generate a substantial amount of data.

10 questions were deemed an appropriate number as these covered the issues the author wished to research and to time-limit completion to no longer than 15 minutes. This was felt to be important in order to keep respondents focused to enable as many questionnaires to be completed rather than being abandoned before completion.

Table 5.2 The Published Questionnaire

All the questions, (with the exception of numbers 8, 9a and 10) are linked specifically to both the Aim of the research and to Objective 3. Further links which influenced the formation of the questions are shown where applicable. To recap:

Research Aim

To determine the public perception of the social health and well-being impacts associated with Hydraulic Fracturing.

Objective 3

Devise the research methodology using qualitative and quantitative data collection methods by means of an on-line questionnaire.

Table 5.2 overleaf, provides an oversight into the reasoning behind the questions asked and any possible subsequent analysis difficulties which might result from the data collected.

Table 5.2 The Published Questionnaire

	Question And Type of Question	Purpose of Question Or any Limitations	Potential Analysis Difficulties
1	Have you heard about Hydraulic Fracturing? Yes/No closed question. Answers of 'no' routed to Q9.	To identify whether or not people had heard of hydraulic fracturing.	Would people be likely to fill it in if they hadn't heard about it? So does that naturally mean people who haven't heard about it won't fill it in.
Linked to Objectives 1 - to establish current knowledge and Objective 3 – support the development of the study's research strategy.			
1a	Where do you get your information from? Open question. A whole list, tick as many as respondents like.	To assess where respondents source their information. Interesting to assess/link the opinion of respondents from where they get information.	Maybe too much information for people to list.
Linked to Study 5 (Popular Epidemiology and "Fracking": Citizens' Concerns Regarding the Economic, Environment, Health and Social Impacts of Unconventional Natural Gas Drilling Operations) to determine how information was gathered by respondents and Study 4 (Stakeholder Perceptions of Socioenvironmental Impacts from Unconventional Natural Gas Development and Hydraulic Fracturing in the Haynesville Shale).			
2	Are you familiar with the Hydraulic Fracturing Process Yes/No closed question. Answers of 'no' routed to Q9.	To identify if respondents understood the actual process of hydraulic fracturing.	Similar to Q1, it is important to establish whether respondents understand the process as opposed to just having heard about it.
Link: As question 1.			
2a	Where do you get your information from? Open Question.	A list of options, tick as many as respondents wish to assess from where they get their information.	Maybe too much information for people to list.
Links are as question 1.			

Table 5.2 cont The Published Questionnaire

	Question And Type of Question	Purpose of Question Or any Limitations	Potential Analysis Difficulties
3	Have you attended any official consultation process? Yes/No closed question.	Consultation will play a significant part in the application process which allows residents to have their say on any application.	Possibly not many official consultations have as yet taken place. However, it will be interesting to see what respondents say and establish what they class an official consultation process.
Links: See after question 3c.			
3a	Please give details of any formal consultations attended.	Data gathering.	None foreseen.
3b	Do you feel you can trust any formal consultation processes? Yes/No closed question.	To give support to the previous question of whether formal consultations have been attended or whether there are other events related to hydraulic fracturing which respondents may perceive as formal consultations.	None foreseen.
3c	Please state why you do OR don't trust any formal consultation process. Open question for comments.	To add context to data gathered from question 3a.	None foreseen.
Link: Study 3 (Unconventional Natural Gas Development and Public Health: toward a Community-Informed Research Agenda). References to undertaking of Community Needs Assessment. Limited reference to consultation in all three HIAs.			

Table 5.2 cont The Published Questionnaire

	Question And Type of Question	Purpose of Question Or any Limitations	Potential Analysis Difficulties
4	Hydraulic Fracturing is often referred to as, 'Fracking' – how does this make you feel? Open question for comments.	Does the word 'fracking' have any bearing on whether people are for or against the process?	Responses are likely to be positive or negative.
Link: Lancashire HIA as this is the location exploration commenced and as a result drew a great deal of, mainly opposing media attention. Therefore, would frequent colloquial use of the word 'fracking' as opposed to, 'hydraulic fracturing' affect the way people felt about the process? Often used in names of opposition groups such as, 'Frack off.'			
5	Do you live, work, attend an educational facility or pursue leisure activities near a proposed Hydraulic Fracturing site? Yes/No Closed Question.	To identify how close to a proposed site respondents are.	None foreseen.
Link: Lancashire HIA as this undertook stakeholder engagement with residents local to potential hydraulic fracturing sites. Study 6 'Place-based perceptions of the impacts of fracking along the Marcellus Shale.'			
5a	Please mark relevant distances relating to whether you live, work, attend an educational facility or pursue leisure activities. Multiple choice question.	This question was broken down into four parts, one for each activity with a number of distances for respondents to choose.	None foreseen.
Link: Study 1. Is Shale Gas an Energy Solution or Public Health Crisis? Account of resident living close to a hydraulic fracturing site hospitalised due to contamination and subsequent contamination of a nurse.			

Table 5.2 cont The Published Questionnaire

	Question And Type of Question	Purpose of Question Or any Limitations	Potential Analysis Difficulties
5b	If you marked any of the above distances in 5a for any activity, please state how this makes you feel. Open question for comments.	Data gathering.	Will depend upon how views that are expressed (but would expect themes to emerge).
Linked to the above to gather further information.			
6	Health is defined in a broad, non-medical way by the World Health Organisation (1948).as: *'a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.'* Considering the definition, what do you think, see or feel that the Social Health Impacts on communities or individuals might be from Hydraulic Fracturing? Open question for comments.	Much of the literature focuses on the medical issues/concerns. This PhD study focuses on the Social Health and Well-Being Impacts as defined by the WHO. It is the crux of the study to identify what these impacts may be.	Respondents' understanding of a very conceptual definition. Are respondents so very focused on the medical health impacts that they haven't had opportunity to consider what they may see as Social Impacts.
Links: To all the Studies 1-7 inc and this definition underpins the HIA process and the foundation of this research.			

Table 5.2 cont The Published Questionnaire

	Question And Type of Question	Purpose of Question Or any Limitations	Potential Analysis Difficulties
7	Do you have any concerns/issues if Hydraulic Fracturing goes ahead near you? Open question for comments.	Important source of data which will underpin this research by reflecting the public response concerning the implementation of the process.	Could be a significant amount of data for analysis as currently there is a great deal of public opposition to hydraulic fracturing.
Links: To both of the UK HIAs as these are based on hydraulic fracturing potentially beginning in the UK.			
8	Do you think there are any opportunities/ benefits if Hydraulic Fracturing goes ahead near you? Open Question for comments.	To offer the opportunity to understand if respondents see any positives if hydraulic fracturing is introduced into the U.K. Might give balancing data to the strong public opposition to the process.	None foreseen.
Link: The research has taken an unbiased approach and as such both negative and positive responses are important.			
9	How important do you think it is to have a range of energy sources? Multiple choice question.	Respondents were offered a range of alternative energy sources which had a ranking order of importance.	None foreseen. Respondents are asked to rank their order of importance.
Link: Chapter 2 Section 2.6 Sustainability and Sustainable Development. All Studies 1-7 as they discuss the use of shale gas as an alternative energy source.			

Table 5.2 cont The Published Questionnaire

	Question And Type of Question	Purpose of Question Or any Limitations	Potential Analysis Difficulties
9a	Taking into account what you might have read or heard, how secure do you think our current energy sources of gas and electricity are? Open question for comments.	To gather data on the level of public knowledge regarding U.K. energy sources, sustainability and security.	None foreseen.
10	Would you consider being involved in further independent community consultation, such as a focus group, as part of this research? Yes/No Closed question.	Given the difficulties encountered in being unable to undertake focus groups, this question was asked to determine if those having undertaken the questionnaire would be happy to be part of further research.	None foreseen. Respondents could leave their contact details should they want to be involved in further consultation.
Extra	A selection of demographic data questions was asked. All tick boxes, one answer only apart from being asked to leave the first three characters of their postcode (or location if outside the UK).	General question to ascertain the spread of respondents, gender, age and employment.	None foreseen, but will give a positive profile of the sample.

Table 5.2 cont The Published Questionnaire

	Question And Type of Question	Purpose of Question Or any Limitations	Potential Analysis Difficulties
Final	Please add further comments about the subject matter or the questionnaire. Open comment box.	As with most questionnaire offers the respondents the opportunity to add something that they think is relevant to the questionnaire that wasn't included within the questions asked.	N/A

5.9 Summary Chapter 5

Having researched, in depth, the methodology to be employed to gather data on the research topic and its subsequent analysis, the author is satisfied that any themes or outcomes will be a true reflection of the data collected.

The following chapter looks at the data collected and its analysis.

Chapter 6 Data Collection and Results

Introduction

The author now looks at the data gathered from the conferences and events attended concerning hydraulic fracturing and then from the questionnaire.

6.1 Conferences and Events Attended – Observations

Water, Oil and Gas Conference, 2nd December 2015. Venue, Coventry University, Organised by British Water.

The aim of the conference was to update water sector companies on developments in the Oil and Gas industry to enable them to identify business opportunities.

Objectives:

- Present an overview of the global landscape and leading players.
- Highlight the procurement processes, current opportunities and available support schemes.
- Identify water challenges and technological requirements.
- Understand the current situation of UK shale gas exploration, its limitations, challenges and opportunities.

Observations

Not the easiest conference to sum up. Person hosting it was lively and engaging but it was like being at a party – they seemed to know each other, which I then wonder how it can be objective.

There was a spokesperson from one of the major Hydraulic Fracturing companies who was dismissive of the general public and referred to some (probably protestors) as, ‘tree huggers.’ How on earth can they get people on-side when you have companies speaking like that in these events?

Brownfield Shale & Unconventional Gas Conference 24 February 2016.
15 Hatfields, Chadwick Court, London, SE1 8DJ

Brownfield Briefing and Environment OnSite together presented the 2016 Shale & Unconventional Gas conference; a unique one-day programme addressing the issues and environmental implications arising from the use of unconventional gases, including shale gas, coalbed methane (CBM), bio-methane, underground coal gasification (UCG), and hydrogen.

Programme

'Examining Policy Drivers & Practical Solutions to Mitigate & Manage the Environmental & Geo-Technical Impacts of Shale and Unconventional Gas Exploration & Production.'

Speakers

Tony Almond, *HID Oil and Gas Policy Team, Health and Safety Executive (HSE)*.
John Blaymires, *Chief Operating Officer, IGas.*
Dr Frederic Coulon, *Senior Lecturer in Environmental Technology, School of Energy, Environment and Agrifood, Cranfield University.*
Charlotte Danvers, *Programme Manager Oil and Gas, Environment Agency.*
Paul Davison, *Managing Director of Proteus UK and Proteus Environmental Hong Kong.*
Graham Dean, *Managing Director, Reach Exploration Reach Exploration.*
Steven J Edwards, *Head of Regulation & Commercial, Wales & West Utilities Ltd.*
Dr Pete Edwards, *Research Fellow, Department of Chemistry, University of York & National Centre for Atmospheric Science University of York & National Centre for Atmospheric Science.*
Dr Paul Goodman, *Researcher in Transport and the Environment, School of Civil Engineering and Geosciences, Newcastle University Newcastle University.*

Mark Hill, *Head of Development Management, North York Moors National Park Authority.*

Anne Johnstone, *Ramboll Environ.*

Lorna Millington, Design Manager, National Grid *National Grid**.***

Nigel Mills MP *Chairman, All-Party Parliamentary Group on Unconventional Oil and Gas (unable to attend on the day).*

Mike Stephenson, *Director of Science and Technology, British Geological Survey*.

Elizabeth Shepherd, *Partner & Head of Environment, Eversheds.*

Emma Taylor, *Senior Policy Officer, Scottish Environment Protection Agency (SEPA*).

Dr Neil Thorpe, *Deputy Director, Transport Operations Research Group (TORG), School of Civil Engineering and Geosciences, Newcastle University.*

Dan Price, *Principal Consultant**,** Ramboll Environ*.

Bethan Winter *Head of Regulation & Commercial, Wales & West Utilities Ltd.*

Observations

Having introduced myself to two senior managers from two different Hydraulic Fracturing companies, they were very interested in what I was doing but said I was ahead of the game and they weren't ready for this yet, but they expected to see lots more of me in the future. It was deemed that the timings to undertake face-to-face interviews with them was not suitable.

South Hambleton Shale Gas Advisory Group. Fracking Question Time

Saturday, 29th October 2016.Venue Galtres Centre, Easingwold, North Yorkshire.

A local shale gas advisory group, which aims to engage with stakeholders and experts and, without campaigning for or against, to provide advice and information to communities and policy makers.

Observations

The event was held in an accessible central location with over 200 people attending. It took the approach of BBCs Question Time, which worked well. The event was lively and engaging, and whilst residents and local communities still don't/didn't like the idea of hydraulic fracturing, the event was well managed without any aggression or abuse.

The meeting was chaired very effectively by Barrister Helen Proops. Panel members included Tom Pickering (Ineos), Kevin Hollinrake MP, Dr Joanne Hawkins (Leeds University), Chris France (NYM National Park Authority), Councillor Lindsay Burr and Dr Robert Arnott (Oxford Institute for Energy Studies)

Harrogate – 6th October 2016. Venue Wesley Chapel, Harrogate.

The event took the form of a debate with proposing and opposing sides. The motion was, 'This House Calls for an Immediate End to Fracking in the UK.'

Each, side had 20 mins to deliver their argument. Proposing the motion was John Plummer, seconded by Ian Crane. Opposing was Ken Wilkinson seconded by Lorraine Allanson. Following the debate was a fifty-minute open session, with questions from the floor.

Observations

It was an aggressive and unfriendly event. When those attending entered the hall prior to the debate, they were invited to put a coin into a box, either for or against the motion, with an option to abstain. A show of hands at the end of the debate was compared to the opinions expressed at the beginning.

Table 6.1 Debate Results

	Before the Debate	After the Debate	Change
For the Motion (ban fracking)	65	71	+6
Opposing the Motion	17	6	-11
Abstained	9	6	-3

Overall, the author gained the impression that whilst some people were in favour of fracking but did not openly commit due to atmosphere in the meeting. The motion was carried.

The link is to the subsequent newspaper report.

http://www.harrogate-news.co.uk/2016/10/19/harrogate-votes-frack-free-future/

UK Onshore Oil and Gas: Planning and Environment Summit, Manchester – Wednesday 6th July 2016. An event organised by Open Forum Events with an aim to explore:

- What local authorities have in place to meet the expected demand of planning applications.
- How they can best work with stakeholders to determine the best decision(s).
- What academics and community groups can do to enhance the work that is taking place.

Observations

There was a picket line outside and the police were present. Not a big picket line but people could have felt intimated. A commentary on the, 'Drill or Drop,' website was live at the time of the event stating:

'Red Line Protest Outside Manchester Oil and Gas Conference'

Campaigners against climate change from across northern England formed a symbolic thin red line outside a meeting in Manchester about UK onshore oil and gas.

Martin Porter, of Manchester Greenpeace, told a demonstration of around 50 people outside the city's conference centre.

"Fracking is our red line"

The police offered the delegates the option of leaving the conference building via a back door, but this offer was not taken up.

From the author's data gathering perspective, the presentation by Neil McBride, Planning Manager, Lincolnshire County Council, was extremely useful in highlighting the difficulties which Planning Departments would have in meeting the Governments criteria of a sixteen-week timescale for approving hydraulic fracturing operations.

There were ten presentations in all, but only one, 'The Shale Gas Revolution?' briefly touched upon the effect of hydraulic fracturing on people, otherwise it was concerns about the environment.

6.1.1 Meet the Regulator's Events

The Author also attended two of these events. These are hosted by a range of governing bodies in relation to hydraulic fracturing. These included, the Environment Agency, the Health and Safety Executive, local planners (not at every event), the Oil and Gas Authority and Public Health England.

The events were held at various locations across the UK and were held in local, accessible locations and premises. They were open between 2-7 pm. The idea for these events was for local residents and communities to attend an informal event to ask questions.

Thursday 21st July 2016. Mickle Trafford, Chester. Informal information session by the Environment Agency, Health and Safety Executive and Public Health.

Observations:

The author attended this event as it was a couple of miles from the author's home. It was quite busy given the location in a smallish village on the outskirts of Chester and all the attendees were engaged and friendly, even if they opposed hydraulic fracturing. There was a small picket outside, who weren't intimidating, just there to represent their view and opposition to the process.

The Environment Agency team were very friendly and approachable. They made sure everyone had refreshments and were coping with the incredibly hot weather.

Wednesday 12th October 2016 at Christ Church Aughton, Lancashire.

About 50 people attended during the time the author was present mixed gender, mainly older people. The atmosphere was friendly as opposed to other events attended, for example, Harrogate.

Observations

The author spoke to three ladies and their comments were:

- 'They see each regulator has to, 'toe the party line.'
- 'They didn't think we needed any more energy.'
- 'But, it conflicts with current government policies such as walking more and conserving energy.'
- There appeared to be no collaboration with research between the regulators.

The author overheard a gentleman saying he had been converted after speaking to the Environment Agency. He was happy for it to happen even if

was in his back yard. His concern was for the younger generation in 20 years' time. Unfortunately, the author was unable to ask him about these concerns.

6.2 Questionnaire Results

The questionnaire was completed by 94 respondents. One respondent did not answer any questions therefore 93 questionnaires were initially analysed. However, it became clear that there was an anomaly, as the pie charts automatically generated by the computer system, showed only 92 completed questionnaires.

Upon investigation, one person had opened two questionnaires to add a further comment, this was established by the time stamp on the questionnaires, therefore the actual total in this analysis is 92.The effectiveness of the questionnaire is evaluated at the end of this chapter.

6.2.1 Age range of Respondents

Of the 92 completed questionnaires, two omitted their age from the ranges shown in Table 5.2.

Table 6.2 Age Ranges of Respondents

Age	Female	Male
Under 18	1	1
18 - 25	1	3
26 – 35	5	2
36 – 45	10	6
46 – 55	18	4
56 – 65	12	12
66 – 75	5	8
75+	1	1
Totals	53	37
Combined Total	90	

It can be seen that there is a wide spread of ages between male and female but with women being 59% of the respondents and men 41%.

6.2.2 Geographical Locations of Respondents

Respondents were asked to give just the first three digits of their postcode for mapping purpose. Within the UK, responses were received from an area stretching from Edinburgh to the South Coast. Analysis of the 80 known locations within the UK shows that 64% live within the Bowland-Hodder Shale Formation. The remaining 36% live within the Weald/Wessex Basin. There were no responses from people living outside these areas. It was not possible to identify if the respondents living abroad lived within hydraulic fracturing areas. There were 88 responses as shown in Table 5.3.

Table 6.3 Geographical Locations of Respondents

UK Responses	UK Locations in Lieu of Postcode	UK Refusals
78	2	1
Europe and International Responses		
Portugal	Australia	Canada	United States
2	3	1	1

6.3 Respondents' Responses to the Questionnaire

The Bristol On-Line Survey (BOS) system identifies the number of respondents who answered each question, shown as *n=xx* on the data graphs and charts. It should be noted that respondents often included more than one response, the total number of which are recorded in the data in the bar charts. These numbers do not necessarily correspond to the numbers of respondents answering the question.

For the open-ended and comment only questions, the data is based on text and thematic analysis. Several of the charts contain an 'undefined' category as, whilst respondents answered the question, there was some ambiguity about them, but there obviously had been research carried out by the respondents.

The following tables and figures present the quantitative and qualitative data obtained from the responses to the questionnaire. Appendix F contains a selection of the written responses to each question. These represent approximately 19.5% of the total written perceptions and concerns expressed by the respondents, just over seven hundred in all.

6.3.1 Question 1 asks, ‘Have you heard about Hydraulic Fracturing?’ and question 2 asks, ‘Are you familiar with the Hydraulic Fracturing Process?’ Both questions then ask, ‘Where do you get your information from? In both questions there are seven possible sources of information listed by the author.

To facilitate an easy comparison between the responses to these questions, both charts are shown on the page 144 overleaf.

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Figure 6.1 Question 1. Number of respondents answering this question *n=92*

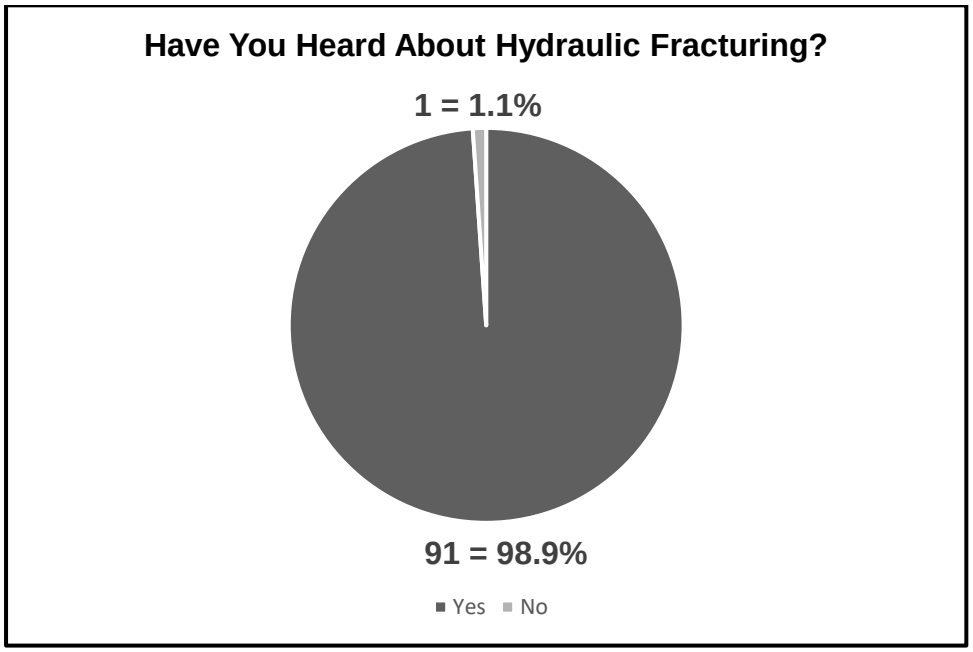


Figure 6.2 Question 2. Number of respondents answering this question *n=91*

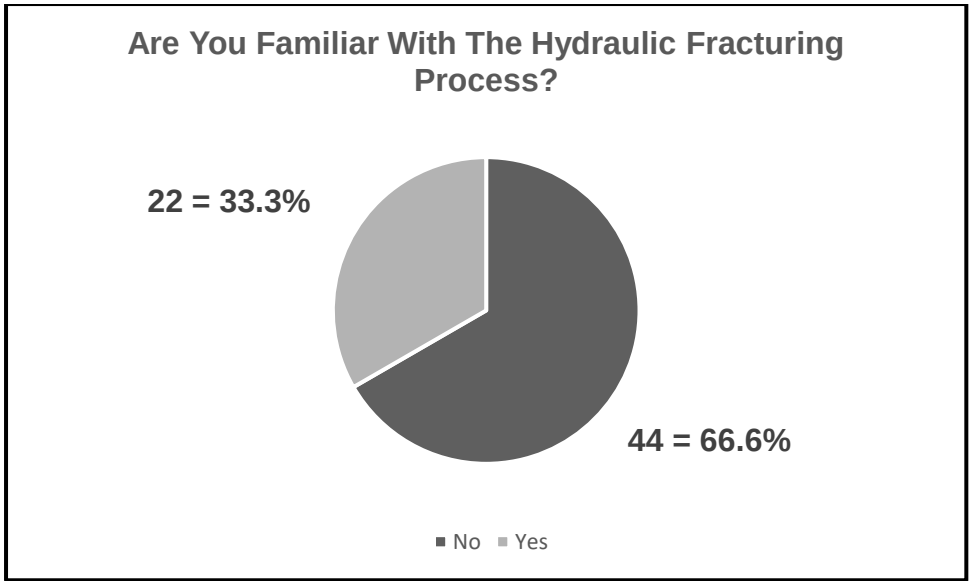


Figure 6.3 Question 1a. Have you heard about Hydraulic Fracturing? Where do you get your information from? *n=82*.

The 'Social Media,' heading includes Facebook and Twitter.

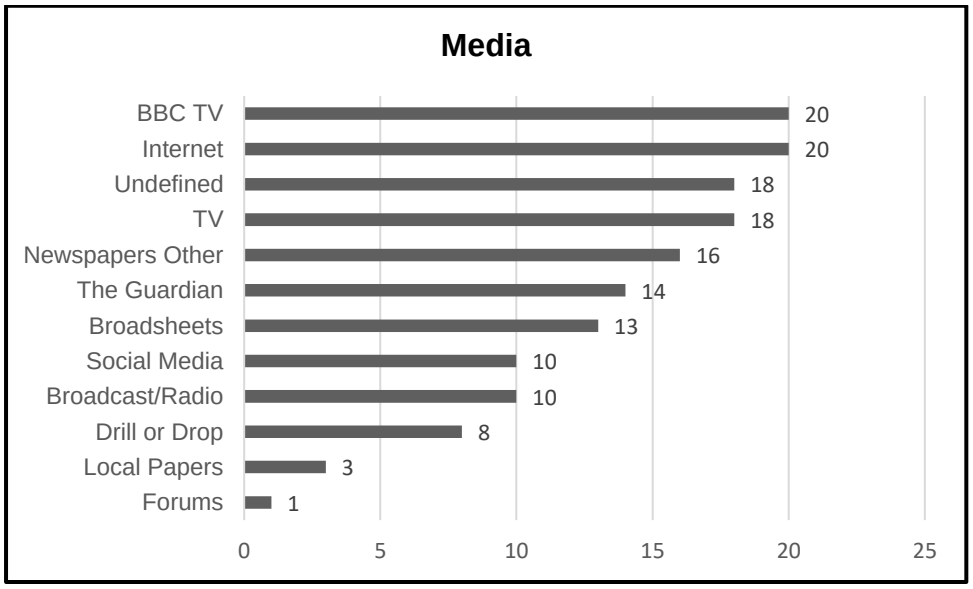


Figure 6.4 Question 2a. Are you familiar with the Hydraulic Fracturing process? Where do you get your information from? *n=47.*

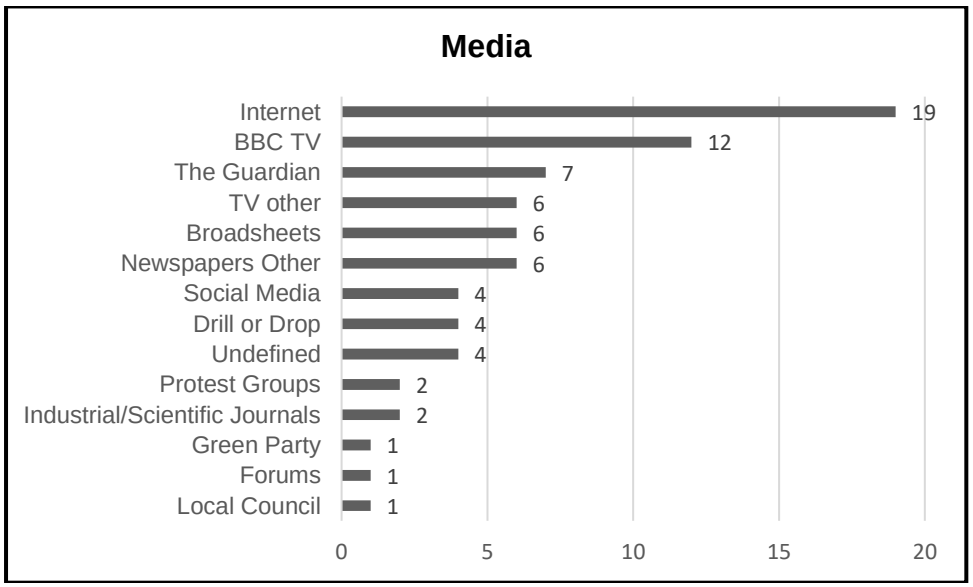


Figure 6.5 Question 1a. Have you heard about Hydraulic Fracturing? Where do you get your information from? *n=52.*

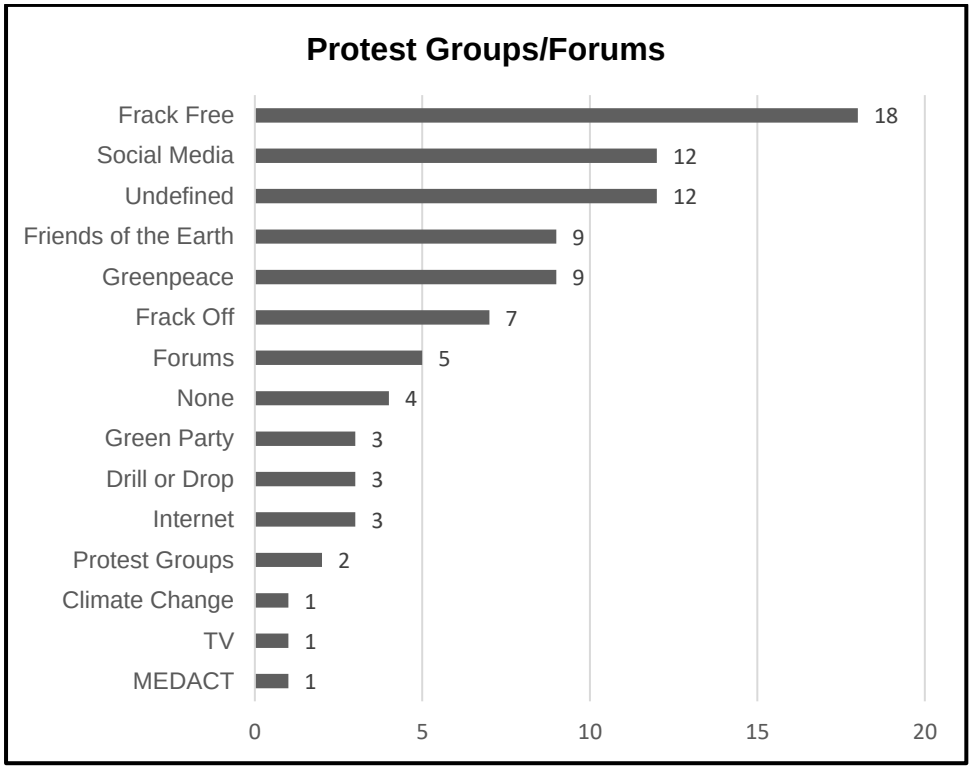


Figure 6.6 Question 2a. Are you familiar with the Hydraulic Fracturing process. Where do you get your information from? *n=32.*

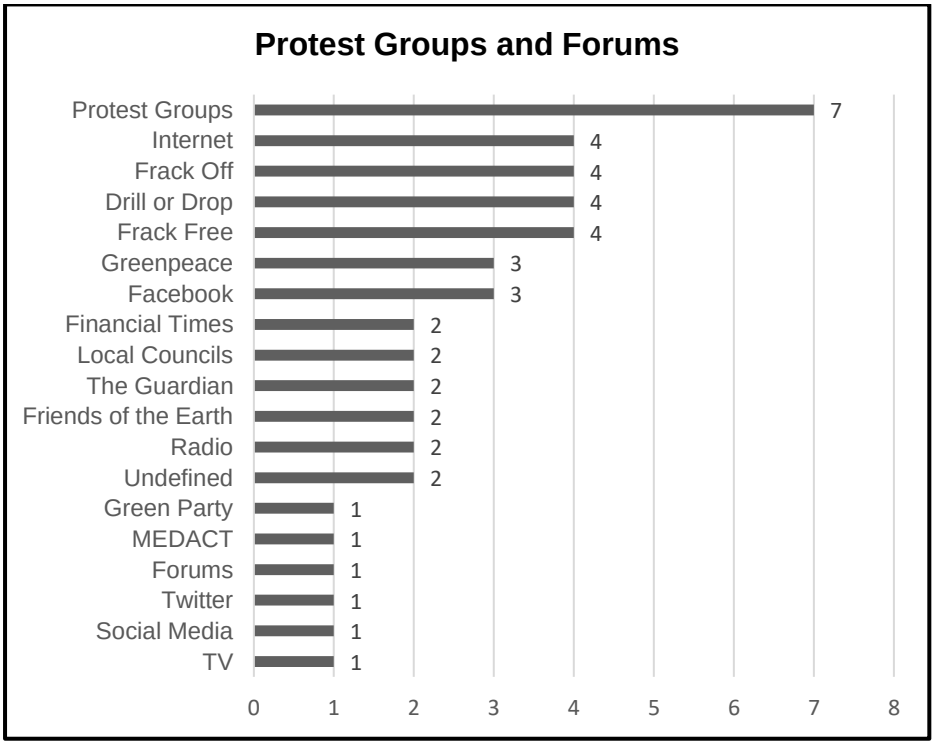


Figure 6.7 Question 1a. Have you heard about Hydraulic Fracturing? Where do you get your information from? *n=28*.

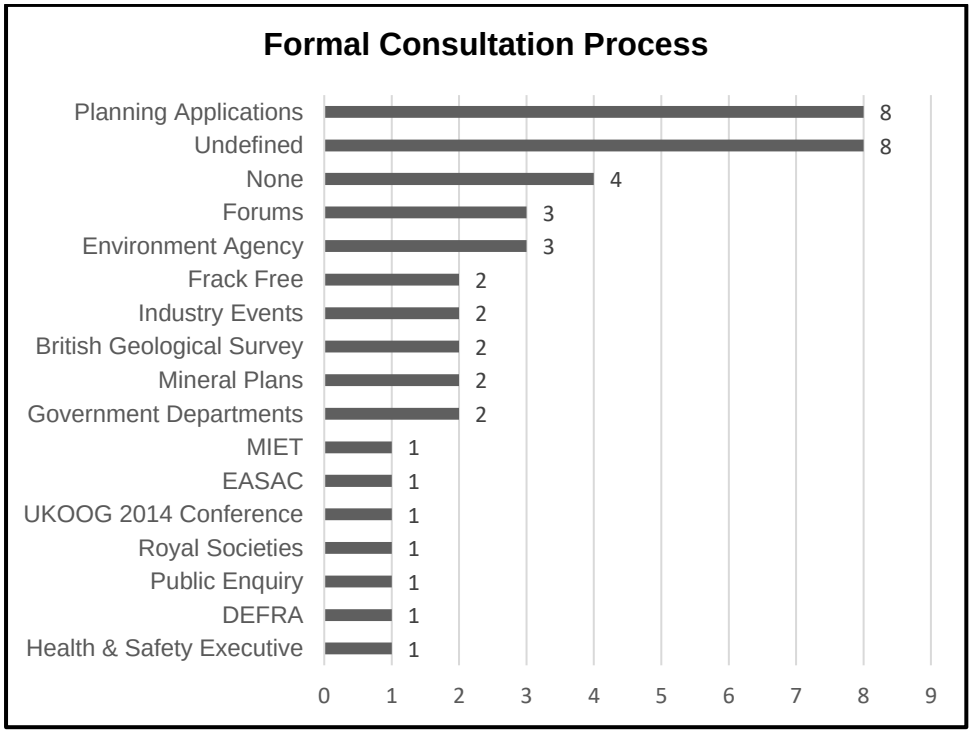


Figure 6.8 Question 2a. Are you familiar with the Hydraulic Fracturing Process? Where do you get your information from? *n=19.*

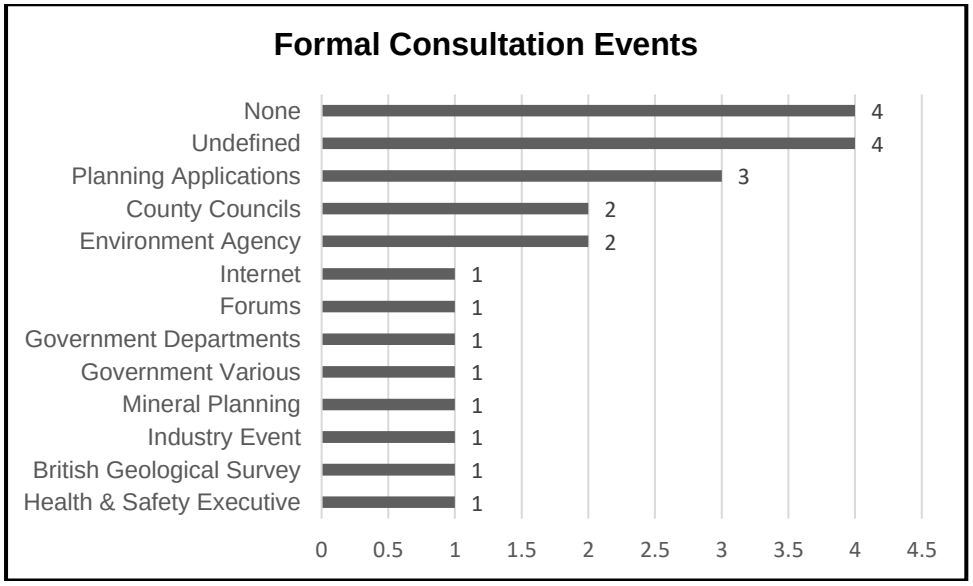


Figure 6.9 Question 1a. Have you heard about Hydraulic Fracturing? Where do you get your information from? *n=36.*

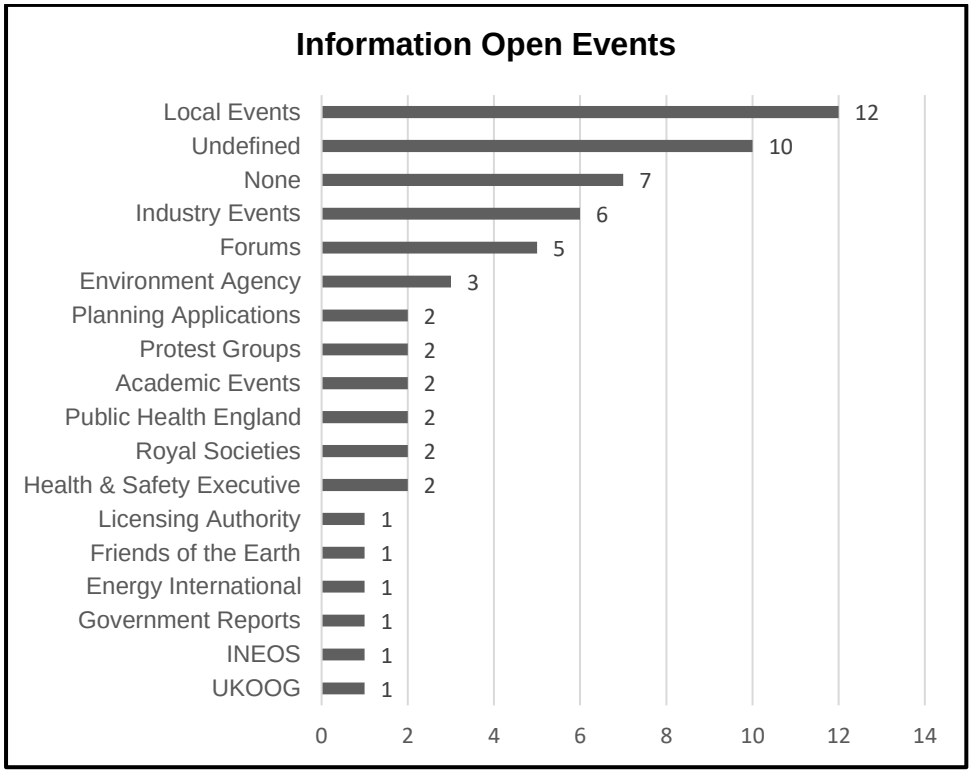


Figure 6.10 Question 2a. Are you familiar with the Hydraulic Fracturing process? Where do you get your information from? *n=23.*

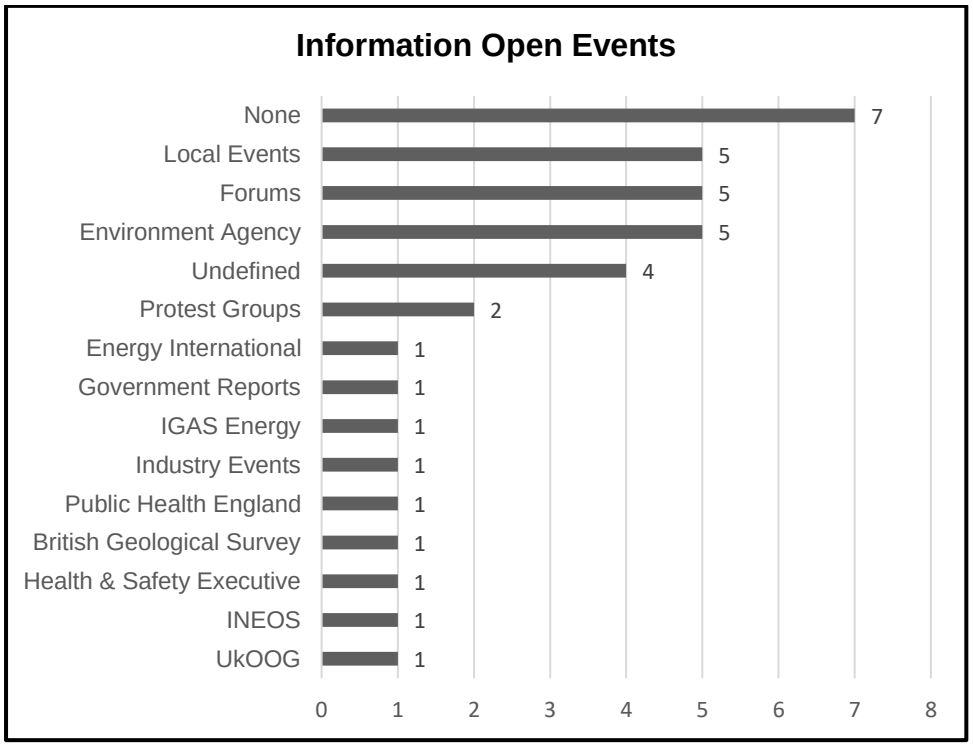


Table 6.4 Question 1 and 2 Reports Referred to by Respondents.

1a	Have you Heard about Hydraulic Fracturing? Where do you get your Information from?	2a	Are You Familiar with the Hydraulic Fracturing Process Where do you get your Information from?
	Government Reports *n=38* Department for Environment. Food and Rural Affairs (DEFRA). Select Committee Reports. Committee on Climate Change. Environment Agency (EA).Public Health England (PHE). 2016 Infrastructure Bill. US Environmental Protection Agency (EPA) and the US Department of Environmental Protection (DEP).		Government Reports *n=28* Department for Environment, Food and Rural Affairs (DEFRA). Select Committee Reports. Disasters Emergency Committee (DEC). Committee on Climate Change. Department for Communities and Local Government (DCLG). Environment Agency (EA). Public Health England (PHE). US Environmental Protection Agency (EPA).
	Academic Reports *n=40* *Only 10 cited specific titles:* British Medical Association (BMA). Refine Project, Newcastle University (cited three times). The Environmental Cost of Fracking,' (Jackson, R. 2014). 'Injection-Induced Earthquakes,' (Ellesworth, W. 2013). 'Keep Moving! Report on the Policing of the Barton Moss Community Protection Camp' (Gilmore J. et al, 2014) 'Fracking: Minding the Gaps' (Hawkins, J. 2015). 'Health and Fracking' (Medact 2014).*		Academic Reports *n= 28* *Only 4 cited specific titles.* 'Towards a Social Impacts Assessment.' (Szolucha, A, 2016). The Environmental Cost of Fracking.' (Jackson, R. 2014). 'The Human Dimension of Shale Gas Developments in Lancashire, UK.' Short articles by Cornell University Professor Anthony Ingraffea.

Table 6.4 cont Question 1 and 2 Reports Referred to by Respondents

1a	Have you Heard about Hydraulic Fracturing? Where do you get your Information from?	2a	Are You Familiar with the Hydraulic Fracturing Process Where do you get your Information from?
	Other *n=39* Carbon Brief. Environmental Campaign Groups. Environmental Consultants. Freedom of Information Act. Friends/Religious Group. Law Papers/Legal Seminars/Trade Unions. Meteorological Society/National Geographic Magazine. NGO Website. Oil and Gas Website and Magazine. Personal Experience. Susquehannal River Basin Study.		Other *n=33* Personal on the-job experience. Campaign groups and scientific journals (New Scientist). ENDS Reports.(endreports.com) The Ends of the Earth? Energy World.' On-line fracking course. 'Is fracking safe,' website.
	Professional Publications Cited by Respondents in their Comments: The University of Cincinnati Water Quality Study. The Texas Commission of Environmental Quality Study. Pennsylvania Environment Protection Study. Shale Gas and Fracking – The Science Behind the Controversy.		

*It should be noted that apart from the Medact report, none is specifically related to the Social health impacts of hydraulic fracturing.

Figure 6.11 Question 3 Have you attended any official consultation process? *n=69.*

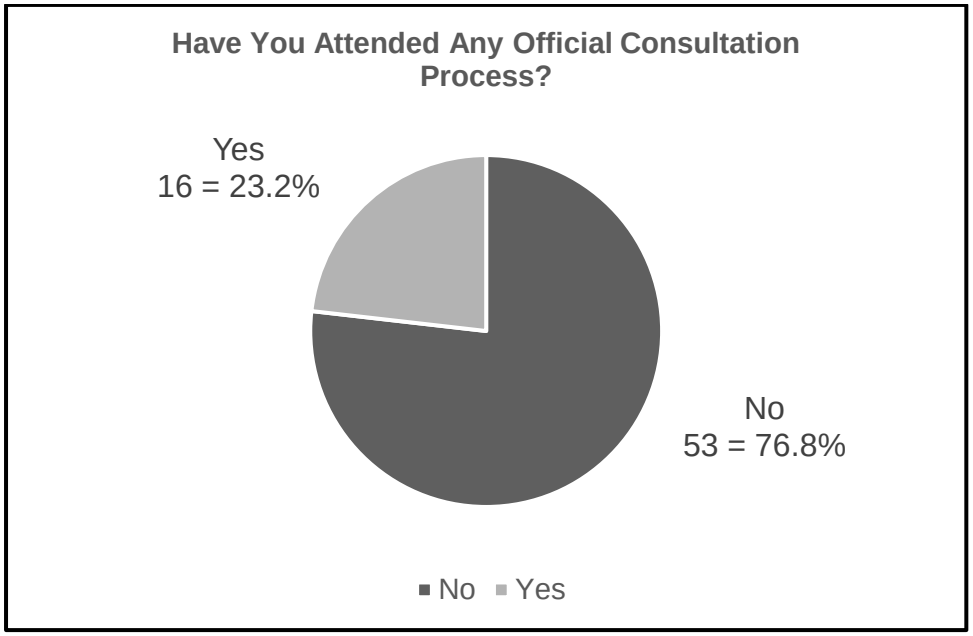


Figure 6.12 Question 3 Please give details of formal consultations attended. *n=18*.

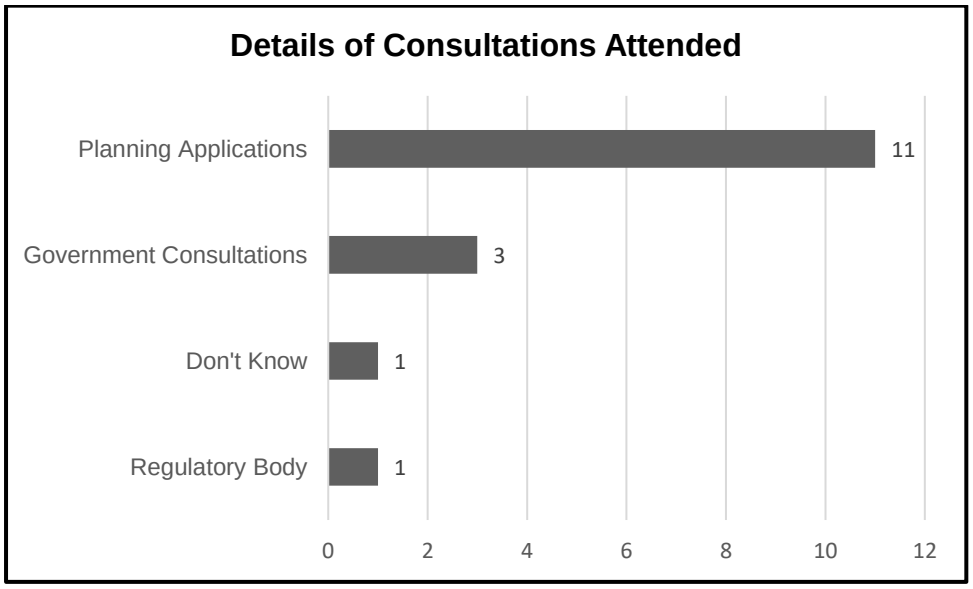


Figure 6.13 Question 3 Do you feel you can trust any formal consultation process? *n=66*.

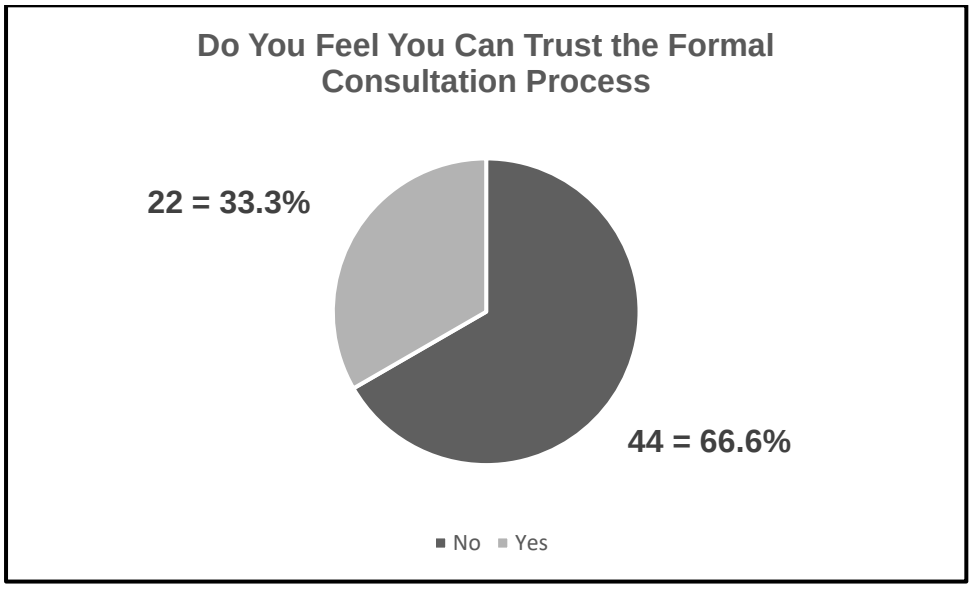
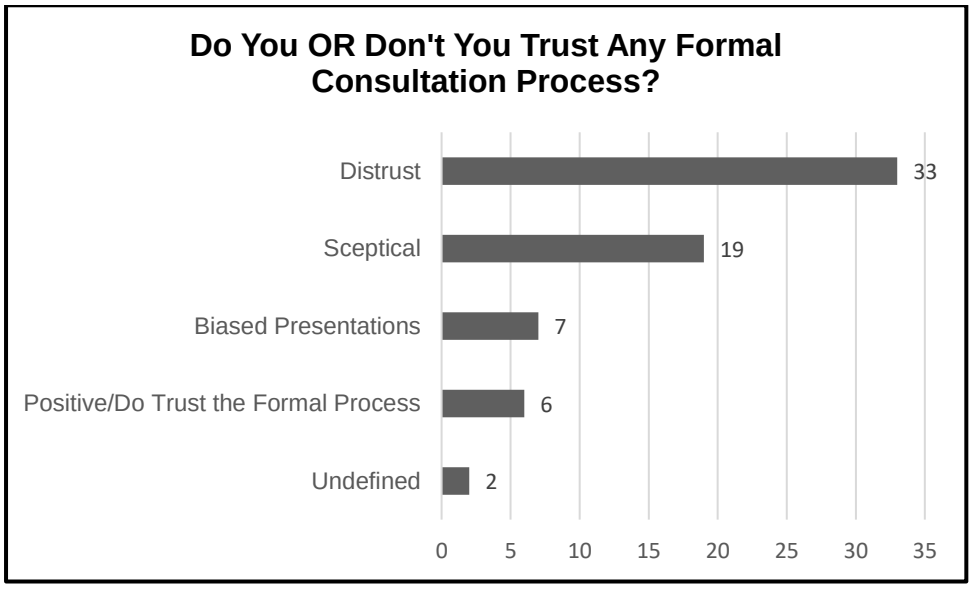


Figure 6.14 Question 3 Please state why you do OR don't trust any formal Consultation process. *n=58*.



Question 4. Hydraulic Fracturing is often called, ‘Fracking,’ how does this make you feel? Number of respondents answering this question *n=91.*

16 respondents stated their indifference to the word. Seven respondents commented on its similarity to a, ‘swear word.’ Other descriptive words indicate an emotional response, for example anxiety, threat and uneasy whilst others used words that conveyed a frame of mind including violent, invasive and pejorative.

There were four positive words from respondents, fine, good, pleasant, and safe. The full list of words used are shown in Table 6.5.

Table 6.5 ‘Fracking’ – Respondents Descriptive words

Afraid	**Fine**	**Safe**
Aggressive	**Good**	Sick
Alarming	Harmful	Substitute
Angry	Helpless	Suspicious
Annoyed	Indifferent	Swear word
Anxious	Insecurity	Threatening
Betrayed	Invasive	Ugly
Concerned	Irritated	Uncomfortable
Confused	Nasty	Uneasy
Dangerous	Nervous	Unnerved
Depressed	Not good	Unpleasant
Devastation	Pejorative	Unprofessional
Dirty	**Pleasant**	Unsure
Don’t like it	Process	Violent
Fearful	Sad	Worried

Question 5. Do you live, work, attend an educational facility or pursue leisure activity near a proposed Hydraulic Fracturing site?

Figure 6.15 Question 5

Do you live, work, attend an educational facility or pursue leisure activity near a proposed Hydraulic Fracturing site. Respondents were offered a range of distances for each option.

Question 5a. Proximity to Proposed Hydraulic Fracturing Sites

Figure 6.16 Question 5a Live

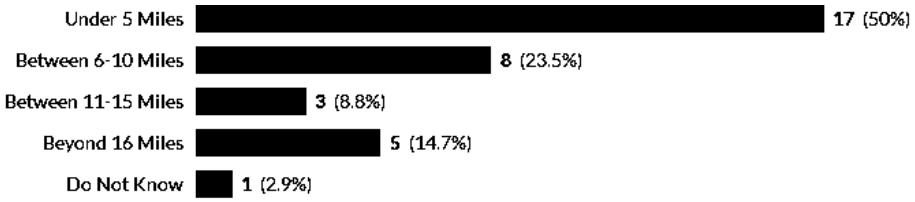


Figure 6.17 Question 5a Work

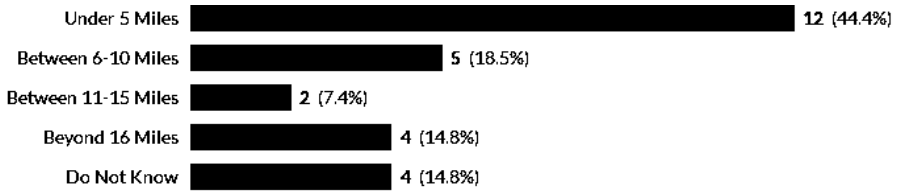


Figure 6.18 Question 5a Attend an Educational Facility

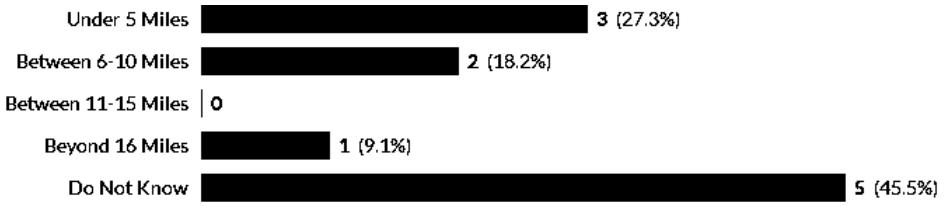
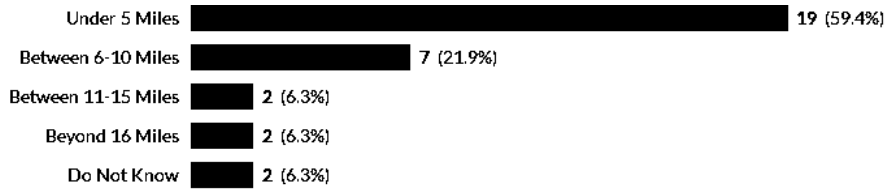


Figure 6.19 Question 5a Pursue Leisure Facilities



The final part of this question asked respondents, 'how does this make you feel?' *n=35*.

The majority of respondents who recorded 'yes' for living, working, attending an educational facility or pursuing a leisure activity near a proposed Hydraulic Fracturing site described negative feelings shown in Table 6.6.

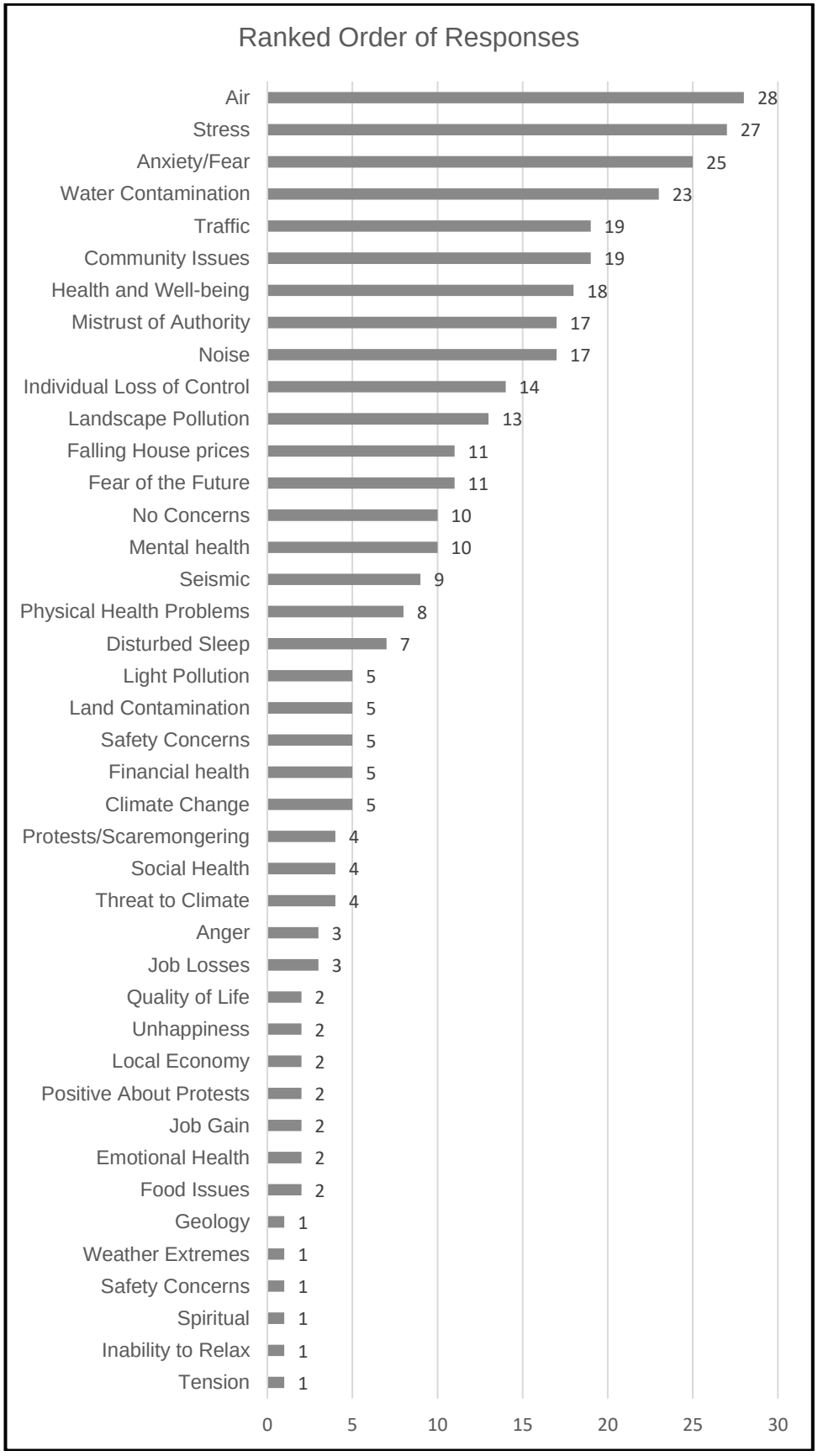
Table 6.6 Respondents Feelings

Abused	Furious	Scared	Uncomfortable
Angry	Good	Stressed	Uneasy
Concerned	No effect	Terrified	Victimised
Downtrodden	Not safe	Threatened	Vulnerable
Exploited	Raped	Tired	Worried

Question 6. Health is defined in a broad, non-medical way by the World Health Organisation (1948) as, *'a state of complete physical, mental and social well-being and not merely the absence of disease.'* Considering the above definition, what do you think, see or feel that the Social Health Impacts on Communities and individuals might be from Hydraulic Fracturing? Number of respondents answering this question *n=89*.

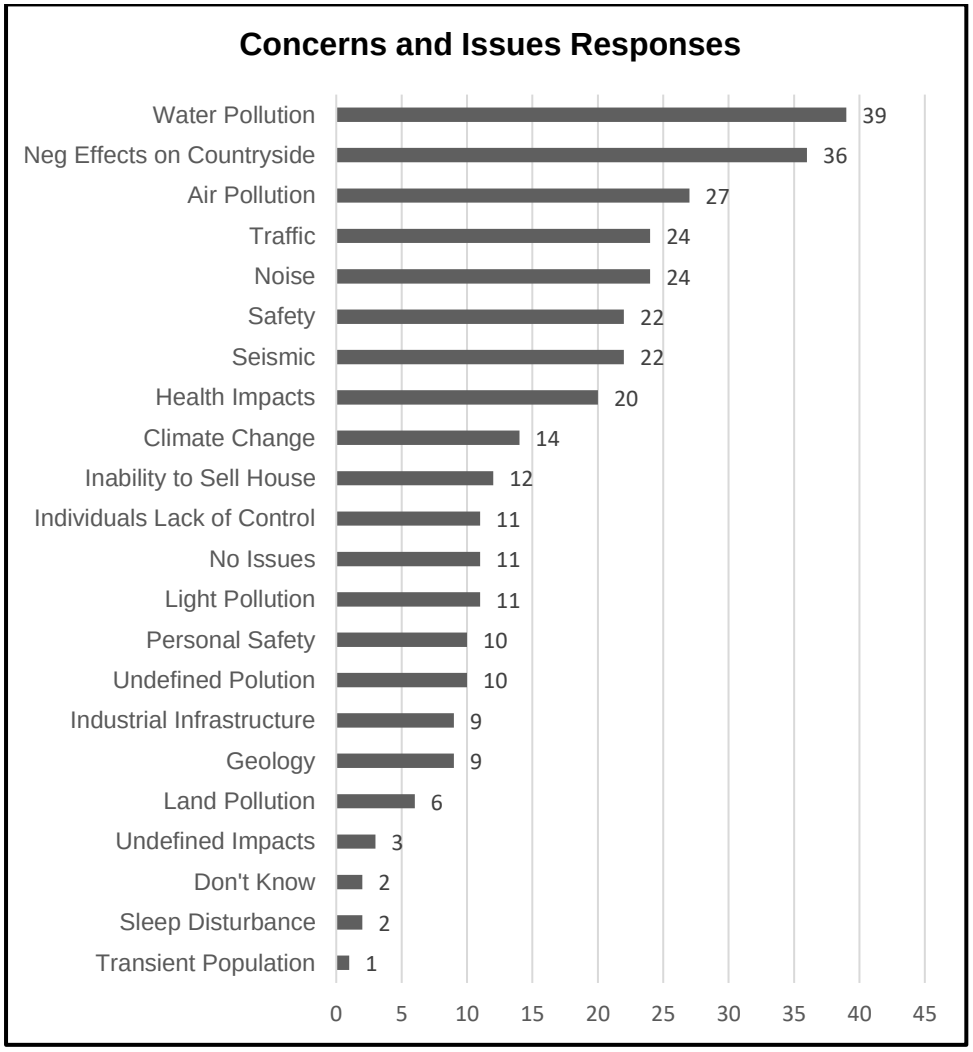
Figure 6.20 overleaf shows the ranked order of concerns.

Figure 6.20 Question 6 Ranked Order of Responses



Question 7. Do you have any concerns/issues if Hydraulic Fracturing goes ahead near you? *n=91*.

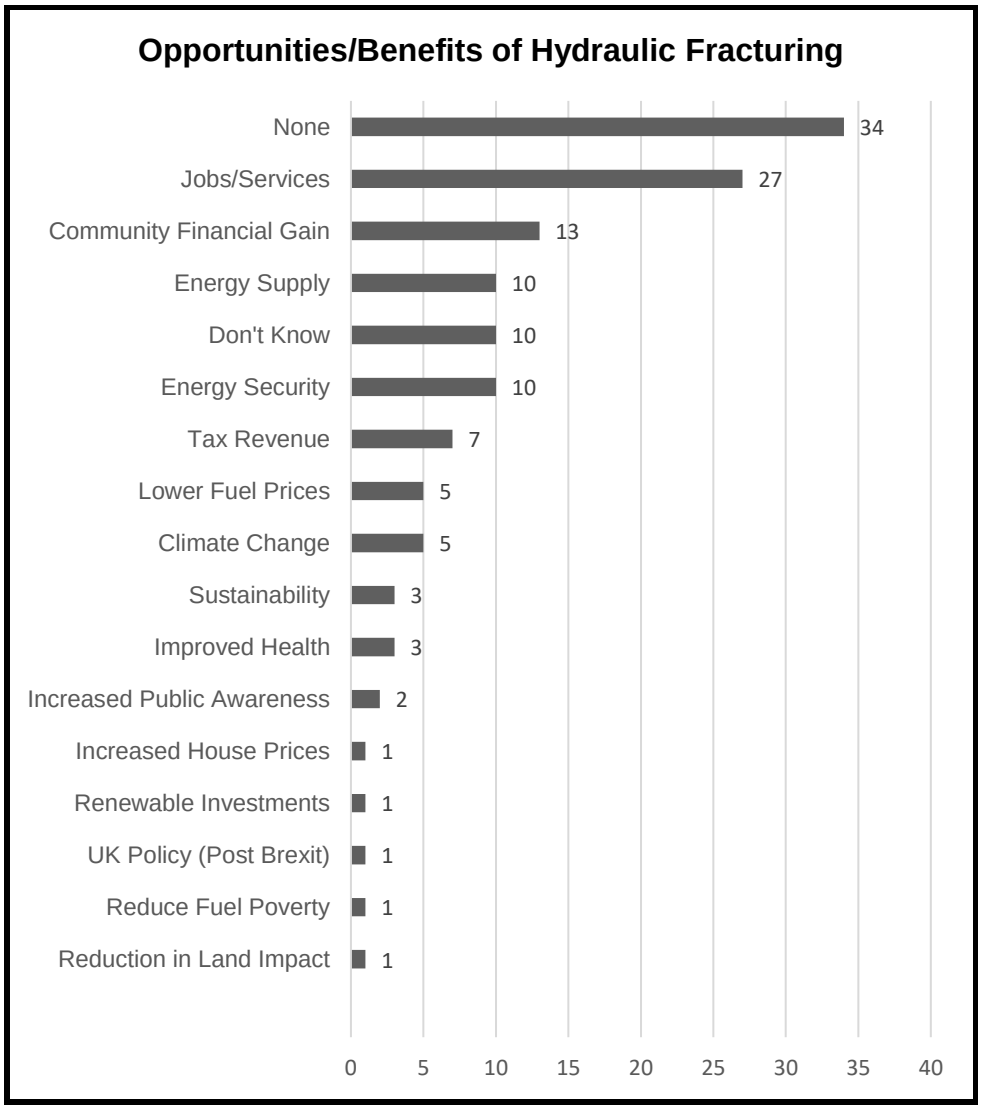
Figure 6.21 Question 7 Concerns and Issues Responses



Contained within the responses to this question, respondents mentioned potential health and well-being impacts including, cardiovascular, neurological, asthma, skin problems, birth defects and mental health problems.

Question 8. Do you think there are any opportunities/benefits if Hydraulic Fracturing goes ahead near you? *n=89.*

Figure 6.22 Opportunities/Benefits of Hydraulic Fracturing



Question 9. How important do you think it is to have a range of energy sources?

Figure 6.23 Wind Turbines

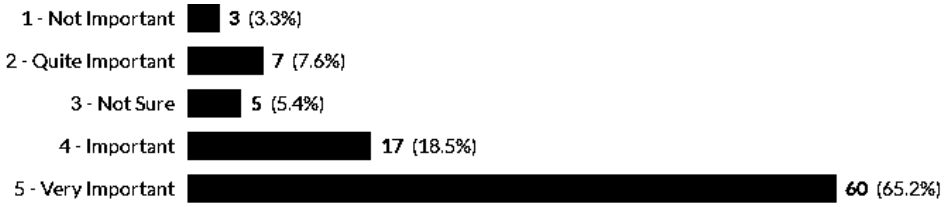


Figure 6.24 Solar Panels

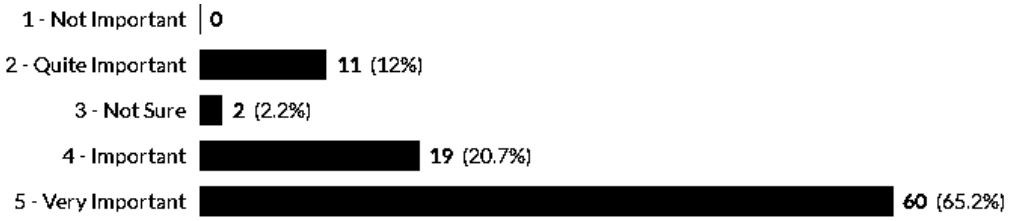


Figure 6.25 Barrage Schemes

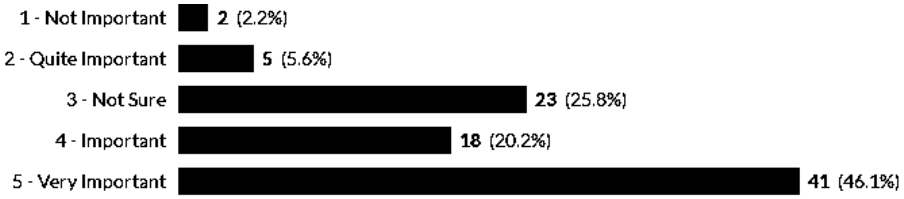


Figure 6.26 Wave Generated Electricity

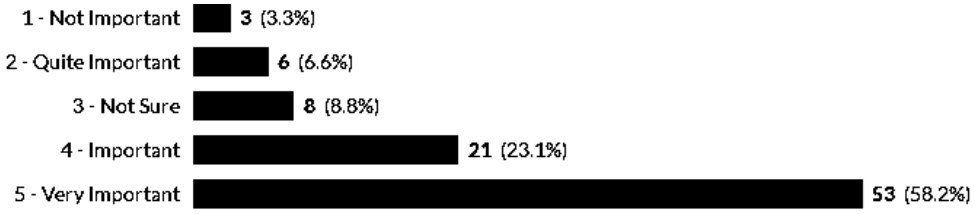


Figure 6.27 Nuclear Installations (Large or Small)

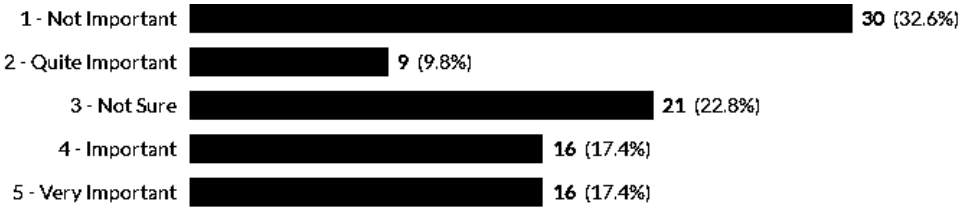


Figure 6.28 New Environmentally Friendly Coal Fired Stations

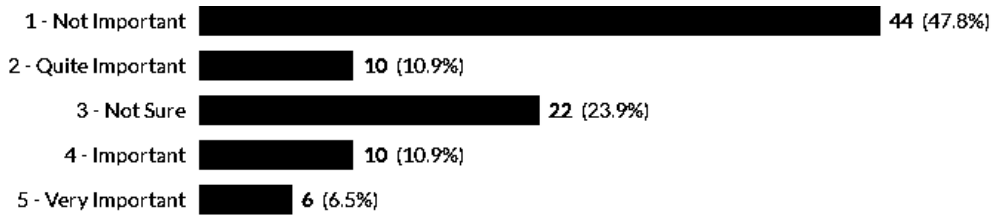
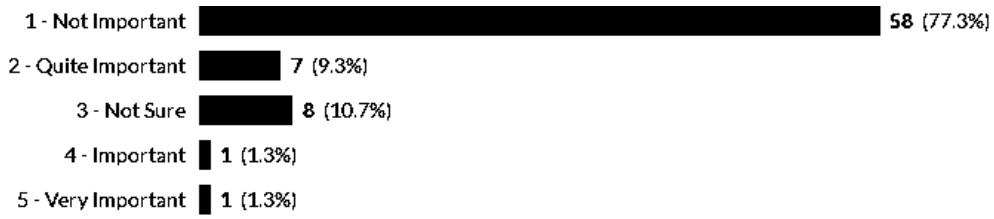
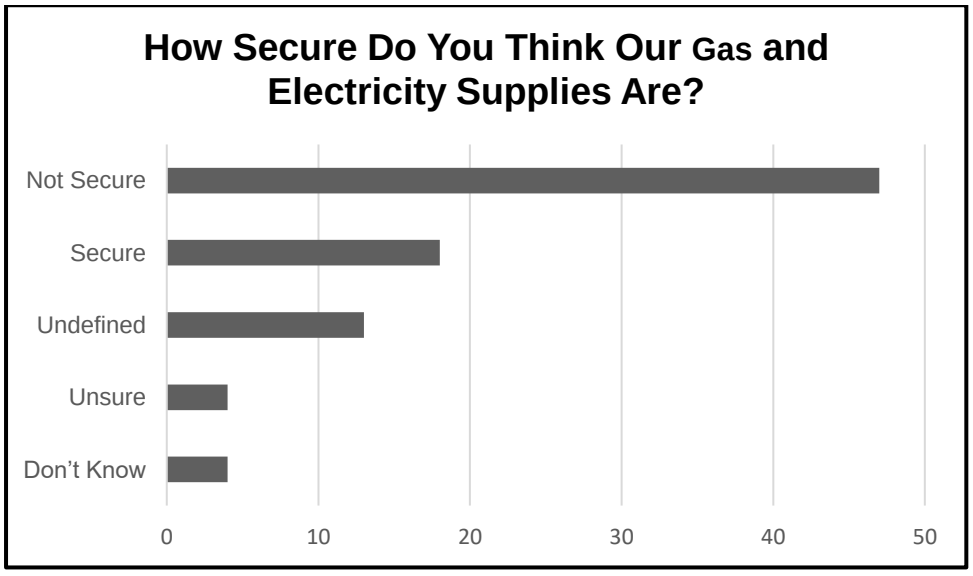


Figure 6.29 Continue As We Are



Question 9. How Secure do you feel our gas and electricity supplies are? *n=88* but only 86 answered the question as asked.

Figure 6.30 Security of Supply



Question 10. Further Details

A range of demographic questions were included at the end of the questionnaire:

Would you consider being involved in further independent community consultation, such as a focus group, as part of this research?

Figure 6.31 Are You willing or not to take part in further research?

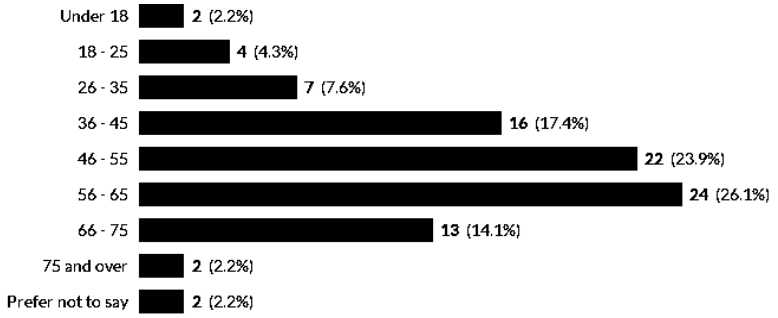
Contact details were requested if respondents were happy to supply them. 49 respondents complied.

Do you consider yourself as? (please mark only one box) One respondent ticked 2 boxes.

Figure 6.32 Male/Female

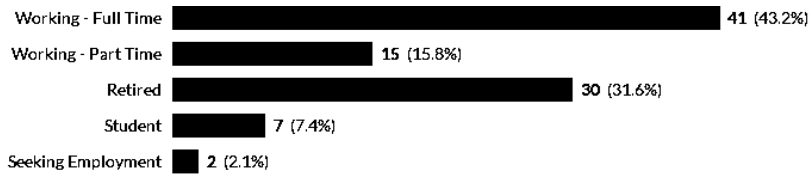
What is your age bracket? (please mark only one box).

Figure 6.33 Respondents Age Range



How would you describe your employment status? (please mark one box only).

Figure 6.34 Respondents' Personal Status



(Authors note: whilst there were 92 respondents the total in Figure 6.34 is 95) For mapping purposes respondents were asked to add the first three letters of their postcode. 87 respondents included their postcode or location.

6.4 Synonyms

A synonym search was undertaken to test the idea that people used different words to express similar feelings or frames of mind. The most frequently occurring words are shown on the top lines of tables 1 to 4 inclusive with Thesaurus options shown in Table 6.7.

Table 6.7 Synonym Table

Table 1			Table 2		
Worry	Anxiety	Fear	Stress	Tense	Strain
Fear	Worry	Worry	Tense	Strain	Stress
Anxiety	Fear	Anxiety	Strain	Stress	Tense
Table 3			Table 4		
Mistrust	Suspicious	Doubt	Annoyed	Irritated	Angry
Doubt	In-Doubt	Mistrust	Angry	Angry	Annoyed
***	***	***	Irritated	Annoyed	Irritated

6.5 The Collected Data: Observations

The information provided by the respondents in answering the questions is self-explanatory with the respondents' comments adding considerable value as to their feelings and perceptions. The author feels there is added value in the collected data which should be highlighted. These are shown as, 'Observations,' where relevant, after the questions.

Question 1 and 2. ‘Have you heard about Hydraulic Fracturing?’ and question 2 asks, ‘Are you familiar with the Hydraulic Fracturing Process?’ These are grouped together as they had the same multi choice options.

Observations

Both questions show very similar wide ranging sources of information. It is also clear from the responses that the respondents have read and researched the issues in some depth. Despite this research, there is considerable doubt about the information.

Question 3. ‘Have you attended any official consultation process?

Respondents were asked to give any such details but also did they feel that they could trust the process and then state why they did or didn’t trust the process.

Observation

Respondents mainly trusted the Planning Process on the basis that it was regulated and supported the democratic process. However, the levels of distrust and scepticism remain significantly high.

Question 4. Hydraulic Fracturing is often referred to as ‘Fracking’ – how does this make you feel?

Observation

A very negative and harsh word, not good PR for the process! Out of the forty five most commonly used words describing feeling, only four were positive the remaining forty-one were highly emotive and negative.

Question 5. Do you live, work, attend or pursue leisure activities near a proposed Hydraulic Fracturing site?

Observation

The data charts and analysis do not remotely reflect the strength of negative feelings expressed by the respondents. Strong feelings such as being threatened, vulnerable, and scared.

Question 6……'respondents were asked what they 'see or feel the Social Health Impacts on communities and individuals might be?'

Observation

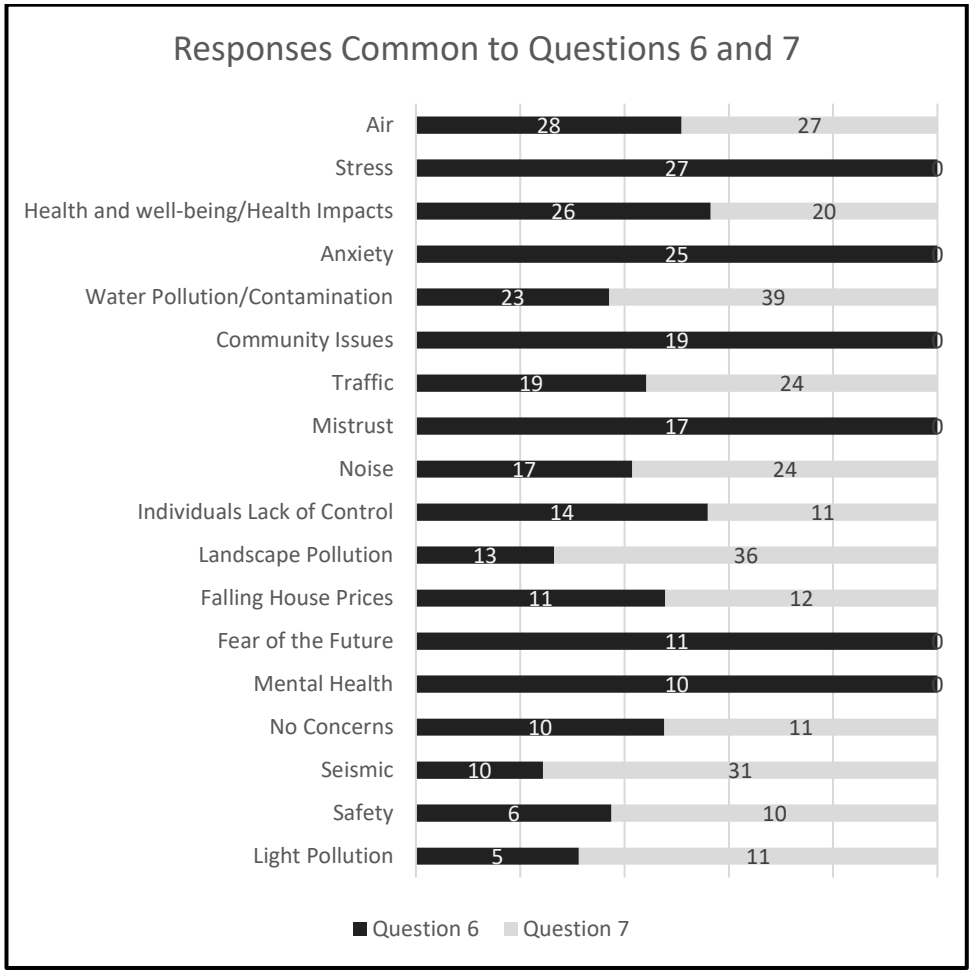
It appears that the respondents have difficulty in determining what constitutes a social health impact, for example anxiety, as opposed to an environmental one such as water pollution, both being seen as a threat.

Question 7. Do you have any concerns or issues if Hydraulic Fracturing goes ahead near you?

Observation

The responses to this question whilst broadly similar to those in question 6 show, that when the data is compared, that the emphasis shifts to environmental concerns. The data shows that when the question presents the scenario of hydraulic fracturing taking place near respondents' residences, there is a major increase in emphasis on potential damage to the environmental and health impacts linked to pollution, but not those linked to the social determinants of health, thus highlighting the complexity and overlapping of the issues.

Figure 6.35 Responses Common to Question 6 and Question 7



Question 8. Do you think there are any opportunities or benefits if Hydraulic Fracturing goes ahead near you?

Observation

The negative is that significant numbers of respondents indicate that they expect there to be no benefits or opportunities to be had if the process goes ahead near them. But, the positive they see is increased energy security and supply, linked to lower fuel prices and reduced fuel poverty. Additionally, there might be a financial benefit to the local community.

Question 9. How important do you think it is to have a range of energy sources?

Observation

Overall analysis for this question indicates that respondents in the main are in favour of alternative and/or renewable energy. They are not in favour of either nuclear or new environmentally friendly coal fired stations which maybe reflects a possible antipathy to new technology, despite concerns about securing UK energy sources.

Question 10. Demographic data

Observation

Table 6.8 overleaf indicates that those in the age range 36-65 are the most interested in the topic. 54 respondents indicate they would be happy to take part in further research.

Table 6.8 Reprise - Age Ranges of Respondents

Age	Female	Male
Under 18	1	1
18 - 25	1	3
26 – 35	5	2
36 – 45	10	6
46 – 55	18	4
56 – 65	12	12
66 – 75	5	8
75+	1	1
Totals	53	37
Combined Total	90	

6.6 NVivo Analysis

NVivo Pro was used to supplement the manual theme analysis from which the bar charts were originally produced, to ensure robustness and validity of the responses to the questionnaire. The Bristol On-line Survey automatically statistically analysed the closed (yes/no) numeric questions and as such these needed no further analysis.

Not all the questions were analysed using NVivo, the author using sub-sections of questions 1 and 2, whilst questions 3 and 8 were also included to test the accuracy of software. Questions 6 and 7 were examined in greater detail for qualitative analysis, these being the two questions which produced the largest number of responses.

In the main, the NVivo analysis corresponded with the manual analysis, but it became clear that the manual analysis has been more contextuality specific and as such, using NVivo alone would have missed and/or excluded data from the analysis as the programme is unable to identify the context of the words being used. An example of this being question 8 which asked for, ‘Opportunities and benefits.’ During the manual analysis, any negative or neutral comments were discounted, however, from a pure text analysis perspective, NVivo captured all the words regardless of context thus including extraneous data. Discrepancies also occurred due to respondents spelling mistakes and use of abbreviations, for example, ‘WWW’ for World Wide Web.

Of the questions reviewed, any discrepancies are explained underneath the appropriate screenshot which are included as validation as they show the words in speech marks used to capture the data. If the count was found to be exact, then no comment is made. If a respondent referred to the answer being in a previous question this was examined and relevant data counted just as had happened with the manual theme count.

Question 1a Media. Have you heard about Hydraulic Fracturing?
Where do you get your information

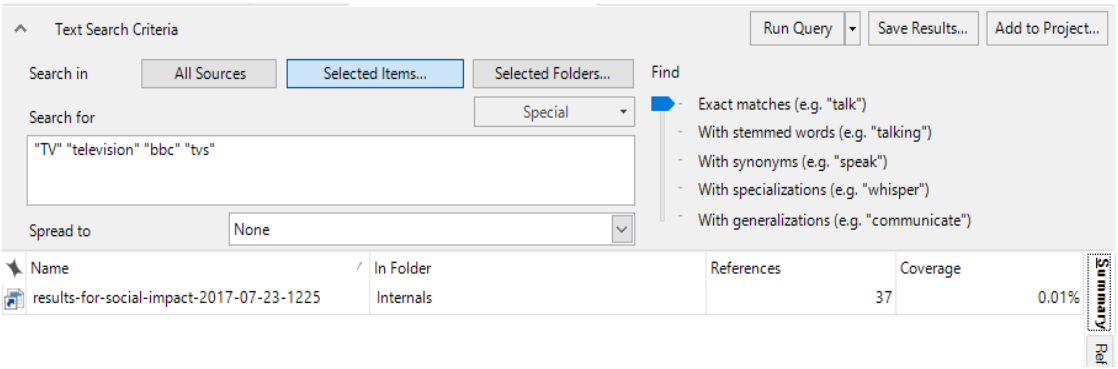


Figure 6.3 page 145 lists BBC TV and TV 38 times whereas NVivo references 37. The combination of words and abbreviations as seen in the screen shot were used as per respondents answers.

Question 2a Media. Are you familiar with the Hydraulic Fracturing Process? Where do you get your information from?

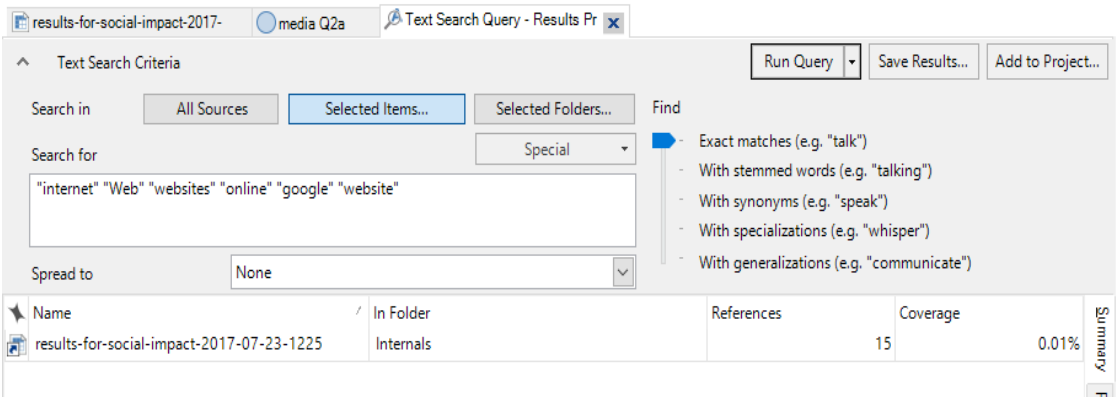


Figure 6.4 on page 145 records 19 responses as the Internet as the source of their information. NVivo records 15, the difference being four respondents answered by referring to the previous question.

Question 1a Protest Groups Have you heard about Hydraulic Fracturing? Where do you get your information from

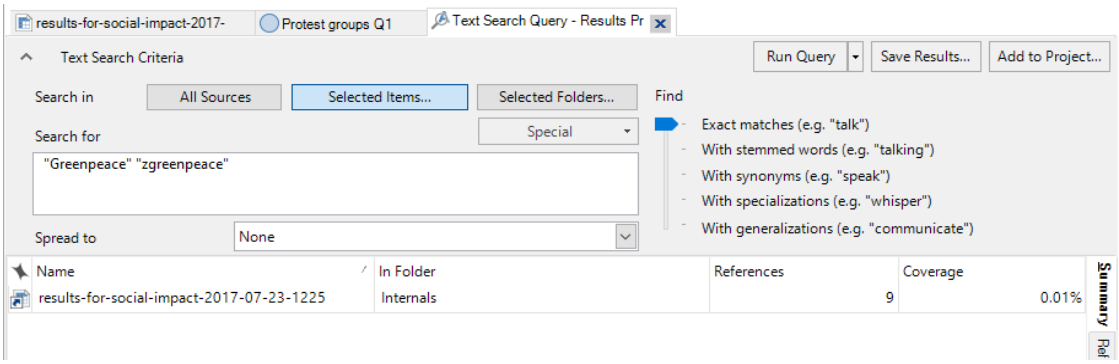


Figure 6.5 page 146. This count was the same for both analysis methods, however as can be seen there was a spelling mistake within the data. This was only identified through the manual theme analysis and was excluded initially from the NVivo analysis.

Question 2a. Protest Groups. Are you familiar with the Hydraulic Fracturing Process? Where do you get your information from?

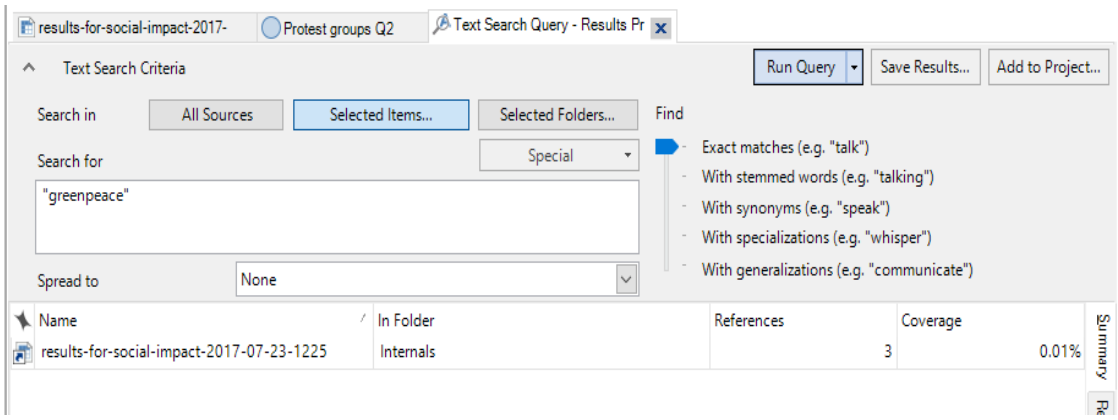


Figure 6.6 page 146. No comment required

Question 3 Please give details of formal consultations attended.

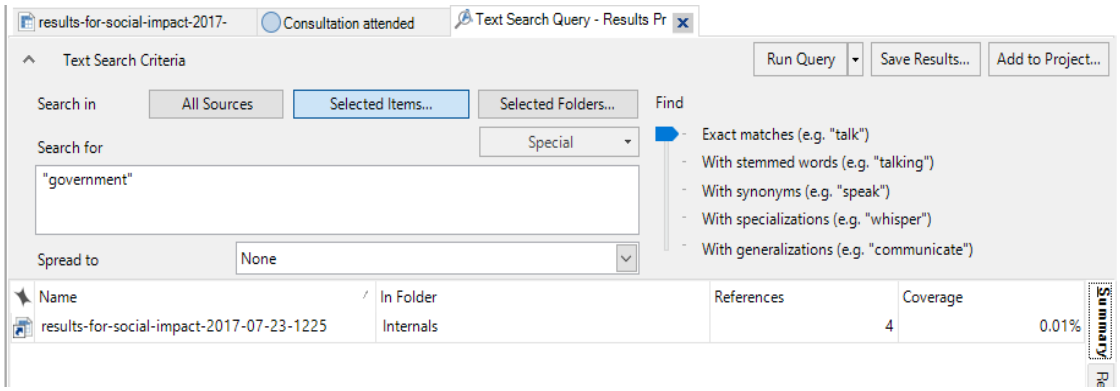


Figure 6.12 page 151. No comment required.

Question 6 Health is defined in a broad, non-medical way by the World Health Organisation (1948) as, *'a state of complete physical, mental and social well-being and not merely the absence of disease.'* Considering the above definition, what do you think, see or feel that the Social Health Impacts on Communities and individuals might be from Hydraulic Fracturing?

Question 6: Air

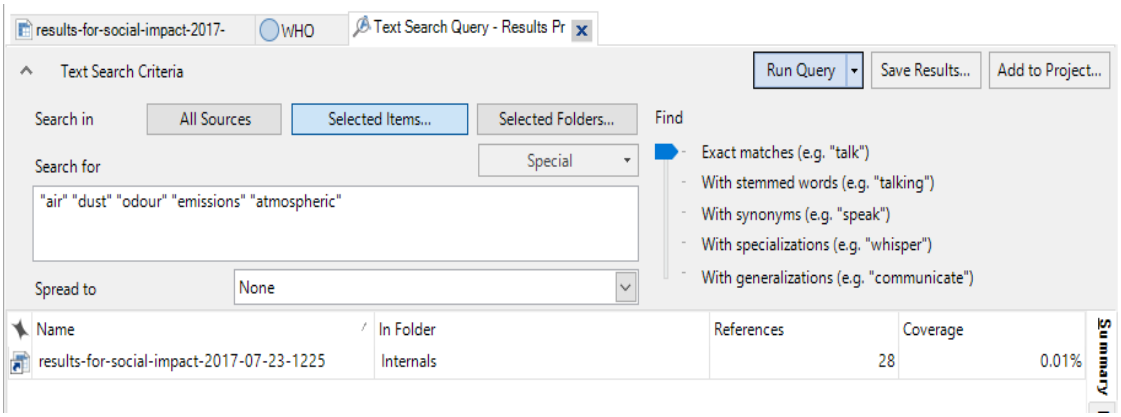


Figure 6.20 page 156. No comment required.

Question 6 cont: Stress

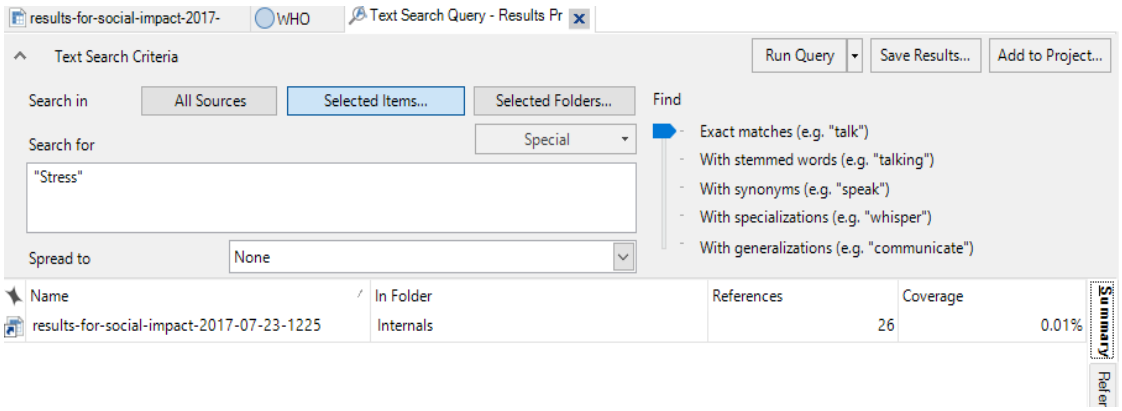


Figure 6.20 page 156. There is an unfound discrepancy of, ‘1’ between the manual analysis and NVivo.

Question 6 cont Sleep

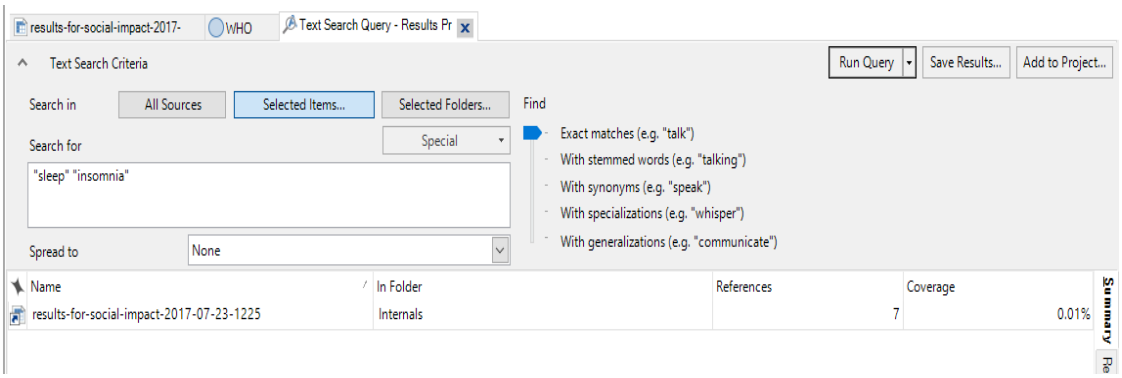


Figure 6.20 page 156. No comment required.

Question 6 cont: Climate Change

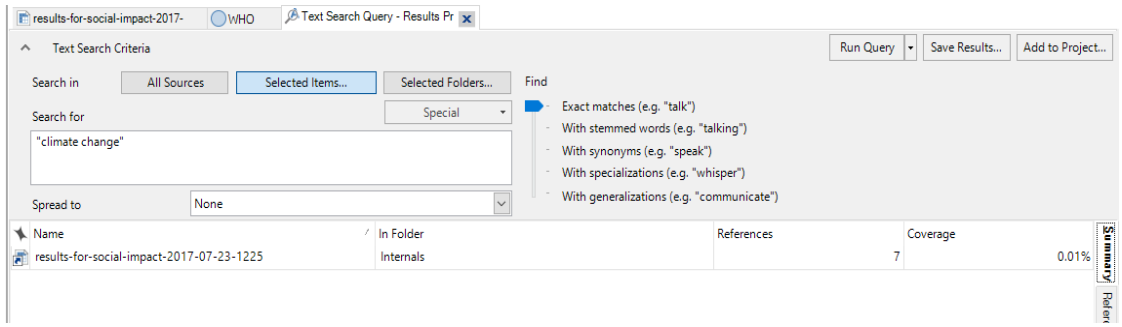


Figure 6.20 page 156. There is a discrepancy of 2 between the manual (5) and NVivo (7). This appears to be the use and context of the word ‘climate,’ used in the phrase, ‘climate change catastrophe’ of which the respondent offered a

neutral viewpoint towards climate change which was out of the scope of the question and therefore invalid for count purposes.

Question 7 Do you have any concerns/issues if Hydraulic Fracturing goes ahead near you?

Question 7 Water

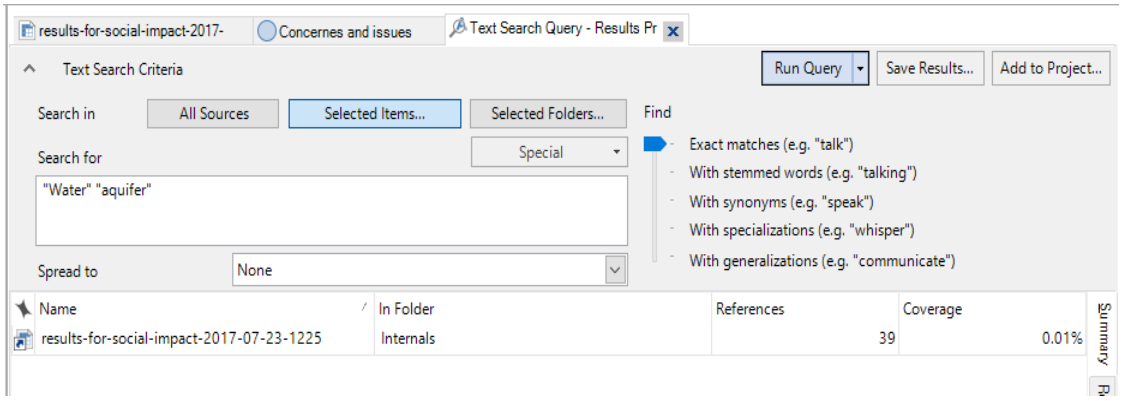


Figure 6.21 page 157. No comment required.

Question 7 cont: Sleep

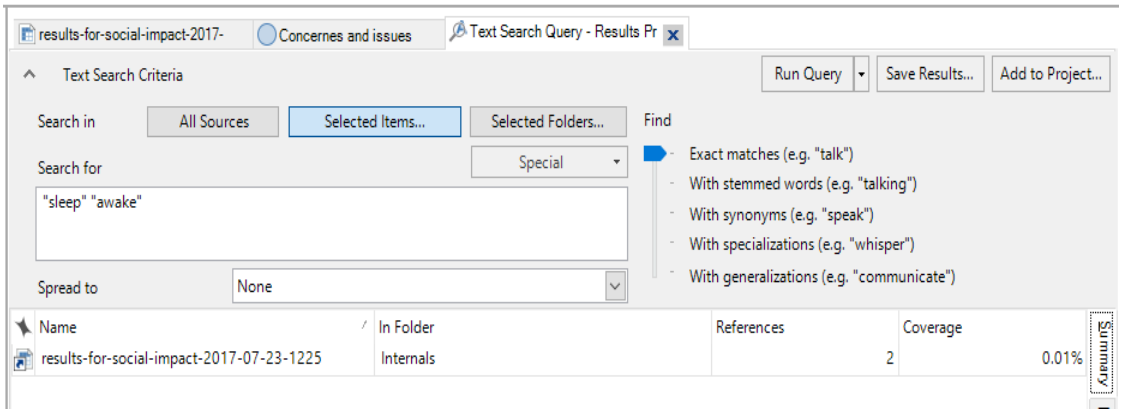


Figure 6.21 page 157. No comment required.

Question 7 cont: Traffic

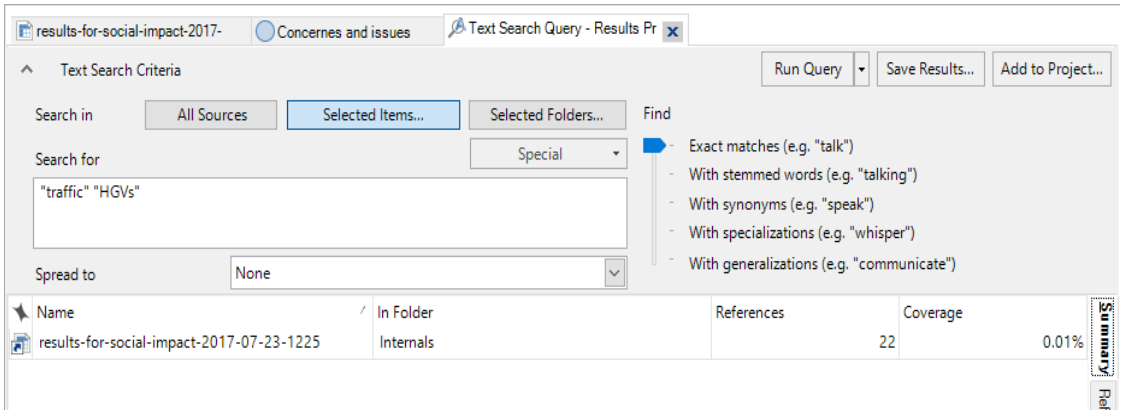


Figure 6.21 page 157. There is a discrepancy of 2 with the manual count showing 24. This is explained by one respondent referring to a previous answer to which they had responded twice with HGV and RTAs, both which were applicable and therefore manually counted.

Question 7 cont: Inability to sell houses.

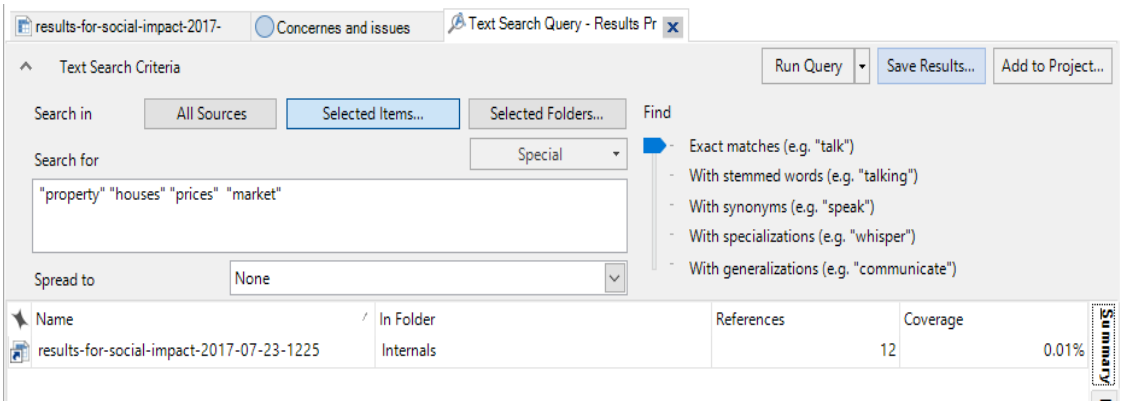


Figure 6.21 page 157. No comment required.

Question 8 Do you think there are any opportunities/benefits if Hydraulic Fracturing goes ahead near you?

Question 8: Community Financial Gain

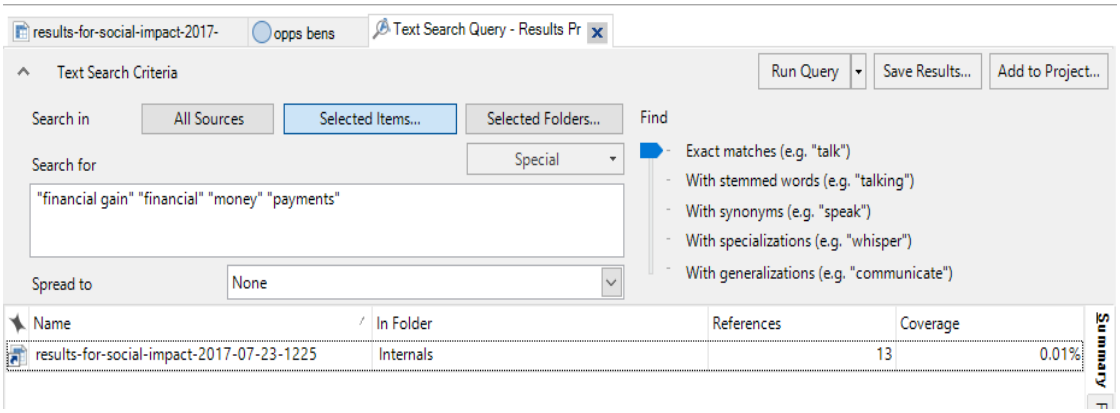


Figure 6.22 page 158. No comment required.

Question 8 cont Sustainability

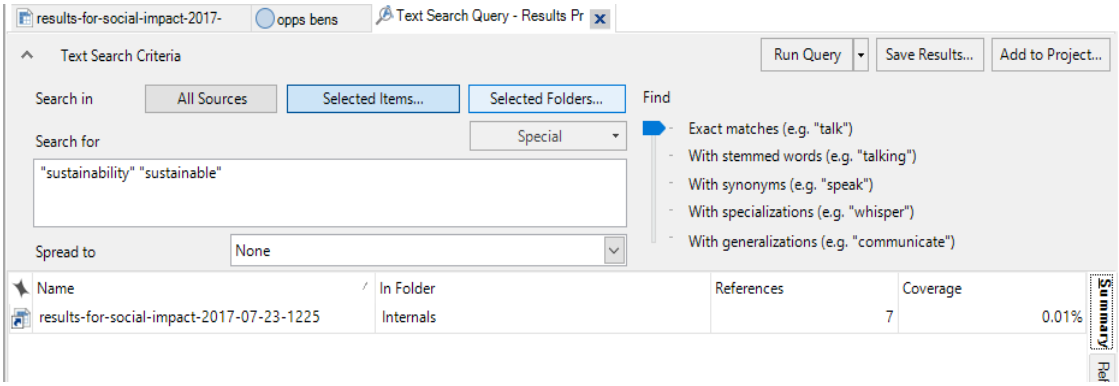


Figure 6.22 page 158. Although showing a variance of 4 (manual count 3), on closer examination of the data, it became apparent that the three were of negative connotation. The question was specifically exploring opportunities and benefits and as such were discounted within the manual count, therefore making the count accurate.

6.7 The Rich Picture and Causal Loop Diagram

A Causal Loop Diagram is different from any key themes that have emerged from the research as the purpose of the CLD is to explore potential inter-relationships between the identified research variables.

6.7.1 The Rich Picture

The data is primarily taken from Figure 6.33 on page 161 which compares the concerns raised in questions six and seven and shows the difficulty respondents had in identifying health issues which either fall into the social determinants of health category, or health matters potentially caused by environmental issues.

Under normal circumstances, the rich picture would include all stakeholders or other interested parties, but due to the unwillingness of local councils to take part the only stakeholders represented are the 94 respondents.

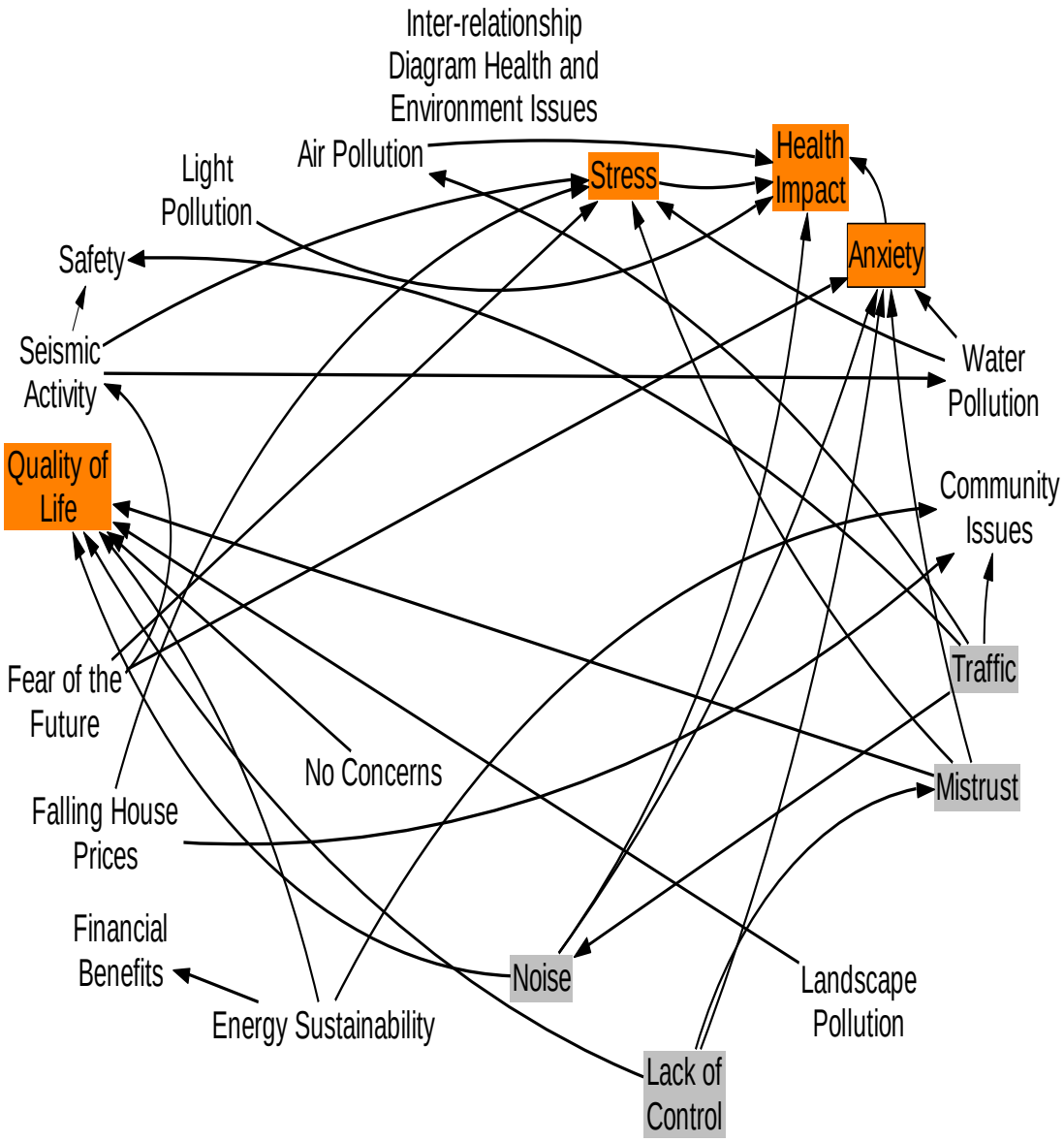
Questions six and seven focussed on the perceptions, feelings and emotions of people likely to be affected by hydraulic fracturing. In total there were 64 concerns raised with, 42 in response to question six and 22 to question seven. When analysed further, 18 were, ‘common’ to both questions despite the context in which the questions were framed. Question six specifically asking about Social health impacts whilst question seven was a more practical question concerning feelings concerning hydraulic fracturing being carried out near to them.

Further rich picture data is added from the responses to question eight which concerned any potential opportunities or benefits from the introduction of hydraulic fracturing, this is shown in the Inter-relationship Digraph under the generic heading of, ‘Financial Benefits,’ such as, job creation and income to communities from the local hydraulic fracturing production of shale gas.

6.7.2 Inter Relationship Diagraph IRD

The IRD shows the inter-relationships of the concerns raised by the respondents, of the potential effects upon people and the environment from the introduction of hydraulic fracturing into the U.K.

Figure 6.36 Inter-relationship Digraph (IRD)



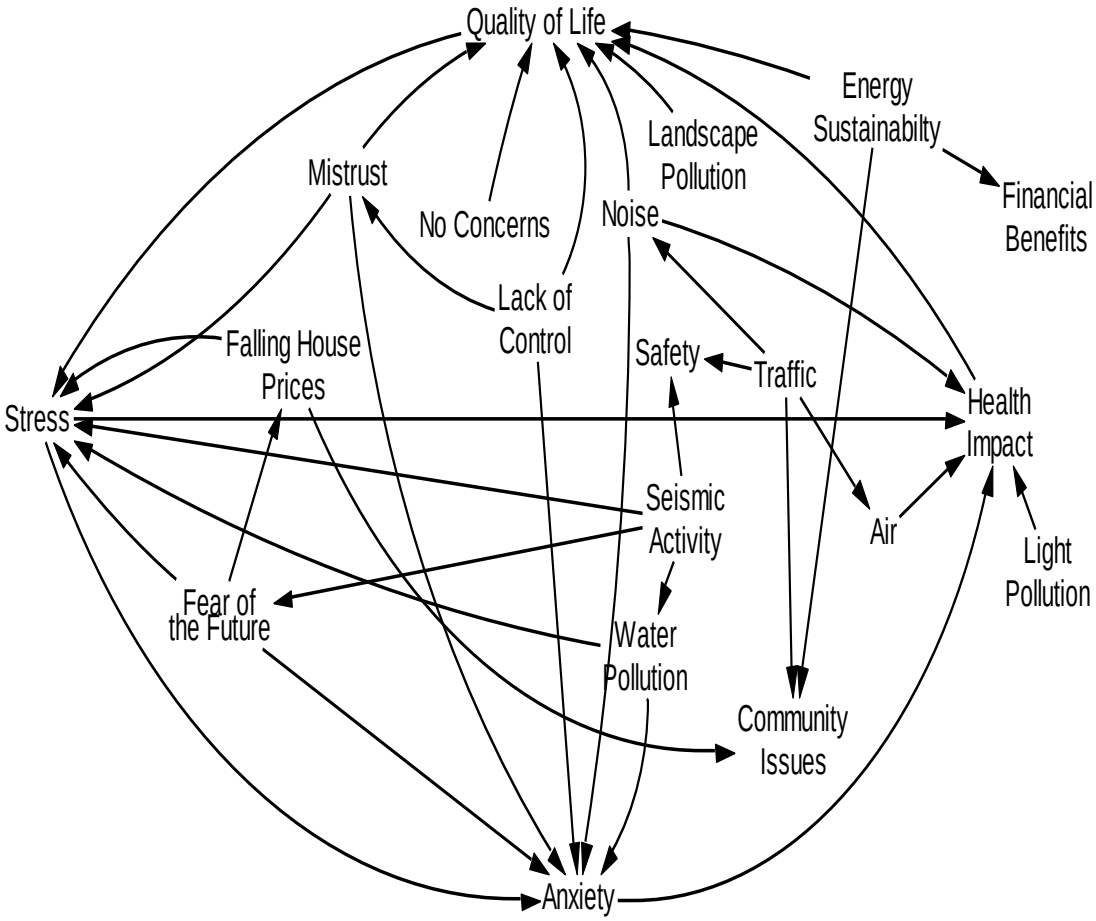
The IRD reveals the four main concerns of the respondents, these are the concerns with the most incoming arrows the 'Outcomes,' shaded red The Drivers are identified, shaded blue, as the concerns with the most outgoing lines. These Outcomes and Drivers form the basis of the CLD.

6.7.2 Causal Loop Diagram (CLD)

The CLD is based upon the four main Outcomes, Quality of Life which includes Mental Health, but not from a clinical perspective, Health Impact, Anxiety and Stress. Whilst the main Drivers are Noise, Lack of Control, Distrust and Traffic. Other important concerns which must be built in, in order to show the true complexity of these inter-relationships are, Seismic Activity, Fear of the Future, Falling House Prices, Water Pollution, Air Pollution, Light Pollution, Landscape Pollution, Safety (Health and Safety) and Community Issues.

It is also necessary to add into the CLD any benefits the respondents perceived of the introduction of hydraulic fracturing and these appear as the Financial Benefits and Energy Sustainability.

Figure 6.37 Causal Loop Diagram



It should be noted that there are no complete loops, which highlights the complexity of the inter-relationships between the variables. These relationships are one directional, but no less significant, for instance, Seismic Activity shows in the responses as causing a Fear of the Future, but this could not happen in reverse.

6.8 Questionnaire Analysis and Evaluation

The author has analysed the published questionnaire with an evaluation of its effectiveness. This is shown in Appendix G.

6.9 Summary Chapter 6

The author is satisfied that the data collected and the subsequent analysis, of the respondents written comments, provides an accurate view of their concerns and perceptions about the potential impacts associated with the introduction of hydraulic fracturing in the U.K.

The high volume of rich data in the responses justified the undertaking of an in-depth word and text analysis.

Whilst the results strongly indicate a commonality of feelings and perceptions there is a variety in the language used to describe them. The NVivo software proved the accuracy of the manual analysis and the reliability of the data graphs and charts constructed from it.

Finally, using the Causal Loop Diagram visually illustrates the complexity of the relationships of concerns expressed by the respondents during this research.

Chapter 7 will discuss issues raised in this study, draw conclusions from the research and recommendations for the next step and any further research.

Chapter 7 Discussion

Introduction

"People cannot so readily defend themselves against social changes which they are not required to promote" (Marris, 1974).

The Aim of this research, was to identify the Social Determinants of Health associated with hydraulic fracturing, which has been achieved.

7.1 Research Outcomes

The research is original and unbiased in that it is the only UK study of the subject, as this contentious, emotive and political process is driven forward by Government. The author can find no other equivalent work, thus the results of this research add to the limited body of knowledge about the concerns for personal health and well-being. The approach is holistic in nature and embraces a multi-faceted view of health.

The research concludes that the public have a very negative and mistrustful perception of Government, official agencies and the Oil and Gas industry in relation to hydraulic fracturing. In terms of the Social Health and Well-Being impacts, respondents to the questionnaire frequently cite, stress, anxiety, fear, loss of locus of control and negative impacts upon their community including that from environmental pollution.

The data collected via the on-line questionnaire was both quantitative and qualitative. The qualitative data content of the questions which invited comment was analysed on a word by word basis and supported with the use of the NVivo software programme.

Analysis of the quantitative data gathered, indicates that the sample of participants is a good representation of the general population based on the demographics of respondents, including, age, gender and residency in an area stretching from Scotland to the south coast (www.statista, no date).

It should be noted that all responses came from the main shale gas basins, even where exploratory drilling is not as yet being considered or proposed. This strongly suggests that there is interest which is not just limited to those areas where such exploration is likely to take place.

However, the above two considerations have also to factor in the caveat that, whilst the response rate to the questionnaire is deemed robust, it was somewhat limited by the e-platforms to which it could be up-loaded. There is also the possibility of bias in that only people interested in hydraulic fracturing would seek out and respond to the questionnaire.

7.2 Key Themes

The interpretation of the results from the data analysis indicates the following three key themes:

Theme 1: Concerns the Social Determinates of Health.
Theme 2: Issues with the Environment.
Theme 3: Relates to the Mistrust of Government, Regulatory Bodies and the oil and gas industry.

The first two themes are likely to have been anticipated based on the literature reviews whilst the third, and perhaps the most unexpected, is the public's general mistrust of all the authorities involved with the hydraulic fracturing process.

These themes, which are in fact interlinked, demonstrate the robust negative response to the potential introduction of hydraulic fracturing as part of the U.K's future energy supply source. The themes are of equal standing and their numbering does not reflect one being more important than the others:

7.2.1 Theme 1 Social Determinates of Health

The first theme, which specifically relates to the research aim concerning the Social Determinants of Health, offered a significant confirmation of the author's previous experience in the health inequalities discipline.

The predominant and most mentioned concerns by the respondents, were: stress, anxiety, worry, fear and loss of control and their potential to cause ill-health. Concern was also raised about the impacts on communities, many of which are unarticulated in detail by the respondents, which in itself can cause fear and worry.

However, some responses indicated potential community divisiveness. This division is due to a number of factors. Some are more obvious such as those in favour of the process and those against, even within families. Other elements of the divide include, the financial aspects, will some people become rich due to the payments made, how and who will make them and how will they be governed? Would there be employment opportunities? There is strong evidence, from the United States, that suggests that an increase of workers for the industry swamps local communities causing significant problems – an increase in crime, drinking, substance misuse all of which put pressure on local infrastructure.

There are some consistencies with themes from the published literature as detailed in Chapter 3. The socio-economic factors that appear in that literature, include stress, fear, anxiety and loss of control and are confirmed by this research. It is interesting to note that these themes appear regularly in the literature where hydraulic fracturing is either happening or more likely to happen within the United States of America.

Esterhuyse, who looked at hydraulic fracturing more speculatively in South Africa, also mentions these factors but adds others such as, 'water stress,' light pollution and generally presents a very negative impact and the need for government to put in place effective regulatory systems.

In respect of the Social Determinants of Health and, 'The Rainbow,' these concerns would lie within the second layer, 'Living and Working Conditions.' Whilst it is accepted that these are very personal and impact on people in very different ways, these elements/feelings can be incredibly destructive and impact on their lives in very negative ways including the aetiology of ill-health and being detrimental to the quality of life.

Interestingly, the results of this research and that within the analysed published literature, indicates that there was very little reference to the Quality of Life or the impacts on mental health. However, the Causal Loop indicates these factors are a major Outcome and as such appears to contradict the findings of the results from the text analysis. This emphasises the value of using primary data to study the inter-relationships of the variables identified.

The results illustrated in the Causal Loop reveal a deeper and more complex context of the public's perception of mental health, mental well-being and the those impacts on the Quality of Life. Does this, in fact, reflect people's understanding of mental health, or is it viewed as a clinical condition or is it a perception as yet, unexplored, as hydraulic fracturing has yet to start in earnest in the U.K. Does this raise the question regarding the links between the social determinants of health and the impacts on mental health and the Quality of Life?

7.2.2 Theme 2 Environmental Issues

The second theme focuses upon the environmental issues. Air quality, water contamination, although whether this refers to aquifer pollution or the return of water used in the fracking process is not clear. Noise, increased traffic, landscape pollution and seismic activity featured as causing considerable concern. These, unsurprisingly, were consistent with those relayed through various media outlets, be it newspapers, protest groups or reports and was not unexpected from an environmental perspective. Pictures of flaming taps in the United States were frequently published as an illustration of the dangers of hydraulic fracturing.

Initially the author had planned to exclude these environmental issues from the discussion as this research focuses on the social determinants of health.

However, the Rich Picture for the IRD, based upon Figure 6.35 page 165, the amalgamated data charts of the responses to questions six and seven, clearly shows that, whilst the responses to question six were about the individual remaining physically and mental well-being of individuals, the responses to question seven focuses on the potential damage to the environment and the effects of this damage that may have on communities, that these environmental issues were of significant importance.

The combined chart of the responses to questions six and seven, demonstrates a move towards environmental concern once the respondents were presented with a hypothetical scenario of hydraulic fracturing happening, 'in your backyard.'

The overall result of this is the clear indication of the complexity of the inter-relationships and difficulties likely to be faced with the introduction of hydraulic fracturing.

Perhaps this complexity demonstrates, as history has already shown, that there is in fact no clear cut divide when considering all the factors that can affect a person's health and this should be borne in mind when looking for any future mitigation. An example of this divide is for instance, noise – what one person might see as stressful and damaging to their health, another might view the same noise as spoiling the environment in which they live, thus causing a different type of stress.

7.2.3 Theme 3 Respondents Perceptions

The third theme, which was of some surprise to the author, was the powerful and emotive expressions of mistrust in the government, the regulatory bodies, advisory bodies and the Oil and Gas industry. Figure 6.13 page 152 shows

that 66.6% of respondents when asked, ‘Do you feel you can trust the formal consultation process,’ replied that they didn’t.

Many participants expressed cynicism about the level and quality of communication, scepticism surrounding the consultation process and finally the lack of transparency particularly over the process and regulatory standards.

The respondents have iterated their criticisms of the style, quality and presentation of information. Answers given at formal presentations were sometimes found to be, ’evasive.’ Respondents noted that the presenters referred to the UK having an environmental, ‘Gold Standard’ applicable to regulating environmental aspects, however, finding the standard had proved impossible.

The author, despite being an experienced literature researcher failed to find any written evidence of the existence of such standards applicable to hydraulic fracturing. Whether or not they exist, is a moot point.

The result of this mistrust of the consultation process is likely to cause people to feel they have no control over the decision making process, as can be seen the IRD identifies both these variables as Drivers. On the plus side, respondents who resorted to using the Freedom of Information Act, were positive about its usefulness and outcomes. Not all comments were negative if somewhat qualified, as illustrated by:

Although I may not agree with the results, consultations provide an important opportunity for stakeholders, regulators and persons of significance to meet and discuss fracking in a formal environment. Surely that is a good, democratic process. The Secretary of State being able to overrule decisions of the Local Planning Authority however, is a shambles and more akin to autocratic processes. 242921-242914-19314123

‘The right to know,’ has been deemed as a, ‘basic human right’ as articulated by Birkinshaw, 2006 in the article titled, ‘Transparency as a Human Right,’ and

as such this growing demand for greater transparency has led to an influx of legislation such as the Freedom of Information Act, 2000 (Birkinshaw, 2006).

Transparency is a relatively new phenomenon, particularly over the past couple of decades in the public sector. The concept of transparency within a public sector setting, came to the fore in the 1990's when, 'Transparency International,' an Advisory Council was formed by a former World Bank employee, although it should be noted this was originally formed to deal with corruption which is something that is not applicable to this thesis.

In the UK, the Nolan Committee, 1995, produced their first report, 'The Seven Principles of Public Life.' The report upheld seven primary principles one of which was, 'Openness' – defining it as:

> *'holders of public office should be as open as possible about all the decisions and actions they take. They should give reasons for their decision and restrict information only when the wider public interest clearly demands it' (Nolan, 1995).*

Transparency and trust seem to go hand-in-hand and as Grimmelikhuijsen notes, trust in government is a necessary requirement and quotes the following by Parsons, 1967, 'without public trust and confidence in the reliability, effectiveness and legitimacy of money, laws and other cultural symbols, modern social institutions would soon disintegrate,' (Grimmelikhuijsen and Welch, 2012).

Transparency of the decision-making process focuses on how open organisations are in displaying how and why they have arrived at any said decision. The UK Government seem to have been up-front and transparent over the drive to explore for shale gas, in its paper, 'The Shale gas and oil policy statement,' by the DECC and DCLG issued in August 2015, (DECC and DCLG, 2015) clearly lays out the intent and yet respondents display much scepticism about the overall veracity of such statements.

As cited in a White Paper undertaken by the World Economic Forum, 'Trust Challenge Facing the Global Oil and Gas Industry,' a Gallup poll (2013), the industry was ranked as the least trusted (equal with the tobacco industry), but the importance of the need for energy was also recognised (World Economic Forum 2016).

But, a cautionary word, Etzioni writes in his paper, 'Is Transparency the Best Disinfectant?' that there are, 'limits to knowing, limits to the people's abilities to process the information' (Etzioni, 2010). The point Etzioni is making highlights the need for information to be presented clearly, particularly when dealing with technical information and processes such as hydraulic fracturing.

As transparency and trust seem to be intrinsically linked to the overarching feelings of negativity towards hydraulic fracturing due to uncertain potential environmental catastrophe and ruin, it offers an opportunity to consider a specific man-made environmental disaster which had a devastating and long lasting effect upon an entire community.

On the 21st of October 1966, 144 children and adults were engulfed in 1.4 million cubic feet of mine slurry, as one of the seven gigantic spoil heaps above the village of Aberfan, finally collapsed after several days of heavy rain.

Residents and local councillors had, over many years, expressed concerns about the spoil heaps slipping and this had been supported by a report written by a Council Engineer The mine spoils had been piled high over the years, dumped on top of underground water springs, the known presence of which was denied in the aftermath, by those responsible for the tipping of the spoil.

This was profoundly disputed by the locals who not only knew the area, but highlighted the location of these springs which were shown on local maps. The main concern of the residents was that with the steep downhill gradient coupled with the dumping of spoil on an unstable base, was, that one day it would slip.

Following the disaster, new legislation was passed and enacted, including the Health and Safety at Work Act, 1974. Additionally, it should be noted that other man-made environmental disasters contributed to the eventual emergence of Environmental Impact Assessment (EIA) and policy reforms.

In 2003, a paper in the British Journal of Psychiatry reported on both the long term medical and psychological Health Impacts of the disaster, citing evidence of residents who were afraid to sleep, children who had a fear of being trapped and other who suffered feelings of guilt and anxiety (Morgan *et al.*, 2003).

The crucial lesson from this appalling disaster[8] is not that this is likely to happen again but that the residents were not listened to. They knew their community and knew it well, they had vocalised their concerns and they were all but ignored and this lack of acknowledgment left a community devastated.

7.2.4 Other Factors

There is now the need to consider other factors relevant to this thesis which emerged from the author's background research which could influence the development of any possible strategy to help alleviate concerns about hydraulic fracturing in the UK.

As has been seen, Environmental Impact Assessment (EIA) was developed to try to avoid further environmental disasters when considering nationally important infrastructure projects and is now a legal requirement, but no similar consideration has been given to the effects of such developments upon people. Health Impact Assessment (HIA) offers a systematic but versatile framework to identify both positive and negative health impacts of the subject being assessed. In a sense, EIA is more predictable in its likely outcomes as it deals with tangible items such as flora and fauna.

[8] The author is not suggesting that such a horrendous occurrence would happen with a hydraulic fracturing site.

Some EIAs are now including social health, but, how difficult a problem does this pose? There are three key reasons why this is likely to be complicated.

Firstly, as raised in Chapter 3, the paper by Watterson and Dinan, which speculates, ‘who would be qualified’ to undertake an HIA - would someone with an EIA background have the skill set to interrogate the social health data, and would this be different if captured as an independent assessment, such as a stand-alone HIA?

Secondly, it is notoriously difficult to measure and, ‘easily put a number,’ on the Social Determinants of Health as each impact is personable to a person, community or affected population at any one time. What stresses one person may not stress another and amalgamating these stress levels to equate a number could invalidate the whole HIA process.

Thirdly, EIA was developed to factor in and mitigate the damage to the environment from infrastructure projects. Initially the drive was to protect the environment from chemicals, but as EIA became a structured approach for environmental assessment this momentum grew and as such has become highly relevant to infrastructure projects and the implications to the environment. Social health was never really intended to be part of this process.

To counterbalance this, Health Impact Assessment was developed with the sole purpose to identify the social health impacts of projects within the built environment arena. It has subsequently become common practice to be used within a multitude of arenas such as mental health in addition to infrastructure based projects, polices and strategies.

The Primer document, ‘Health in Environmental Impact Assessment,’ (Middleton and Simon, 2017) was published with the intention to, ‘spark discussion.’ The document states that EIA, ‘is a key public health and environmental sustainability activity,’ and that the new EIA Directive, amended and transposed into UK law, 2017, offers the supposed much needed

contemplation of the inclusion of human health The ultimate key message was that dialogue is required to develop necessary guidance.

Combining the two systems is a problem that has been contemplated between HIA and EIA practitioners over the last few years and is on-going.

Generally, the U.K. has a good safety record in the offshore oil and gas industry, although obviously there are considerable environmental and population differences and hopefully that experience will be used to develop best onshore practice. Similarly, there are differences between the U.K. and the U.S. They have a very different regulatory process compared to the U.K. and in the U.S. regulatory bodies can vary from state to state and chemical declaration is confusing, yet much of the detail in general about hydraulic fracturing appears to be being disseminated from America.

Finally, the author has written about the emergence of public health and its many years of concentration upon environmental factors to keep the population healthy, but only from the point of them being able to work rather than gain any personal benefit.

Decades elapsed before the Social Determinants of Health were used on a consistent basis and even then was only quantified in 1991 with the development and publication of the, ‘Rainbow.’ The question, maybe unanswerable, is why did it take so long? Was it because the medical profession held the power? Did the social philosophers of the time have a battle on their hands, maybe not too dissimilar to today and the primary focus was on the economy?

7.3 Research Limitations

Due to the lack of cooperation from Parish Councils and when attending official events, the author observed at first hand, the open aggression on display from both anti-fracking protestors and some attending members of the public. This aggression required a change of plan to ensure the safety of the author.

The only other option available to collect data was a questionnaire developed to be distributed on the internet. The was effected following an extensive literature search and developing questions based upon the objectives of the research. As has been seen, the questionnaire was in fact successful in gathering unique data for analysis.

7.4 Methodological Limitations.

The need to alter the data collection method from focus groups, of which the author has had much experience, to an on-line questionnaire posed problems.

The primary limitation was designing of the questionnaire by the author, who had limited knowledge in their design. However, this was overcome with an extensive literature search and several iterations, before piloting, of the questionnaire and final amendments following feedback from the participants.

Problems may have arisen had the questionnaire been too long, all one type of question (for example all closed questions), used technical language that a lay person may not understand. There were two other main areas of potential limitation for data gathering using the questionnaire.

Firstly, on-line questionnaires have the potential to create difficulties concerning adequate sample size as there is no control over distribution.

Who would complete it, only those against hydraulic fracturing, would there be a demographical imbalance, gender and age for example? Not having the control over numbers, such as is possible with focus groups, could have restricted the sample size which may have resulted in reduced or little data for analysis.

Secondly, difficulties in identifying suitable e-platforms that conformed to the non-bias approach required by the author. This naturally constrained the locations of where the questionnaire could be up-loaded.

Whilst these were all deemed as limitations for the research, using a questionnaire as the only source of data collection has proved its worth and as such provided a wealth of data for analysis.

7.5 Conclusions

7.5.1 The introduction of hydraulic fracturing into the U.K. as an alternative energy source is seen as a threat to personal health as a result of the stress, fear and anxiety it appears to be creating.

The public seem not to have a well-informed knowledge of the reasons for the Government's drive to explore for shale gas – energy security, sustainability and the need to produce low carbon based electricity.

7.5.2 The threat of pollution of the environment is also cause for concern and the unknowns this might imply for the future, creating uncertainty and fear of the future.

7.5.3 Respect must be given to the public's perceptions of the hydraulic fracturing process and how the process of granting licences and planning permission to explore for onshore shale gas are granted in the UK.

Very few respondents had actually attended either formal consultations or open events. This could be due to as yet, not many having taken place, but there is a need to encourage public and stakeholder engagement through consultation for them to, 'have their say.'

Respondents shared concerns about the consultation process, generally not trusting it. The author's experience with contentious HIA projects, has underlined to the author the importance of undertaking consultations through stakeholder engagement. This can give the public the opportunity to have a say and to express their views, based on the HIA values of democracy, equity and towards a sustainable future. Carried out effectively without bias, can help

build and support local relationships, which is hugely important in what are highly emotive, complex and uncertain situations.

This mistrust of the authorities has been exampled recently in Derbyshire of an EIA not being required when applying for planning permission to explore for shale gas.

The question could and maybe should be asked, how can someone in central government give permissions to explore for shale gas whilst changing planning rules and regulations when they may not know the area and certainly not the people and the local communities? Does this make it a fair and democratic process and how does this help alleviate the lack of trust shown towards the government? Such actions are likely to exacerbate the already expressed high level of mistrust.

The respondents' responses show that information is gathered from a wide range of sources, including all forms of the media, government reports, scientific journals and anti-fracking web sites. By far the most prolific areas consulted were in fact what might be termed as the, 'unofficial' channels and therefore possibly politically biased for or against, as opposed to reputable bodies such as the British Geological Society.[9]

Information is viewed as difficult to access, poorly presented in public consultations and sometimes patronising. Much of the information in the public domain seems to have emanated from the United States of America and presents a very negative view of the process.

The Primer document, 'Health in Environmental Impact Assessment - A Primer for a Proportionate Approach,' (Middleton and Simon, 2017) in which one of the key messages was, 'to open the dialogue.'

[9] They too have seriously erred and misled the public by saying they had undertaken community consultation at Ince Marshes in Cheshire, when in fact they had not and had to subsequently issue an apology.

The author would argue that discussions and dialogues have taken place over the last 10 years, if not more, of how to integrate health into the EIA process. Maybe it's time to accept this cannot be done, recognise it and look for different approaches?

If integrated as has been talked about for a number of years, this would mean that if, as has happened already, the Government decided to dispense with EIA under given circumstances, then HIA would also fall by the wayside. It has been the author's long held opinion they should not be integrated, neither is more important than the other – indeed, what value is one without the other?

Understanding why they should be kept separate, yet closely worked together will be key. This research clearly shows that the social impacts identified, and likely be common across all major infrastructure projects, will be difficult to include within an essentially quantitative process as is EIA.

As seen in Chapter 3, the call for the use of HIA is growing, whilst it is accepted this is predominantly within the U.S., there are key institutions within the U.K. calling for the use of HIA relative to hydraulic fracturing.

7.6 Recommendations

7.6.1 In view of the uncertainty revealed in the respondent's comments in being unable to clearly identify environmental or health and well-being concerning hydraulic fracturing, this research presents a strong argument that both HIA and EIA be a compulsory but separate parts of the planning application process.

7.6.2 It should be borne in mind that HIA is a proven academic tool and whilst initially used in the Built Environment, is now being applied for use on policies, projects and strategies which could have significant effects for people, populations and communities. As such it is ideal for use when looking at the effects upon people of hydraulic fracturing. Developing a stand-alone, HIA based toolkit, may be a tangible solution to do this. The development of an

HIA Best Practice Support Document for Hydraulic Fracturing© would be just such an approach, which will include the four Outcomes identified in the IRD and confirmed in the CLD.

The document would be developed based on HIAs ethos and principles. Usage would be by local communities and local planning authorities, but will also be an advisory document to both Government, the Oil and Gas industry, associated industries and be standard practice as a stand-alone procedure. This document would be user friendly for a range of stakeholders and other interested parties

Due to the lack of transparency and poor communication by Government, regulatory authorities and the Oil and Gas industry there is an urgent need to for this mistrust to be confronted. This process could begin by undertaking a number of focus groups and face to face interviews with all stakeholders, to better understand why there is so much mistrust. Ideally, these should be based in locations close to the major shale gas basins as opposed to the south east and in an independent environment not associated with any of the authorities involved in the exploration for shale gas.

Another significant difference, which is constantly under debate, is that EIA is statutory (in confines of the EIA Directive and attached Annexe's) whereas HIA is not.

In order to develop such a toolkit, it will be crucial to undertake with the major stakeholders involved with hydraulic fracturing, further research to mitigate the impacts of the three key themes which have emerged.

As stakeholder engagement is an important factor when dealing with large infrastructure projects, developing the use of social network mapping tools for mapping stakeholder influence will be essential within the toolkit. Using these tools can likely help identify where any stakeholder, 'sits' within a hierarchal situation. Using such tools can aid not only where a stakeholder sits but maybe more importantly this could influence others (Bourne and Walker, 2005).

Finally, as this chapter opened with a quote from Peter Marris, perhaps he should also have the last word:

'When those who have power to manipulate changes act as if they only have to explain, and when their explanations are not at once accepted, shrug off opposition as ignorance or prejudice, they express a profound contempt for the meaning of lives other than their own' (Marris 1974).

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Appendix A Complexity Theory

Complexity theory is a field of study which aims to analyse complex systems (Ref Ferreira MIT paper) and considers system thinking. It can cross multi-disciplines such as, computer science to ecology. The paper, by Ferreira, 2001, 'Tracing Complexity Theory,' offers the premise that, 'complexity theory has a large scope of application in today's life, mainly because real world systems are all complex (Ferreira, 2001).

The theory emerged as a concept in the late 20th Century with work by Edward Lorenz, a mathematician and meteorologist, who studied the non-linear pathways of weather forecasting. from observing non-linear activities in the natural sciences and has more recently been adapted for use in management and the management of projects.

As stated in the paper, by Remington 2008, 'Complex Projects, what are they and how can we manage them effectively,' it is explained concisely that a project is like a system which display a number of similar factors such as, inter-connectiveness, hierarchy, communication and control (Remington, 2008).

Complex Adaptive Systems (CAS) is a school of thought said to have risen out of the Santa Fe Institute in the mid-1980s and, as described by the Health Foundation as, 'a way of thinking about and analysing things by recognising complexity, patterns and interrelationships rather than focusing on cause and effective' (The Health Foundation, 2010).' Examples of CASs, include immune system, termite colonies and human, such as a committee (Plesk, 2001).

Within this growing use of Complex Adaptive Systems across multi-discipline areas, six common characteristics or components are revealed.

1. Inter-relationships.
2. Emergence.
3. Adaptability.
4. Feedback.
5. Self-organisation.
6. Non-linearity.

These are briefly defined and described as follows:

1. Inter-relationships: where the behaviour of individual components can affect others and possibly influence actions.

2. Emergence: the literature stating this as, ‘the whole is greater than the sum of the parts.’ This is described by the Evidence Scan paper, ‘Complex Adaptive Systems,’ that agents, in this case, stakeholders, appear to interact randomly or indiscriminately (The Health Foundation, 2010).

3. Adaptability: which relates to the flow of information within a, ‘system.’ When new information is fed into the process, how will it impact on individuals and their behaviours?

4. Feedback: where information is fed into a system but has been altered by others and then re-fed back into the system.

5. Self-organisation: within CAS’s they do not have a chain of command, nor a leader, and that rather than the traditional theory of disorder, that self-organisation is achieved.

6. Non-linearity: This component focuses on the commonly experienced non-linear factor, and is described as how small changes in an environment can have unpredictable consequences.

In addition to the components or characteristics as described above, it is important to mention the four types of project complexity that have been identified. These lie within the broad context of project management across a range of commercial (financial services to oil and gas) and public sectors (health care and government). Managing the complexity of any project will be key to success.

1. *Structural Complexity* is linked to large projects with a number of parts that interconnect.

2. *Technical Complexity* which faces challenges of possible unknown design and/or technical difficulties.

3. *Directional Complexity* which considers projects where elements are unshared or unknown.

4. *Temporal Complexity* which relates to changing environmental situations or circumstances.

The type of project complexity can be directly in relation to a project's life cycle and phases of a project. Elements of which are likely to include length of phases within a project, resources and project governance (Remington, 2008).

Shale gas and oil policy statement by DECC and DCLG - GOV.UK

Policy paper

Shale gas and oil policy statement by DECC and DCLG

Published 13 August 2015

Contents

This publication is available at https://www.gov.uk/government/publications/shale-gas-and-oil-policy-statement-by-decc-and-dclg/shale-gas-and-oil-policy-statement-by-decc-and-dclg

1. Shale gas and oil policy statement by DECC and DCLG

The Secretaries of State for Energy and Climate Change and for Communities and Local Government wish to set out the Government's view that there is a national need to explore and develop our shale gas and oil resources in a safe, sustainable and timely way, and the steps it is taking to support this. This statement should be taken into account in planning decisions and plan-making.

2. The national need to explore our shale gas and oil resources

Exploring and developing our shale gas and oil resources could potentially bring substantial benefits and help meet our objectives for secure energy supplies, economic growth and lower carbon emissions.

Having access to clean, safe and secure supplies of natural gas for years to come is a key requirement if the UK is to successfully transition in the longer term to a low-carbon economy. The Government remains fully committed to the development and deployment of renewable technologies for heat and electricity generation and to driving up energy efficiency, but we need gas - the cleanest of all fossil fuels – to support our climate change target by providing flexibility while we do that and help us to reduce the use of high-carbon coal.

Natural gas is absolutely vital to the economy. It provides around one third of our energy supply.

- About one third of gas supply is used for industry and services, not just for power or heating but also as feedstock, e.g. for chemicals;
- one quarter is used for electricity generation; and
- the remainder is used in domestic households for heating and cooking. [1].

Since 2004, the UK has been a net importer of gas due to the rapid decline of production from the UK Continental Shelf.

- Last year around 45% of UK gas supply was made up of net imports. [2]. Our projections suggest that domestic production will continue to decline and, without any contribution from shale gas, net imports could increase to 75% of the gas we consume by 2030. [3].
- Domestic oil production has also declined since reaching a peak in 1999. Currently net imports comprise around 40% of the oil we use and DECC projections suggest net imports could increase to 73% by 2030. [4].

Meanwhile events around the world show us how dangerous it can be to assume that we will always be able to rely on existing sources of supply. Developing home-grown shale resources could reduce our (and wider European) dependency on imports and improve our energy resilience.

There are also potential economic benefits in building a new industry for the country and for communities.

- Nationally, we will benefit from development of a new industrial sector, building on the experience and skills developed here in 50 years of on- and offshore oil and gas development.
- Developing shale resources would deliver investment in key domestic energy infrastructure, boosting the UK's capital stock and leading to increased productivity and growth.
- Reducing imports would improve the balance of trade.
- Consultants EY estimated in 2014 [5]. that a thriving shale industry could mean cumulative investment of £33 billion and support 64,500 jobs in the gas, oil,

construction, engineering and chemical sectors at peak. Locally that might mean new facilities and jobs for local companies.

We do not yet know the full scale of the UK's shale resources nor how much can be extracted technically or economically.

- The British Geological Survey estimates the shale gas resource in the Bowland-Hodder basin under Northern England could be 1300 trillion cubic feet (tcf) [6]. , compared to current UK annual gas consumption of around 2.5 tcf [7]. The industry need to test how much of this gas in place can be extracted technically and economically.
- National Grid's Future Energy Scenarios (2015) report [8]. presents a wide range for potential shale gas production in the UK up to a peak of 32 bcm/year in 2030. This would be around 40% of all the gas we are projected to consume and result in our import dependency falling to 34%, compared to current projections that net imports could reach 75% in 2030.

Shale gas can create a bridge while we develop renewable energy, improve energy efficiency and build new nuclear generating capacity. Studies have shown that the carbon footprint of electricity from UK shale gas would be likely to be significantly less than unabated coal and also lower than imported Liquefied Natural Gas. [9].

The Government therefore considers that there is a clear need to seize the opportunity now to explore and test our shale potential.

3. Safety and environmental protection will be ensured through responsible development and robust regulation

This must and can be done whilst maintaining the very highest safety and environmental standards, which we have established with a world-leading framework for extracting oil and gas for over 50 years.

Reports by the Royal Society and Royal Academy of Engineering, Public Health England and others have considered a wide range of evidence on hydraulic fracturing in the UK context, and concluded that risks can be managed effectively if the industry follows best practice, enforced through regulation. [10]. [11].

The Government is confident we have the right protections in place now to explore shale safely (see Annex). Planning authorities can also have confidence that the regulators will enforce safety, environmental and seismic regulation effectively. But we are not complacent. We will continuously look to strengthen and improve regulation where necessary as the industry develops.

4. Transparency and information for the public

It is also important that the public has objective information about shale and that communities where shale development is proposed are effectively engaged, with the opportunity to hear from the expert regulators at the Health and Safety Executive and the Environment Agency. The Government allocated £5m for 2015-16 in the last Autumn Statement for this purpose.

5. Planning

The Government is committed to ensuring that local communities are fully involved in planning decisions that affect them. We are also making the planning system faster and fairer for all those affected by new development. No one benefits from the uncertainty caused by delay. This is why we expect every planning application or appeal, large or small, to be dealt with as quickly as possible.

There is a clear expectation that local planning authorities should ensure that decisions on planning applications are made within statutory timeframes: 16 weeks where an application is subject to Environmental Impact Assessment. This should be supported through an upfront timeline agreed with the applicant including the anticipated decision date.

To avoid unnecessary work causing delay, when determining planning applications, local planning authorities should carefully consider which issues can be left to other regulatory regimes, taking full account of the Government's planning guidance on this issue.

We also expect local planning authorities to make full use of the funding available for 2015/16 through the £1.2m shale support programme. This will ensure there are adequate resources locally to enable the timely determination locally of planning applications for shale gas. Local planning authorities should also agree to Planning Performance Agreements where this is appropriate.

But we cannot be complacent. Therefore, as of today:

- Appeals against any refusals of planning permission for exploring and developing shale gas, or against non-determination, will be treated as a priority for urgent resolution. The Secretary of State for Communities and Local Government may also want to give particular scrutiny to these appeals. To this end he will revise the recovery criteria and will consider for recovery appeals for exploring and developing shale gas. This new criterion will be added to the recovery policy issued on 30 June 2008 and will be applied for a period of two years after which it will be reviewed.
- The Secretary of State will also actively consider calling in shale applications. Each case will be considered on its individual merits in line with his policy. Priority will be given to any called-in planning applications.
- The Government commits to identifying underperforming local planning authorities that repeatedly fail to determine oil and gas applications within statutory timeframes. When such applications are made to underperforming local planning authorities, the Secretary of State will consider whether he should determine the application instead.
- The Government has published its response to consultation and will take forward amending permitted development rights to allow the drilling of boreholes for groundwater monitoring. The Government is also inviting views on proposals for further rights to enable, as permitted development, the drilling of boreholes for seismic investigation and to locate and appraise shallow mine workings. These proposals will speed up the delivery of essential monitoring information for safety and environmental protection and free local resources for where the express attention of the local planning authority is required.

6. Sharing shale income with communities

We also strongly believe that communities hosting shale gas developments should share in the financial returns they generate. The Government welcomes the shale gas companies' commitment to make set payments to these communities, which could be worth £5-10m for a typical 10-well site, and we want to go further. As announced by the Chancellor in the 2014 Autumn Statement, and set out in our manifesto, we are determined to ensure that local communities share more of the proceeds and feel more of the benefits, using a proportion of the tax revenues that are recouped from shale gas production. We will present our proposals later this year for how we intend to design the sovereign wealth fund.

7. Safety and environmental protection

- Our regulatory system is robust and we are proven world leaders, with a 50 year track record, in well-regulated, safe and environmentally sound oil and gas developments. We have strict requirements through environmental permitting and DECC licencing for on-site safety, to prevent water contamination, air pollution and mitigate seismic activity.
- The Health and Safety Executive and the environmental regulators (the Environment Agency in England) are independent and highly specialised regulators. They will enable the development of shale gas in a safe and environmentally sound manner.
- The Environment Agency assesses the potential use of chemicals used in hydraulic fracturing fluids on a case-by-case basis. The use of hazardous chemicals will not be permitted where there is a risk that they may enter groundwater and cause pollution.
- The Health and Safety Executive scrutinise well design and require week by week written updates on drilling progress.
- DECC has implemented a thorough system of rigorous checks before any drilling or fracking and a live traffic light system during the actual operations, to ensure earth tremors will not occur.

To reinforce the existing regulatory regime further, the Infrastructure Act 2015 brought forward a range of additional requirements and safeguards if an operator is to carry out hydraulic fracturing.

- These include taking account of the environmental impact of development, baseline monitoring of methane in groundwater in the 12 months preceding hydraulic fracturing operations, disclosure of all chemicals, community benefits and the exclusion of protected areas.
- Draft regulations, laid on 16 July, defining the protected areas in which fracking will be prohibited as specified areas of groundwater, National Parks, Areas of Outstanding Natural Beauty, the Broads and World Heritage Sites. Fracking can only take place at depths below 1200 metres in these areas.
- Ministers also set out their clear commitment to ensure that hydraulic fracturing cannot be conducted from wells that are drilled at the surface of National Parks and other protected areas. This is not intended to impact on conventional drilling operations.

8. Transparency and information for the public

Following the Autumn Statement announcement of £5m for 2015-16 to "provide independent evidence directly to the public about the robustness of the existing [shale gas] regulatory regime", DECC received £1.7m to establish independent environmental monitoring and is working with a research consortium led by the British Geological Survey to expand an existing Lancashire-based programme for gathering baseline environmental data to North Yorkshire, where a planning application for a shale gas project is being submitted. The data produced would be made available to the public.

In addition, DCLG announced in March a £1.2m fund to support Mineral Planning Authorities dealing with shale planning applications. The Health & Safety Executive has received £0.5m to increase the availability of inspectors for onshore oil and gas operations and to double its local engagement capacity. The Environment Agency received £1.5m to undertake pro-active local engagement by deploying dedicated local officers. The Government is also publishing factual material on shale, including web documents and videos.

1. DECC, Digest Of UK Energy Statistics, July 2015
2. DECC, Digest of UK Energy Statistics, July 2015

3. DECC, UK Oil and Gas Production Projections, March 2015
4. Ibid
5. EY, Getting Ready for UK Shale Gas, April 2014
6. BGS/DECC, Bowland Shale Gas Study, June 2013
7. Based on DECC, Digest of UK Energy Statistics, July 2015
8. National Grid, Future Energy Scenarios, 2015
9. Mackay-Stone report (requested by DECC), Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use, Sept 2013
10. The Royal Society and The Royal Academy of Engineers, Shale gas extraction in the UK: a review of hydraulic fracturing, 2012
11. Public Health England, Review of the Potential Public Health Impacts of Exposures to Chemical and Radioactive Pollutants as a Result of the Shale Gas Extraction Process

Briefing

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EPRS | European Parliamentary Research Service
Author: Gregor Erbach

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Shale gas and EU energy security

SUMMARY

While the United States has abundant supplies of cheap gas thanks to the 'shale revolution', the EU remains dependent on gas imports. The Ukrainian crisis has given rise to increasing concerns about the security of the EU's gas supply. At the request of the European Council, the European Commission has analysed the situation, and published a European Energy Security Strategy. Among other elements, the strategy focuses on increasing energy production in the EU and diversifying external supplies.

This briefing addresses the question whether, and to what extent, shale gas can contribute to European energy security. Some European regions have significant shale gas resources, but more exploration is needed to find out whether they can be developed commercially. Most analysts agree that shale gas in Europe will be more expensive than in the US, due to different geology and the need to address public acceptance and environmental impact. Shale gas will not resolve short-term energy security issues as exploration and development will take 5 to 15 years. In any case, the volumes produced will not make Europe self-sufficient in gas, but could help to reduce gas prices.

The increased production of shale gas in the US has already reduced global gas prices by reducing US demand for liquefied natural gas (LNG). Future gas exports from the US will contribute further to this trend, but prices for exported gas will be higher than domestic US prices due to the cost of LNG transport. Moreover, many analysts believe that exports of US shale gas will go to Asian markets. Prices in Asia are higher than in Europe, where ample supplies of conventional pipeline gas compete with LNG. Analysts agree that Russia will remain an important gas supplier for the EU.

Shale gas drilling in the province of Lublin, Poland.

In this briefing:

- Background: the 'shale revolution'
- Europe's gas import
- Shale gas resources in Europe
- Developments in EU Member States
- EU approach
- Shale gas exports from the US
- Role of the European Parliament
- Economic impacts
- Outlook

Glossary

Energy security: the uninterrupted availability of energy sources at an affordable price. The International Energy Agency distinguishes short-term energy security (the ability of the energy system to react to sudden changes in the supply-demand balance) and long-term energy security (timely investments to supply energy in line with economic and environmental needs).

Hydraulic fracturing (fracking): injection of water, sand and chemicals at high pressure into an underground rock formation, in order to break up the rock and extract gas or oil.

Liquefied Natural Gas (LNG): natural gas which is turned into a liquid by cooling it to -162°C, reducing its volume 600 times. It is transported in special ships.

Shale gas: natural gas which is trapped in shale, a fine-grained sedimentary rock consisting mostly of clay particles. It is extracted by horizontal drilling and hydraulic fracturing.

Background: the 'shale revolution'

Over the past decade, the United States has experienced spectacular growth in the production of shale gas, thanks to technological innovations such as horizontal drilling and hydraulic fracturing (fracking). This new supply of energy has led to falling gas prices and a reduction in energy imports. Low gas prices have benefitted households and industry, especially steel production, fertilisers, plastics and basic petrochemicals.

Environmental concerns about fracking persist, and are being addressed by industry and regulators in Europe and North America. The replacement of coal by gas for electricity production has led to a drop in US greenhouse gas emissions. The future climate impact of shale gas would be positive if it replaces carbon-intensive coal, and methane emissions can be minimised. On the other hand, it would be negative if cheap gas discourages investments in energy efficiency and renewable energy sources.

The shale revolution in North America has changed global energy flows. North America imports less energy, so that more liquefied natural gas (LNG) is available for Asian markets. More US coal is exported to Europe and Asia, as it has been replaced by gas for electricity generation in the US. To enable gas exports from the

US, it is planned to convert LNG import terminals (which had been built in the expectation of rising gas imports) to export terminals.

The shale boom in the US has been enabled by specific geological, geographic, industrial, financial and regulatory factors in North America.

In the light of considerable uncertainty about the extent of the ultimately recoverable shale gas and oil resources, analysts are divided about the longer-term outlook for North American energy production. Some look forward to a century of abundant energy supplies while others fear that the shale revolution is a short-lived financial bubble and that gas prices will rise.

Europe's gas imports

The EU imports 53% of its energy needs. In 2013, the EU imported 305 billion cubic metres (bcm) of natural gas – 66% of its consumption. Russia supplied 39% of EU gas imports by volume, Norway 33%, and North Africa (Algeria and Libya) 22%. Six EU Member States are dependent on Russia for their entire imports of natural gas. Conversely, Russia depends on the EU as a customer – 71% of Russian gas exports go to the European market. The EU's dependence on gas imports is expected to increase with declining indigenous production of conventional gas. Worldwide energy demand is projected to increase by 27% up to 2030, which also has an impact on Europe's energy security.

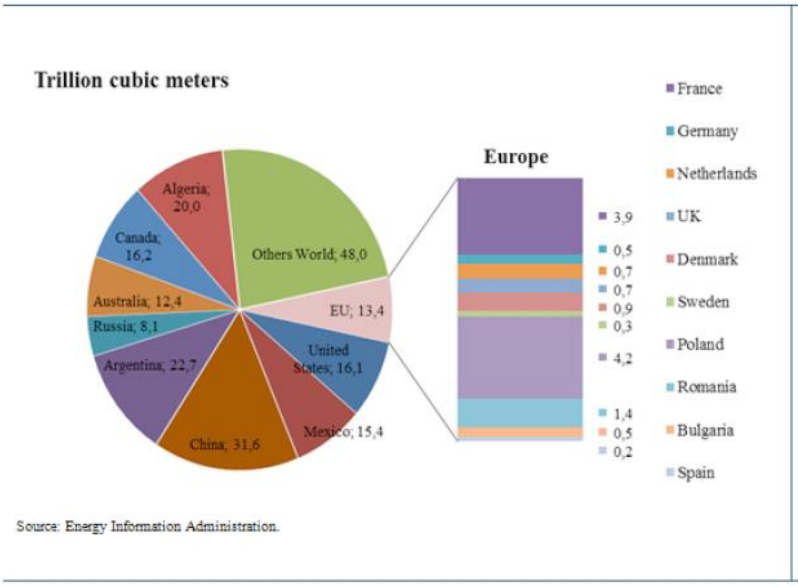
Europe is well connected to its principal gas suppliers by a network of pipelines with a total capacity of 530 bcm/year. Although roughly half of Russia's gas exports to Europe is transported through Ukraine, there are alternative routes through Belarus and under the Baltic Sea (Nord Stream), which have some spare capacity. New pipelines are under construction to bring gas from the Caspian region, and later maybe from Iraq and Iran, to Europe via Turkey and Italy. The construction of a new Russian pipeline (South Stream), which was to connect Russia with the Balkans and Austria, has been suspended due to non-respect of EU common market rules.
In addition to pipelines, Europe has 19 LNG import terminals, with more under construction. Due to higher LNG demand from Asia, the EU's LNG imports have fallen to 37.4 billion cubic metres (bcm) in 2013, down from 76.5 bcm in 2011. In the first eight months of 2014, only 16% of the current capacity of 207 bcm was used. Europe currently has enough LNG import capacity for over a third of its total gas demand.

Shale gas resources in Europe

According to the 2013 energy study by Germany's Federal Institute for Geosciences and Natural Resources (BGR), technically recoverable shale gas reserves in Europe amount to 14 trillion cubic metres (tcm), and exceed Europe's conventional natural gas reserves– estimated at 5.2 tcm. Poland and France have the largest estimated shale gas resources in the EU. However, only a few exploration wells have been

drilled in Europe so far, so these estimates come with a lot of uncertainty and are subject to revision. Moreover only part of the reserves is economically recoverable. Other unconventional hydrocarbons, such as tight oil, have much less potential in Europe.

Figure 1 – Unproved technically recoverable shale gas resources



Unproved shale gas Technically Recoverable Reserves[2]		
Tcm	2011	2013
Total EU	15,8	13.3
Of which		
France	5,1	3,9
Germany	0,2	0,5
Netherlands	0,5	0,7
Norway	2,4	0
UK	0,6	0,7
Denmark	0,7	0,9
Sweden	1,2	0,3
Poland	5,3	4,2
Bulgaria	/	0,5
Spain	/	0,2
Romania	/	1,4
Total US	24,4	16,1
Of which		
Marcellus	11,0	5.3
Total World	187,5	203,9

Source: Energy Economic Developments in Europe, European Commission, 2014

According to the Commission's In-depth study of European Energy Security, shale gas resources in the EU appear to be significantly smaller than in the US. Thus shale gas production in the EU is unlikely to achieve the same volumes and costs as in the US. Moreover, potential reserves in the EU are spread across several countries, which may limit economies of scale. IHS, a consultancy, expects that European shale production will only be 4 bcm a year by 2020, compared with over 70 bcm in America today.

Shale gas resources in the EU's neighbourhood

Algeria, Africa's leading gas producer, has the world's third largest shale gas resources, according to US (EIA) estimates. Several energy companies have signed exploration agreements, and Eni SpA has already begun exploration. Depending on the outcome of the exploration, Algeria could double its gas production in the next two decades. Algeria already has pipeline connections to Spain and Italy.

Ukraine has potential shale gas reserves, and signed agreements with Chevron and Royal Dutch Shell for exploration and development in 2013. Some commentators have argued that Russia's attitude towards Ukraine is in part motivated by the desire to gain control of offshore gas resources in the Black Sea and to hinder Ukrainian shale gas production.

Turkey started hydraulic fracturing operations in 2013 to extract shale gas in the Thracian and south-eastern regions. The development of shale gas in Turkey may help reduce the country's dependence on energy imports, but Turkey is not expected to become a gas exporter. Over the past decade, Turkey has diversified its gas suppliers through the opening of pipelines to theCaspian region.

Developments in EU Member States

Those Member States with shale gas resources have taken very different approaches. While some countries, notably Poland and the UK, are enthusiastic about shale gas development, others have banned all exploration or production. A third group of countries takes a cautious approach.

Public opinion on shale gas is divided, and varies greatly between Member States. Proponents argue that the risks are manageable and point to long-term economic benefits and reduced energy dependence. Opponents are concerned about water use, air and water pollution, earthquakes, disruption of natural habitats, as well as disturbance of local communities by truck traffic and drilling noise. Addressing these environmental and social concerns is considered to be critical for the successful development of shale gas, and will add to the costs of shale gas development. Former NATO Secretary-General Anders Fogh Rasmussen has accused Russia of supporting environmental organisations that oppose the development of shale gas.

Bulgaria imposed a moratorium on fracking in January 2012, and revoked licences for shale gas exploration. A recent study indicates that shale gas development in Bulgaria could create 25 000 to 39 000 jobs, and increase GDP growth by 0.6 to 0.74 percentage points over a 40-year period.

Denmark approved exploratory drilling in Jutland in 2014. A majority of Danes support shale gas exploitation.

Germany is taking a cautious approach to shale gas development, in line with a recent report from the federal environment agency. New legislation is in preparation, based on strict principles agreed by the environment and economics ministries.

Spain: The Spanish government supports shale gas development. About 70 exploration permits (for different types of hydrocarbons) have been issued, and a further 75 await authorisation, according to the Spanish Oil and Gas Association (ACIEP). Most shale gas reserves are located in the Basque-Cantabrian basin in the north of Spain. In 2013, the region of Cantabria banned fracking, but the Spanish constitutional court declared the ban unconstitutional in June 2014. According to a study on the potential economic impacts of shale gas in Spain, the country could become independent of gas imports by 2030, and export gas by 2050.

France has some of the largest estimated shale gas reserves in Europe. However, the French government banned fracking in 2011 and cancelled exploration licences. In October 2013, France's constitutional court upheld the ban. President François Hollande has promised to maintain the fracking ban as long as he is in office.

Netherlands: Shale gas exploration in the Netherlands has been suspended, while a study (to be completed in 2015) on its environmental and social effects is carried out.

Lithuania is in the process of introducing 'investor-friendly' shale gas regulations. Earlier this year, oil company Chevron, which had won a tender to explore for shale gas in Lithuania, pulled out of the country citing an uncertain legal framework.

Poland has the largest shale gas resources in Europe, according to US (EIA) estimates. However, the first exploration wells have shown disappointing results, and prompted some operators to leave Poland. By June 2014, 64 exploratory wells had been drilled in Poland, and 20 more are planned for this year. In order to encourage shale gas exploration, domestic shale gas extraction will be tax-free until the end of 2020, and taxes will not exceed 40% after that. In August 2014, Poland amended the 2011 Geological and Mining Law to streamline licensing procedures and strengthen supervisory powers. The European Commission opened legal proceedings against Poland in June 2014, on the grounds that the new law infringes the environmental impact assessment (EIA) directive by allowing drilling at depths of up to 5 000 metres without having assessed the potential environmental impact. A majority of Poles support shale gas exploitation.

Romania: Romania lifted an earlier ban in 2013, and is supportive of shale gas. In May2014, Chevron started exploratory drilling in Romania. A 2013 report shows that Romania has good potential for shale gas development.

UK: The current government is in favour of shale gas development, and has adopted regulations. Licences for shale gas exploration have been issued. According to industry, it will take five years and the drilling of 20 to 40 fracking wells to judge whether the UK has a viable shale gas industry.

EU approach

Security of gas supply

The security of EU gas supply has been a priority since Russia cut off gas deliveries to Ukraine – an important transit country for European imports of Russian gas – in 2006 and 2009. EU Member States have diversified gas suppliers and supply routes, built LNG import terminals and expanded gas storage capacity, so that today Europe is much better prepared for such disruption.

Recently, events in Ukraine and the related Russian-Ukrainian dispute about gas prices and payments have given renewed prominence to concerns about the security of EU gas imports. To address these concerns, the March 2014 European Council requested the Commission to develop a European energy security strategy, which was published in May 2014. Besides energy efficiency and completion of the internal energy market, the strategy proposes to increase domestic energy production in the EU and to diversify supplier countries and routes. According to the strategy, shale gas 'could partially compensate for declining conventional gas

production provided issues of public acceptance and environmental impact are adequately addressed'.

European energy security is to be strengthened further by establishing an Energy Union. This is one of the priorities of the new European Commission, to be coordinated by Vice-President Maroš Šefčovič. Member States are to pool resources, combine infrastructure and negotiate with one voice vis-à-vis third countries. Security of supply is to be achieved by diversifying energy suppliers and routes of energy imports, and reversing energy flows if necessary.

Energy trade is also a subject of the negotiations towards an EU/US Transatlantic Trade and Investment Partnership (TTIP).

Shale gas
As the choice of energy sources remains the competence of Member States, there is no legal basis for a specific EU policy with respect to the development of shale gas. However, the environmental impacts of shale gas development fall under the EU's competence in the environmental field.

In January 2014, the Commission adopted the non-binding Recommendation 2014/70/EU concerning the use of hydraulic fracturing for the exploration or production of shale gas/oil. The Recommendation mostly concerns the environmental aspects of hydraulic fracturing, which can have cross-border impacts. The public should be informed about any chemicals used in the process. Member States remain free to choose whether they go ahead with exploration or choose to ban fracking. Member States that opt for fracking were invited to apply the recommendation by July 2014, and report annually to the Commission. The Commission will review national measures within 18 months, and decide if the voluntary approach is working or if EU legislation is needed.

In order to strengthen the scientific/technological knowledge base, the Commission launched a European Science and Technology Network on Unconventional Hydrocarbon Extraction in July 2014.

Shale gas exports from the US

US natural gas exports to overseas markets would be in the form of liquefied natural gas (LNG). Import terminals that were built in the expectation of rising LNG imports into the US are now idle and could be converted to LNG export terminals. US LNG export projects will have a cost advantage over projects in other parts of the world because much of the required infrastructure is already in place.

All exports of natural gas from the US must be authorised by the Department of Energy, in a slow two-stage process. Exports to countries with which the US has no free trade agreement are only allowed if it can be shown that they are in the national interest. In the US, 45 applications for LNG export licences have been made, and 39 US projects had been approved as of October 2014. Exports are expected to start in late 2015. HIS estimates that the US export capacity will reach

66 bcm/year early in the next decade. US gas exporters are profit-oriented companies who will try to get the best price for their product on the global market. With the enlarged Panama Canal due to come into use in the next couple of years, large LNG carriers will more easily be able to transport gas from the US Gulf coast to Asian markets where gas prices are higher. Several European energy companies (Iberdrola, Fenosa, Endesa) have recently signed long-term LNG supply contracts with Texas-based Cheniere Energy, despite analysts' expectations that US producers are more likely to export LNG to East Asia. During his visit to Brussels in March 2014, US President Barack Obama stressed that the EU should not rely on US exports, but make its own efforts to ensure its energy security, including through the development of indigenous sources.

Role of the European Parliament

The European Parliament considered the issue of shale gas development and adopted two resolutions on 21 November 2012. The resolution on the industrial, energy and other aspects of shale gas and oil calls for 'robust regulatory regimes', and the application of environmentally friendly processes and best available techniques in order to achieve the highest safety standards. The resolution on environmental impacts proposes a thorough analysis of existing EU regulations applicable to shale gas. It calls for special plans for water use, recycling of water, and disclosure of chemicals in fracking fluids. These requests were taken up to a great extent in the above-mentioned Commission Recommendation.

In March 2014, the EP adopted a revision of the Environmental Impact Assessment Directive, following a compromise agreement with Council. Despite EP requests, the agreement does not include mandatory environmental impact assessments for the extraction and exploration of shale gas. However, new aspects of gas projects will have to be considered, notably human health risks due to water contamination, use of soil and water as well as the quality and regenerative capacity of water underground. If Member States decide that no environmental impact assessment is needed, they will have to provide a justification.

Economic impacts

It is unlikely that shale gas in Europe can be produced as cheaply as in the US. According to the International Energy Agency, production costs in Europe may be twice as high due to geological and geographical differences, higher population density, and lack of natural gas infrastructure in many places. Bloomberg New Energy Finance estimates that the cost of shale gas in the UK will be 50% to 100% higher than in the US. Estimated prices for shale gas produced in Europe vary between US$6 and US$15.5 per million British thermal units (BTU – approximately 0.3 megawatt-hours, or 28 m_3 of gas). However, these prices may come down with improvements in drilling productivity, and European shale gas may become competitive with LNG and even pipeline gas.

A study carried out on behalf of the International Association of Oil and Gas Producers compares three scenarios for European shale gas production: a baseline

scenario with no shale gas, a scenario with some shale, and a 'shale boom' scenario that would require the drilling of 33 500 to 67 000 wells up to 2050. Compared to the baseline, wholesale gas prices are 6% lower in the 'some shale' scenario, and 14% lower in the 'shale boom' scenario. Gas import dependency in 2035 would rise to 89% in the baseline, while it would be 78% in the 'some shale' scenario and 62% in the 'shale boom' scenario. In the 'some shale' scenario, GDP in 2035 would be 0.3% higher than the baseline, and 0.8% higher in the 'shale boom' scenario.

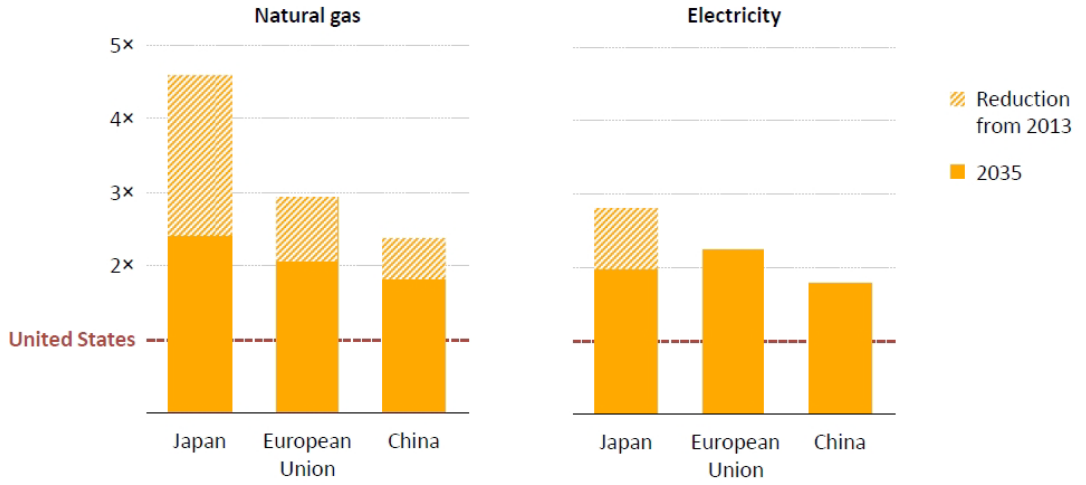
Daniel Gros of think-tank CEPS argues that indigenous shale gas production is uneconomical now, as conventional gas can be produced more cheaply, and suggests keeping shale gas reserves in the ground for a later time when the economics are more favourable.

A recent study for the European Commission concludes that the choice of different environmental risk management policies for shale gas has almost no impact on energy production, energy prices or energy demand, and therefore no impact on the economy. The increased production of shale gas in the US has already reduced global gas prices by reducing US demand for liquefied natural gas (LNG). When US gas can be exported, the US (Henry Hub) spot price could become a global benchmark for gas prices. Where LNG transport is required, the cost of liquefaction, transport and regasification must be added (estimated to be around US$6 per million BTU for transport to Europe, and around US$5-8 for north-east Asia).

Future US LNG exports may reduce world gas prices, according to an analysis by the Center on Global Energy Policy at Columbia University. Europe would benefit the most from US LNG exports, which could lead to an estimated 11% drop in European gas prices. Although Russia is expected to remain a major supplier to Europe, it will suffer economically from a small drop in export volumes and a large drop in the sales price, according to the economic modelling.

US LNG exports would lead to somewhat higher domestic gas prices in the US, an increase in gas production and a slight decrease in gas consumption, according to a 2012 study carried out for the US Energy Department. A 2013 report on macroeconomic impacts concludes that allowing gas exports will lead to net economic benefits for the US. The International Energy Agency (IEA) expects regional differences in gas prices to narrow, but to persist for decades. Fatih Birol, IEA Chief Economist, warned that 30 million European jobs are at risk due to the US shale gas boom, as energy-intensive industries move operations to the US where energy costs are far lower.

Figure 2 – Ratio of industrial energy prices relative to the United States



Source: International Energy Agency, World Energy Outlook 2013

Outlook

With respect to shale gas production in the EU, most experts seem to agree that:
• There are great uncertainties in the resource estimates, and more exploratory drilling is needed to assess the real extent of technically and commercially recoverable resources in Europe.
• Shale gas will not be produced commercially in the short term, due to the time needed for exploration and licensing. It could take a decade or more before many of the reserves can be developed, according to John Watson, CEO of Chevron. Shale gas development in Europe will be more evolution than revolution.
• European shale gas will not be as cheap as in the US, due to different geology, higher environmental standards, and a less developed drilling services industry.
• The volumes produced will be lower than in the US, but can compensate at least in part for the decline of conventional gas production in Europe.
• The EU can learn from developments in the US, in order to avoid environmental problems such as methane leaks.
• The EU will continue to depend on imports of natural gas, and Russia will remain an important supplier despite all diversification efforts.

While indigenous shale gas production will not dramatically change the energy situation for the EU as a whole, it can help prevent a further increase in import dependency and contribute to economic growth and job creation in those Member States that choose to develop their shale gas resources.

With respect to exports of natural gas from the US, most experts agree that:

• US gas prices will rise, as gas exports reduce supply on the US market. However, the IEA expects US gas prices to remain well below European prices until 2035.
• Imported US gas will be more expensive in Europe than in the US, due to the cost of LNG (liquefaction and regasification) and transport.
• Most US exports will go to Asian markets where price levels are higher.

• Increased LNG supplies lead to a larger, more liquid and more diversified gas market, and may mean the end of long-term gas contracts linked to oil prices.

In conclusion, shale gas will not make a contribution to the EU's energy security in the *short-term*, as it will take years before indigenous shale gas production starts, or before significant US exports are on the market. Short-term supply security must be ensured by gas storage, exchange of gas between EU Member States (reverse flows), switching to alternative fuels and LNG imports. Recent energy security stress tests carried out by the European Commission concluded that households in most Member States can be supplied with gas, even if Russian gas imports are cut for six months.

In the *medium and long term*, according to most analysts, indigenous shale gas production can offset declining European production of conventional gas. However, it is less clear whether shale gas will be competitive with conventional gas supplied by pipeline from outside the EU. If this is not the case, tax breaks or other government incentives would be needed to support indigenous shale gas production.

Moreover, the relationship of shale gas with the EU's climate policies needs to be considered. According to the European Commission's 2050 Energy Roadmap, gas can play a key role in decarbonising the economy by replacing carbon-rich coal. On the other hand, higher carbon emissions would result if shale gas developments lead to additional gas consumption or to reduced investments in renewable energies. Some analysts argue that investments in renewable energy sources and in energy efficiency can make a stronger contribution to European energy security than shale gas. Others point out that intermittent renewables like solar or wind must be backed up by flexible generation capacity, for which gas is very well suited.

Energy security analysts believe that Russian gas will continue to dominate European markets, as long as suppliers are chosen on the basis of price, and not out of political considerations. Even if Russian gas remains important, diversification of suppliers is considered as essential, as it can lead to lower prices and reduce the possibility of using energy supplies as a political weapon. The Oxford Institute for Energy Studies points out that economic and political considerations may diverge. In this case there may be an economic price to be paid for achievement of political energy-security objectives, just as following a purely economic logic may come with a political cost.

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Briefing

Public expectations and EU policies

July 2016

EPRS | European Parliamentary Research Service
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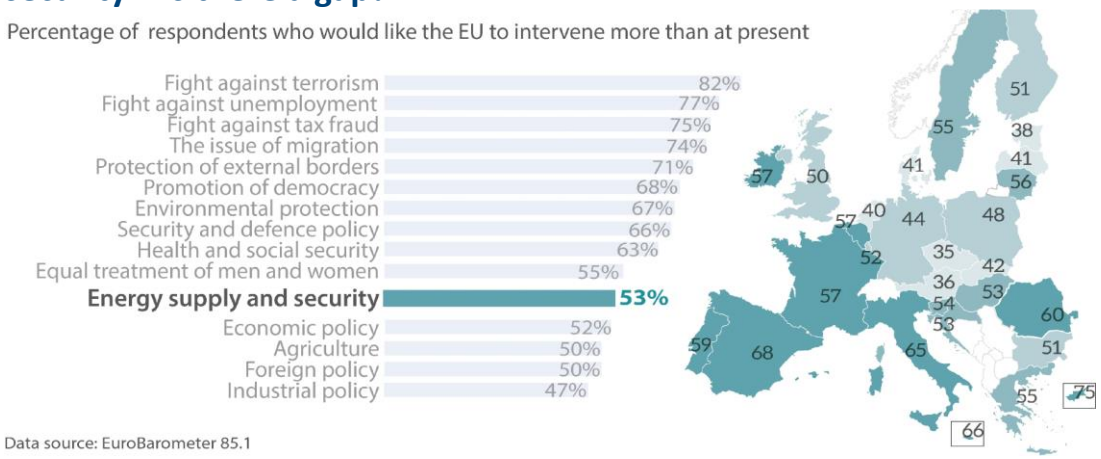
Members' Research Service PE 586.587 EN

Energy supply and energy security

OVERVIEW

More than half of EU citizens would like to see the EU play a bigger role in energy supply and energy security. The EU was given competences in energy policy by the Lisbon Treaty in 2009. The main objectives of EU energy policy are sustainability, affordability and security of supply. The Energy Union strategy, adopted in 2015, provides a holistic framework for further integration of European energy markets. According to analysis carried out by the European Parliament, a more integrated single market for energy could result in annual efficiency gains worth €250 billion. Energy-related expenditure is spread across different parts of the EU budget. Energy is among the priorities of the European Fund for Strategic Investments (EFSI).

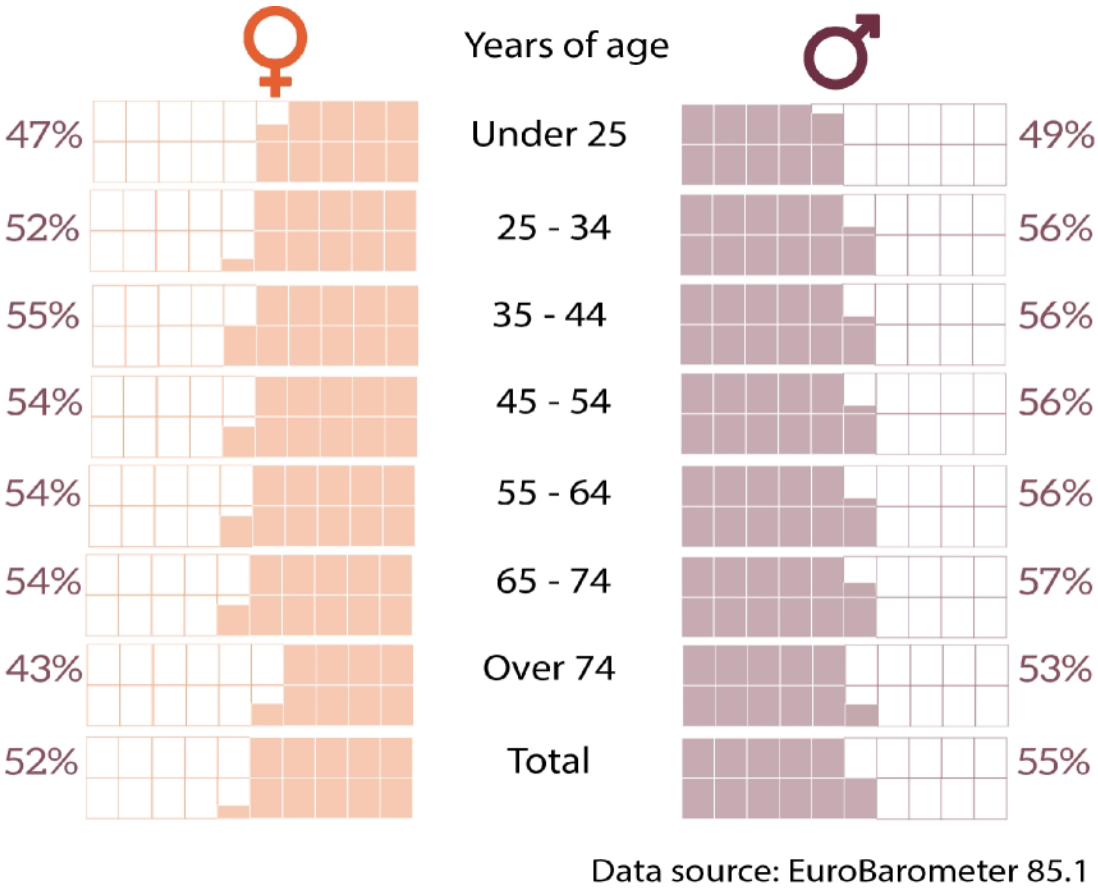
Public expectations and EU commitment on energy supply and energy security – is there a gap?



According to a new Eurobarometer survey of the European Parliament on 'perceptions and expectations', around half of EU citizens would like the EU to intervene more in energy supply and security than it does currently. There is significant variation in opinion across Member States. The strongest support for increased EU action was recorded in Cyprus (75%), Spain (68%) and Malta (66%), while the weakest was in the Czech Republic (35%) and Austria (36%). Energy supply and security is one of only two policy areas (together with equal treatment of men and women) in which more citizens rate current EU action as adequate (45%) than as insufficient (37%). Only in some countries is there a gap between citizens' expectations of EU involvement in energy supply and security, and actual EU involvement in this policy area.

Public support for spending in this area was stable between 2008 and 2011 – 22% perceived the energy sector as a priority spending category in both 2008 and 2011. However, support for EU funds being spent on energy dropped to 16% in 2015 (Eurobarometer data). Such a drop could reflect satisfaction with current EU involvement in this policy area (evident from the data), or indicate that other priorities have become more salient.

Figure 1 – Opinion by generation, gender



Data source: EuroBarometer 85.1

Differences across socio-demographic groups in terms of preference for more EU involvement are generally small. People under the age of 24 and over 75 express somewhat lower support for greater EU involvement in energy supply and security policy.

Legal framework

Energy policy was made an explicit EU competence by the Lisbon Treaty. The objectives of EU energy policy, set out in Article 194 of the Treaty on the Functioning of the European Union (TFEU), are a functioning energy market, interconnected energy networks, security of energy supply, promotion of energy efficiency and saving, and the development of new and renewable forms of energy. Articles 170-172 TFEU concern trans-European energy networks. Combating climate change is one of the objectives of EU environmental policy (Article 191 TFEU).

Energy policy is a shared competence between the EU and its Member States, and subject to codecision by the European Parliament (EP) and the Council (ordinary legislative procedure). However, Member States remain free to choose their energy sources and the structure of their energy supply.

EU energy market policy has been successively developed since the 1990s as part of the broader single market. However, the EU internal energy market is still to be fully completed. Energy has been part of European integration from the very beginning (European Coal and Steel Community, 1952, and European Atomic Energy Community, 1958).

Current implementation and EU action

Energy has become a renewed focus of EU policy under the Juncker Commission, which published an Energy Union strategy in 2015. This strategy builds on the 2030 policy framework for climate change and energy and on the previous European energy security strategy. The Energy Union strategy has five inter-related aspects: energy security, solidarity and trust; a fully integrated European energy market; energy efficiency contributing to moderation of demand; decarbonising the economy; and research, innovation and competitiveness.

The internal energy market in the EU was established by three market liberalisation packages adopted in the 1990s, 2003 and 2009, which provide for the 'unbundling' of energy production and supply from energy-transmission networks, as well as third-party access to gas storage facilities, stronger consumer protections, and enhanced regulatory surveillance.

The EU climate and energy framework for 2020 aims to ensure the security of energy supply by increasing production from (mostly indigenous) renewable sources, and by reducing energy demand through efficiency measures. Even though Europe aims to reduce its dependency on energy imports, ensuring a reliable supply of fossil fuels (especially gas) remains an important priority in the light of declining indigenous production. The European energy security strategy of May 2014 focussed on short-term challenges as well as longer-term goals that have been taken up in the Energy Union strategy. In October 2014, the European Council endorsed the EU 2030 climate and energy framework, which sets targets for cuts in greenhouse gas emissions, renewable energy and energy efficiency. Its implementation is part of the EU's contribution to the Paris Agreement on climate change, which aims at a transition towards a low-carbon energy system.

Potential for better implementation and further EU action

Better implementation

Despite incremental market liberalisation since the 1990s, the internal energy market in the EU has yet to be completed. The European Parliament and the European Council have repeatedly urged full transposition and implementation of the third internal energy market package. The Court of Auditors special report 16/2015 found that the objective of completing the internal energy market by 2014 had not been reached, and that more and better targeted infrastructure initiatives were needed.

European Parliament implementation appraisals of energy efficiency, emissions trading and renewable energy analyse the implementation of these policies and suggest possible ways to improve their effectiveness. According to the European Parliament study 'Mapping the Cost of Non- Europe, 2014-19 (third edition)', a more economically and physically integrated single market in energy could bring annual efficiency gains worth at least €250 billion.

New EU tools

The Commission's 2015 summer energy package consists of two legislative proposals (energy efficiency labelling; reform of the Emissions Trading System) and communications on energy markets and consumers. In February 2016 the Commission presented the sustainable energy security package, which consists of two legislative proposals (security of gas supply; intergovernmental agreements) and two communications (liquefied natural gas and gas storage strategy; heating and cooling strategy). Vice-President Šefčovič announced that 2016 would be the 'year of delivery', in which all the major initiatives for the Energy Union would be presented, so that they could be adopted during the current legislative term.

Possible ways forward

The Energy Union strategy provides a framework for the further integration of the European internal energy market and coordination of national energy policies and energy diplomacy. The annual reports on the State of the Energy Union will provide an opportunity to take stock of progress, and debate the possibilities for further EU action. Parliament expressed its views on the Energy Union in a resolution of 15 December 2015, reiterating its calls for more ambition on energy efficiency and renewable energy and for a fully integrated European energy market. The recurrent debates about gas pipelines (notably the Nord Stream 2 project) and electricity interconnections show there is an interest in coordinating energy supply and energy infrastructure at European level, in a spirit of solidarity among Member States.

The EU budget and energy

Energy supply and energy security issues are connected to a number of other policy areas. Many programmes and funds include objectives related to energy, energy efficiency, a low-carbon economy or climate action. It is difficult to clearly indicate all related EU funding because it is spread across many different budgetary headings.

The European Energy Programme for Recovery provided almost €4 billion for key EU energy projects running from 2009 to 2019. The Connecting Europe Facility (CEF) was created under the 2014-2020 Multiannual Financial Framework (MFF) to promote and part-finance cross-border transport, energy and telecommunications infrastructure links. It includes a financial envelope of €5.4 billion for energy-related projects. CEF funding can leverage other funds using financial instruments, such as project bonds.

Other funding is available to Member States via the European Structural and Investment Funds (ESIF). For instance, around €2 billion from the European Regional Development Fund (ERDF) is allocated to large-scale electricity and gas infrastructure, 'the low carbon economy' being one of four priority areas for the period 2014-2020.

The EU also encourages research activities in the energy field, with the aim of developing new technologies for energy supply and increased energy security. In terms of financial support, the International Thermonuclear Experimental Reactor (ITER) is probably the biggest project, with a budget of almost €3 billion under the 2014-2020 MFF. In this case, EU funds are channelled via the European Joint Undertaking for ITER and the Development of Fusion (F4E). Horizon 2020 provides financial support for research projects focused on both nuclear and non-nuclear energy. It will provide €5.9 billion in funding between 2014 and 2020.

Energy cooperation, particularly around supply, is an important element of European Neighbourhood Policy. The European Neighbourhood Instrument also has an energy policy

element, specifically in terms of energy efficiency and renewable energy, and energy networks.

Financial instruments outside the EU budget

Energy is among the priorities of the European Fund for Strategic Investment (EFSI), which is pooling EU contributions to specific projects with European Investment Bank (EIB) funding, with a view to attracting public and private investments worth at least EUR 315 billion. The EIB helps finance energy projects in the areas of renewable generation, infrastructure, and new technologies by providing companies with loans and other financial instruments.

The European Development Fund, which is outside the EU budget, includes a budgetary heading on energy, which is one of the key objectives of EU development aid. With the creation of the EFSI, the financial leverage of EU funds has become an increasingly important aspect of EU policy. This principle is also applied within the NER 300 programme for carbon capture and storage and innovative renewable energy technologies.

Potential for further financing at EU level

The European Court of Auditors recommends better targeting of EU funds to selected priority projects. This is in line with an earlier EP resolution from 2013 calling for support for key infrastructure projects that may not be commercially viable.

The EP resolution from 2015 calls for a pan-European electricity grid and gas network with the capacity to transmit power and gas across EU countries from multiple sources. More specifically, it calls for better interconnection of Spain and France and for a Mediterranean Gas Hub with increased LNG capacity. In the same document, the EP also calls on the Commission to explicitly list the different funding and financing instruments at its disposal.

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Appendix E Dissemination of the 3 HIAs

HIA	Battlement Mesa
Who commissioned the HIA?	Garfield Board of County Commissioners (BOCC).
Who carried out the HIA?	Colorado School of Public Health (CSPH). Supported by the Pew Health Impact Project who funded consultation support from an HIA expert organisation.
Who funded the HIA?	See above for part funding.
Aim of the HIA.	Address community concerns regarding future land use decisions and to provide specific health information in relation to the developer's plans for natural gas extraction. Also to provide a qualitative and quantitative analysis of existing environmental, exposure, health and safety data relating to the local community.
Stakeholder Engagement.	Stakeholders for the developer's drilling plan included residents and community groups, the developers and other operators and service providers (for example medical, and water providers).
Methodology.	Generic HIA methodology.
Scope	Screening and scoping identified eight areas of focus, air emissions, water and soil contaminations, traffic (truck), noise/light/vibration, health infrastructure, accidents and malfunctions, community wellness and economics/employment. Each area was reviewed using literature on physical, mental or social health.

Appendix E cont Dissemination of the 3 HIAs

HIA	Battlement Mesa
Date, time frame and point at which the HIA was carried out.	Draft report 2010. 2009 the Battlement Mesa Service Association (homeowners association) requested BOCC and CSPH for them to address health concerns before development began. BOCC requested the HIA by CSPH, before the developers submitted their Land Use Review and Comprehensive Drilling Plan (late 2010) for permit consents – of which these documents would play a part in the HIA (they weren't submitted by the time the HIA was completed).
Assessment of Health Impacts.	Seven attributes were devised by the HIA team to rank the health impacts. Examples of the attributes include positive or negative, relationship to geography to health effects (based on demographic health profile) and proximity to proposed gas development site, the likelihood of health effects occurring and vulnerable people considered affected by a stressor – area of concern.
Limitations.	Only limitations to the health profile were mentioned. No specific stakeholder engagement appeared to have been conducted as part of the HIA with previous stakeholder meetings used for screening and scoping purposes.
Opportunities.	None mentioned.
Consultation/pre-consultation.	Eight mentions of consultation but none appeared to be relevant in terms of actual consultation nor pre-consultation.

Appendix E cont Dissemination of the 3 HIAs

HIA	Battlement Mesa
EIA	No mention of EIA in the HIA but two references have the focus on EIA, human health and one referenced to integrating health and EIA.
Other	Used previous documentation, studies and reports of baseline health data. Community in a prime gas location and witnessed a previous 'boom or bust' scenario. Number of previous community groups had met to express their concerns over the proximity of the proposed gas extraction development. Health concerns at these meetings included:- • Air quality. • Water and soil contamination. • Fires and explosions. • Motor vehicle accidents and • Changes in community, 'liveability.' Question – are these stakeholder meetings part of the HIA?
Recommendations and/or Conclusions.	Recommendations • Promote Pollution Prevention. • Protect Public Safety and • Address Boomtown Effects. Next Steps • Establish Baselines. • Enhance Environmental Monitoring. • Ensure Transparency and • Enhance Current Regulations.

(Witter *et al.*, 2010).

Appendix E cont Dissemination of the 3 HIAs

HIA	Lancashire
Who commissioned the HIA?	Lancashire County Council (UK).
Who carried out the HIA?	Ben Cave Associates (BCA).
Who funded the HIA?	Lancashire County Council (LCC).
Aim of the HIA.	Purpose of the workshop (stakeholder engagement) was to, 'solicit local views on issues associated with shale gas exploration and extraction and health and wellbeing.'
Stakeholder Engagement.	Two structured workshops, facilitated by Ben Cave Associates. LCC organised the publicity and venues.
Methodology.	Generic HIA methodology – although this report is the Community Engagement Report associated with the HIA.
Scope	N/A.
Date, time frame and point at which the HIA was carried out.	2014
Assessment of Health Impacts.	Responses from the workshops were recorded against a schedule of determinants of health relevant to the exploration for and extraction of shale gas, but this was not commissioned to be aligned against, 'grey or published literature.' The schedule domains were as follows:- • Environmental factors. • Economic factors. • Social factors. • Personal factors and • Access to services/facilities. Any language used was organised into formal language and that language that had potential impacts on health and well-being had a public health alignment to align with the determinants of health schedule.

Appendix E cont Dissemination of the 3 HIAs

HIA	Lancashire
Limitations.	General commentary to undertake HIAs stating in order for this as a pragmatic approach it is somewhat dependent on human and financial resources available.
Opportunities.	For local communities to have their say and express their views.
EIA	There is mention of the legal standing and intention of EIA and that HIAs may be submitted alongside EIAs as part of a planning application.
Other	N/A
Recommendations and/or Conclusions.	Recommendations • The developer 'needs to be guided by the four values for HIA as laid out in the Gothenburg Consensus paper.' • Changes to regulations. • Transparency. • Public confidence is elicited by LCC taking the lead with HIA. • To conduct full HIAs prior to any planning and consent determination. • Overview of the UKs energy policy. • Emergency planning and preparedness. • Assessment – of existing community health data. • Differences between US and the UK. • Local communities need help and support. • Future consultation events, wider invites are circulated.

(Lancashire County Council Cabinet, 2014).

Appendix E cont Dissemination of the 3 HIAs

HIA	Scotland
Who commissioned the HIA?	Scottish Government (SG) in 2015.
Who carried out the HIA?	Health Protection Scotland although a collaborative effort from various organisations such as, planning departments, British Geological Society and environmental health departments.
Who funded the HIA?	Scottish Government.
Aim of the HIA.	Three questions were asked by SG and summarised below; 1. What are the potential risks to health? 2. What are the wider health implications of deploying the technology necessary for the exploration and exploitation? 3. What options could there be to mitigate any potential adverse impacts that are identified.
Stakeholder Engagement.	Not applicable.
Methodology.	Generic HIA methodology.
Scope	Using the following definition of health. 'Health is defined broadly and includes positive wellbeing as well as ill health. The HIA process includes consideration of evidence in health status directly associated with exposure to specific (environmental) hazards. HIA is also specifically intended to consider wider health impacts; meaning indirect health outcomes associated with the psychosocial and socio-economic consequences of introducing a new policy or technology, such as UOG.

Appendix E cont Dissemination of the 3 HIAs

HIA	Scotland
Scope cont	The purpose of this HIA was requested by SG that the HIA, 'should consider generic issues that might arise from unconventional oil and gas extraction, rather than predicting the health impacts of a specific proposal in a specific location and who in the defined population will bear such impacts.'
Date, time frame and point at which the HIA was carried out.	2016
Assessment of Health Impacts.	Issues were taken from a variety of community group views, industry and previously published issues. Issues and evidence included:- • Generally evidence was deemed inadequate as to whether UOG would pose a risk to human health. • A number of environmental hazards were explored against available evidence including, water and air borne, seismic activity and silica on workers' health. • The HIA reported, 'ambivalent views' within an evidence context in regards wider health implications. Highlighted self-reported concerns, stress and anxiety as well was traffic-related impacts, housing, loss of community identity, control and social capital and inequalities in the distribution of these impacts. The HIA also states that whilst it is recognised that these impacts are regarded as wider determinants of health, the evidence that was reviewed did not make any direct or indirect links associated with UOG.

Appendix E cont Dissemination of the 3 HIAs

HIA	Scotland
Limitations.	Whilst not a limitation it should be noted that this was a undertaken and requested very generic HIA and focused on potential health impacts as opposed to impacts on communities to support SG on the development of further UOG policy.
Opportunities.	
Consultation/pre-consultation.	
EIA	
Other	
Recommendations and/or Conclusions	Summary of relevant conclusions • There are inadequacies within the regulatory framework and as such local community engagement and local HIAs to be considered. • If UOG was to be permitted in the future in Scotland a precautionary approach should be adopted, whilst being proportionate to the development and therefore the potential hazards.

(Health Protection Scotland, 2016).

Appendix F Respondents Comments

Respondents comments are reproduced below and include the unique reference number allocated to them by the BOS package.

Question 1. ‘Have you heard about Hydraulic Fracturing?’

Media

A small amount of information from newspapers/news websites (Guardian, BBC), though only minimal based upon media political biases. 242921-242914-19204065

Nationally there is political influence so there is severe bias. Only a few give the actual story, as opposed to the "opinion" of government and the industry. the guardian is generally accurate on fact. 242921-242914-19207992

I'm exposed to this but always question who is providing the information and what their motives are. 242921-242914-20143874

Television news channels providing coverage and debate on the subject. 242921-242914-20265749

Various, although most not worth much.242921-242914-19204819

Most protest groups worldwide are in touch via social media so actual experience is available .242921-242914-19207992

Formal Consultation Process

Occasional planning consultation, though as a former planning Councilor, I find these events incredibly staged and heavily biased in their information towards the applicant. In my experience, decisions also appear to be made before hand and these events are just lip service to the democratic/planning system. 242921-242914-19204065

Information Open Events

regulators' roadshow was a joke, none of the agencies charged with regulating fracking could define "Gold Standard" regulation the government purports to exist. 242921-242914-19207992

I intend on visiting my local Information event held by INEOS in Long Eaton, Derbyshire in March. 2017242921-242914-19314123

Government Reports

As with media and formal consultations, these are usually heavily biased politically, but can be a good source of information if viewed carefully and followed up with FOI requests. 242921-242914-19204065

House of Commons Library. 242921-242914-19204819

Academic Reports

Numerous studies. Yale University, Johns Hopkins PHE, BMA, ReFINE (Newcastle University) Other University studies, BGS, New Scientist, Lancet, The Ecologist. 242921-242914-19193259

The ReFINE project in Newcastle/Durham. Too many academic articles to cite all at one. Jackson et al. (2014) give a good overview. Elsworth et al (2015) on seismicity in the U.S. midcontinent is a good article. Montgomery and Smith (2006) is a good article on the history of fracking. The Keep Moving Report from Liverpool John Moors provides a good insight into policing at Barton Moss. Joanne Hawkins report on Fracking (Minding the Gaps) has been influential.242921-242914-19314123

I do take note of various academic reports, due to their usual high degree of expertise. However, they can also be heavily biased, particularly those written by pro-industry academics, or those funded by the industry. I always try and source truly independent research wherever possible. 242921-242914-19204065

Other

I live in Roseacre and have spent the last 4 years researching and reading. I cannot possibly list every paper I've read. 242921-242914-19193636

Freedom of Information Act requests can usually provide more detailed information than any of the above in relation to specific sites/issues 242921-242914-19204065

Question 2. Are you familiar with the Hydraulic Fracturing Process?

Media

Mainly through online reporting- in particular some of the reports that have come out of the US where they have described impacts on communities and as part that provide information about the process. 242921-242914-20138169

As previously explained, due to my being directly affected by fracking operations i have read *pretty much every article, report and investigation published in the last 4 years. It is impossible to list evert article ive studied. 242921-242914-19193636*

Very little information from media sources, because it is usually overly simplistic and gives a false impression - sometimes, I suspect, intentionally. 242921-242914-19204065

fracking nightmare Ian Crane .main stream trivialises it .242921-242914-19200609

Protest Groups/Forums

When I first became introduced to this topic I did find out some information on the processes via Facebook groups, but these, too, can sometimes not be 100% accurate when describing the actual processes and stages involved 242921-242914-19204065

Formal Consultation Process

All where there is relevant peer reviewed literature 242921-242914-19194869

Information Open Events

EA PHE + 2 others at long lane Ormskirk. 242921-242914-19200609

Various Oil Industry and Environmental Presentations 242921-242914-19203719

Some information has come from open information events, but depending on the organiser, these can also be biased and present information in different ways that, in the case of industry/pro-industry events, don't always tell the whole truth 242921-242914-19204065

Government Reports

can be difficult to read but persevere 242921-242914-19212032

Two government reports (DEFRA, DCLG) established that the worst impacts would be suffered by the local communities. Dr Damien Short's research shows no community which he visited which originally welcomed the industry would do so again. As Prof. Michael Stephenson of the British Geological Society (BGS) said in a lecture at the LSE Energy Society, Shale Gas and Fracking: the Science behind the controversy last month (Feb

23rd, 2016) "There is no doubt that this is a very dirty, noisy industry" and "You should never frack near or close to a fault line!"

242921-242914-19194869

Academic Reports

Numerous ones. I always check expert comment from Energy in Depth
242921-242914-19201100

Other

There are so many things that go into the process of hydraulic fracturing, it is not possible to write down all the sources of information I have for this as it would take several hours. The above answers to q2a are just a couple of examples. I do get some information from company websites such as Cuadrilla.
242921-242914-19314123

Visited industry in Pennsylvania and saw fracking first hand and spoke to experts. Discussed the process with fracking engineers.
242921-242914-19193259

Individual experts in Geology; Water; Planning; NORMs and radioactivity
242921-242914-19194869

I've spent 3 years researching this several hours a day!!!
242921-242914-19196180

Evidence of lying by government and shale gas industry
242921-242914-19200609

Question 3. 'Have you attended any official consultation process?

Surrey Council acceptance of Surrey anti-fracking group petition

242921-242914-19193316

Meeting with the EA Oil and Gas team. Several industry information events. Local Authority Planning Events. Meet the regulator events (twice) BGS, HSE, EA and PHE. 242921-242914-19193259

Local events put on by County Council featuring MP, EA, policy and company
242921-242914-19194869

Notts County Council Planning Committee meetings
242921-242914-19196180

Public meetings called by Cuadrilla. Community Engagement meetings, Regulatory body consultations, Planning meetings, Planning permission meetings, Borough Council meetings, Planning appeal meetings, meetings with my MP and government consultations.242921-242914-19193636

Third energy had a meeting with an idiot who spoke of people as receptors. And kept saying we would have gold standard regulations. He was practically laughed off stage. 242921-242914-19236755

Question 3 cont Please state why you do OR don't trust any formal consultation process

I'm not convinced views are always incorporated into final recommendations
242921-242914-19189061

The government is so pro fracking that as civil servants they are unable to discuss some of the risks and impacts openly. The EA particularly is under resourced and has no experience in overseeing fracking operations but will not admit any shortcomings for fear of government criticism. But having met with them it is clear the EA does not have sufficient capacity or expertise to deal with the scale of fracking. The government has altered laws and policies to favour fracking - such as the Infrastructure Act. It was recommended that water should be monitored for 12 months before any fracking took place - but the government changed this to water will be monitored for three months in the 12 month period before any fracking. This is just one example of cutting corners to push through fracking. Hydrogeologists state that aquifers should be monitored for 12 months to correctly assess seasonal changes to the water flow etc. There are numerous examples of this. 242921-242914-19193259

Because the public authorities are not up to the job and what they promise in the way of safety and regulation they are unable to deliver. Several years after the first experience of exploration and initial high volume hydraulic fracks in Lancashire those of us who were sceptical have noticed that the actual experience of world class regulation has been less than perfect. All the exploratory shale gas wells drilled by Cuadrilla in Lancs had some technical difficulty. In addition to 10 breaches of planning conditions, there were 5 examples of drilling problems, three reprimands, as well as accusations of well integrity failure, trespass and damage and several cases where it wasn't clear whether or not Cuadrilla had broken regulations. Meanwhile in Yorkshire, Rathlin Energy exploratory well North of Hull breached 14 permit conditions between early July and mid October 2014 of the same year.
242921- 242914-19196180

(Authors Note: The above paragraph is taken from a long comment highlighting the failure of various authorities to regulate or enforce regulation across the country).

Because it is clear that the decision to Frack has been taken by central government behind closed doors before any public views are sought. Consultation and planning meetings are then held purely as a 'Box Ticking' exercise.242921-242914-19193636

They are usually heavily biased towards a specific end goal, and therefore not all necessary information is provided. From experience, decisions have usually already been made by this stage and these processes are simply lip service to the planning/democratic system 242921-242914-19204065

I have no faith in the hierarchical systems of government, local or national as they are all influenced by lobbyists and information provided to the people in power is simplistic and bias (I have seen it) 242921-242914-19204930 process itself seems ok - it's what is behind it that might be a problem 242921-242914-19206700

The government have decided to "go all out for shale" so consultations are totally useless and opinions against are ignored. 242921-242914-19207992

Corruption can always be present in what seems the most transparent processes. There are many players that stand to gain. The Cuadrilla-Glasgow University funding thing saw the Professor stripped of his Emeritus privileges. The government can override local council decision making (Lancashire). I think one has to analyse carefully what all sides are saying and attempt to decipher the motives and interests of each party. The truth will be there, somewhere, but isn't usually what is been said out loud. However, I also answered 'yes' as I do believe we have to put faith in such things, otherwise what else do we have to regulate what is happening to our land, communities? But we must watch out for what invested bodies stand to gain (or not) and be alert to the possibilities of spin, holding back of information. 242921-242914-19240080

Although I may not agree with the results, consultations provide an important opportunity for stakeholders, regulators and persons of significance to meet and discuss fracking in a formal environment. Surely that is a good, democratic process. The Secretary of State being able to overrule decisions of the Local Planning Authority however, is a shambles and more akin to autocratic processes. 242921-242914-19314123

I guess I'd need to be convinced that it was impartial.... 242921-242914-20412005

Question 4. Hydraulic Fracturing is often referred to as ‘Fracking’ – how does this make you feel?

I think it is an aggressive, threatening word. 242921-242914-19189061

It makes everyone feel like its a dirty word. It should be renamed "staying warm in winter" *242921-242914-19196112*

Annoyed - since the main problem is unconventional gas field development with all its processes and installations at scale - and the word fracking focuses attention on what is likely to be the least of the problems. *242921-242914-19196180*

Depressed, angry and helpless because no matter what the Effect on me or my community and no matter how many of us scream "No," our voices, opinions, health and welfare are ignored by politicians who lie to our faces and care nothing for our concerns, our safety or our lives. 242921-242914-19193636

Fine, though I know it upsets a lot of older people I know. 242921-242914-19204930

As it is about breaking something apart, it does give a fear of something akin to an earthquake. I'm sure if I lived near to a proposed site I would feel very anxious to hear this word. 242921-242914-19205486

Fracking explains only one part of a much larger process. Fracking is the use of high pressure to stimulate wells to release gas. However, you cannot have that specific act without the overall process (from consultation to the setting up of wells to production and decommissioning). So to me fracking does include the whole process. I don't really like this question 'how does this word (fracking) make you feel?' It is almost a loaded question. However, fracking makes me think of fossil fuels, gas and oil which is the reason for the use of the technique of fracking. Fossil fuels to me are old-fashioned, unsustainable and an archaic means of generating consumable energy. Although the government describes fracking as a 'bridge to a low carbon future' the right thing to do morally, as well as legally (following the Climate change Act 2008 reducing baseline levels to 80% of 1990 level; also COP 21 etc.) is to pursue renewable forms of energy as quickly as possible. Yes shale gas could play a part in that transition, but it should not take away from investment on renewables which, unfortunately, is the current state of affairs. 242921-242914-19314123

I associate it with hysteria rather than facts and evidence 242921-242914-19967672

No effect - it's just a technical term to describe an industrial process. 242921-242914-20096929

Neutral; it's a good description 242921-242914-20164864

Like I'm reading a media article not anything written by a subject matter expert. 242921-242914-20266920

Neutral, it has both positive and negative connotations. It just describes a process. 242921-242914-20305762

The word fracking has negative connotations and can be used by the media to suggest a dirty process 242921-242914-20582755

Question 5.

Do you live, work, attend or pursue leisure activities near a proposed Hydraulic Fracturing site? If you marked any of the above distances for any activity, please state below how this makes you feel:

I feel normal because it is more than 500 metres away. 242921-242914-19193580

It makes me very angry. The government has changed laws and policies to facilitate this industry and completely ignores the feelings of local people. They took away our trespass rights and can frack under our homes without even informing us. Planning laws have been changed to favour fracking. The government care nothing about our lives, health, homes community or countryside. Fracking has been banned in numerous countries and there is a moratorium in Wales, Scotland and Northern Ireland - yet the English are having it forced on us against our wishes. There is no adequate compensation available and this adds to worry and stress. I have been to Pennsylvania and seen what living with fracking is and it makes me incredibly angry that the government is downplaying and ignoring the impacts. I have never felt this way before, I have lost faith in the government - completely. 242921-242914-19193259

worried. Will my house fall down? 242921-242914-19968497

Rather than merely saying 'Under 5 Miles,' try I live 500 metres away. My property value has been slashed, my health has been hugely adversely affected and everything I've spent my life working towards for my retirement snatched from me. I obviously don't matter and shouldn't have bothered. Clearly neither I nor my life mean anything to politicians. 242921-242914-19193636

I'm retired so work is not relevant. It doesn't bother me being near a fracking site anymore than it would being near any other industrial activity such as a factory or new build housing estate. 242921-242914-19198240

I have never been impacted by fracking meaningfully yet there are wells very near my home. 242921-242914-19196112

Makes me feel a victim. Trying to do something healthy but always aware that there may be unseen dangers that could affect my health makes me feel exploited and very uneasy. 242921-242914-19212032

Concerned for myself and my family and very angry at the government's disregard for well documented evidence of the dangers of this process in any place. 242921-242914-20143874

Question 6…….respondents were asked what they 'see or feel the Social Health Impacts on communities and individuals might be?'

Stress, disturbed sleep, anxiety, tension and fear of the future. Inability to relax. 242921-242914-19189061

The people around PNR and Roseacre have had severe mental impacts for years with the worry stress , lack of sleep . Many people became involved because they felt the earthquakes and their houses or land was damaged. Fracking companies will tell you Prove it then and people can't afford to go to court .Only the very rich now can get justice in this country 242921-242914-19200609

Fracking has made a massive positive impact on social health by clearing the air of much carbon associated with coal production. It has also had an incredibly positive impact on health from all of the jobs and opportunity that it has created. The negative impacts of fracking are tied to the misinformation that is spread by organizations such as Friends of the Earth. These organizations terrify people with their scare stories of cancer and bad water, plummetting home prices - none of which are they able to prove. It is a shame, but they have had meaningful negative impact on social health in and around communities where fracking will take place. 242921-242914-19196112

Cuadrilla and our government acting in concert have stripped away any feeling of well-being. They have made my life a living hell. Even when the planning inspector said after a 6 week inquiry, that Roseacre was not suitable for fracking and that planning permission should be refused the Secretary of State, Sajid Javid, disagreed, said he thought she was wrong and that regardless of her findings he was 'Minded' to allow fracking to go ahead. In his mind I clearly have no rights to any say over my life, all my life's plans for my retirement are dashed at one stroke of a pen by a man who doesn't see fit to so much as answer one of my letters. I may as well be dead. 242921-242914-19193636

I don't think people will be effected any more than they would be by any other industrial activity in their area.242921-242914-19198240

Substantial mental strain in the form of stress, worry, insomnia, depression/anxiety. This can then produce more physical symptoms. Having experienced the (lack of) 'Gold Standard' regulations and the many incidents at sites across the country, issues such as odour releases, noise, light and traffic also have a significant impact upon peoples' health and well being Illegally discharging fluids at Horse Hill made several people very ill from the smell, though this was denied by the company and the EA (who based their 'investigation' purely upon what the company had told them - info found out via FOI requests). 242921-242914-19204065

Depends on location. Some positive impact on jobs, some possibly filled by incomers. More money for local economy in general. 242921-242914-19204819

Communities are affected even before any planning application now that we are aware that seismic surveys are taking place. The earlier communities had no idea they are happening. Stress even before is tremendous. Raising awareness in the community, gathering opinion, forming a group against, responding to planning applications, going through the process, decision, appeal, public inquiry then the fallout when the Secretary of state overrules local democracy. All this affects health and well-being even BEFORE hydraulic fracturing occurs. 242921-242914-19207992

Increased levels of worry and stress, and physical health problems if fracking goes ahead. 242921-242914-19229667

A definite impact on emotional wellbeing with the uncertainties surrounding the safety concerns of fracking. Heightened levels of stress linked to the above. 242921-242914-19988414

Uncertainty and anxiety. It casts a long shadow. 242921-242914-20181460

I think people are getting needlessly stressed out over this. This is whipped up by 'professional' protesters who are in denial about what our energy needs are and how we can best achieve them. 242921-242914-20103721

Question 7. Do you have any concerns or issues if Hydraulic Fracturing goes ahead near you?

Start by reading the New York Compendium. There you will find 900 peer reviewed scientific reports into the dangers and adverse outcomes of Fracking. We are told that none of this can happen in Britain because we have Gold Standard Regulations. Only no-one can tell you what Gold Standard means or what such regulations are. Due to budget cuts there are insufficient inspectors to enforce any regulation whatever standard it is. So we have a mass of scientifically proven hazards with no inspectors available to enforce regulatory compliance. 242921-242914-19193636

I'd be pleased that our national energy supply was being provided locally and providing jobs for local people rather than providing revenue for anti-democratic regimes like many in the middle east and Russia. 242921-242914-19198240

My real concern is that the protesters will block roads and create a general nuisance for the community. 242921-242914-19196112

yes that the community will be listened to by the operator and that activists from outside will not be accepted into our community. That I can speak about the subject both for and against without judgement 242921-242914-19201635

Greenhouse gas emissions; dangerous emissions - methane, ethane, Volatile organic compounds; radon, NORM contamination; seismic activity leading to fractured well casings and degraded cement seals and therefor water contamination; airborn silica; noise; light pollution etc etc - all leading to cardio vascular problems, neurological problems, asthma, skin problems, mental health problems, social conflict - sexually transmitted disease and drug addiction - particularly if the US experience is anything to go by methamphetamine addictions (from transient young men working in the industry without any loyalty to the place trying to stay awake long hours) accidents...damage to local economies (tourism, agriculture with soil and water contamination from spills etc); bills to the local authority for road damage, bills to the local authorities to clean up the mess when the industry goes bust - partly because the OGA is not doing its job properly in regulatory oversight....etc etc 242921-242914-19196180

In addition, my town is riddled with coal mines, one 50' away from my house. It doesn't take a science degree to work out what extra damage a frack inspired earthquake might do to properties and the road infrastructure. The worry about fracking (a license has been sold for this area) has already affected my wellbeing - I lost £1000 in income last year just from the time spent studying the problem. I use the local countryside to keep my well being and mental health in shape a doctor's prescription in effect. If all that countryside is covered in fracking wells and surrounded by their toxic waste, where am I to go? Politically, it looks like the local council have little urgency towards fracking, their local plan seems to be intent on building as many houses on the greenbelt which would also be potential frack sites, thereby a sullied attempt to wash themselves of the politically unsurmountable problem. 42921-242914-19197948

yes that the community will be listened to by the operator and that activists from outside will not be accepted into our community. That I can speak about the subject both for and against without judgement

242921-242914-19201635

I'm based in London where my council has announced itself a frack-free zone. However that doesn't mean that it could never happen and I would be very concerned. Health in terms of noise; environmental concerns in damaging green spaces and wildlife habitats ; flawed consultation processes; health of eventual workers on site; climate change impacts e.g. particularly methane emissions 242921-242914-19205486

Threat to livelihood as a cattle farmer, pollution, water contamination, cattle deaths, light pollution, increased road traffic, industrialisation of the countryside. 242921-242914-19229667

Massive concerns, polluted water, air, light pollution, wildlife, flora , fauns SSSIs, traffic noise pollution and damage to environment and socially, travel. Irrevocable damage, inherited health issues and blight on the areas thru this process. Concern for next generations. Proliferation of fracking areas. not any proper control of fracking process. democratic process not adhered to, being over-ruled by Govt. Majority of people don't want it. Ridiculous claims by fracking companies. Safety aspects of this industry
242921-242914-19212032

I am concerned about the rumors and expect company and Government scientists to investigate the processes thoroughly and answer questions truthfully. Clearly, it needs to be well regulated but we do need to go ahead to confirm the process is safe or otherwise. 242921-242914-20096929

No. Not if it is registered and regulated stringently
. 242921-242914-19193580

No more than I do about many industrial processes.
242921-242914-20586020

Question 8. Do you think there are any opportunities or benefits if Hydraulic Fracturing goes ahead near you?

It will help reduce CO2 emissions, it will have minimal land impact (relative to solar and wind), it will create tens of thousands of jobs (direct and indirect combined), it will lower gas prices to an extent, it will help those who suffer from fuel poverty, it will create greater energy security, it will ensure a reliable grid, it will allow the government more independence to pursue foreign policy initiatives that are in keeping with the UK's core values and interests, it will create significant wealth in communities that host the industry, it will create large amounts of wealth for the UK, it will create significant tax revenue for the government, it will serve as a bridge to sustainable renewable investments. BTW, it should be noted that the definition of "sustainable development" according to the Brundtland Report, are those developments that first meet the needs of the poor. Fracking for gas is much more sustainable, in the light of this qualifier, than wind/solar/tidal/biomass forms of power generation.
242921-242914-19196112

It will wake people up to the limits of economic growth - how we are in a phase of uneconomic growth where costs exceed benefits - and that the public authorities have not got a clue - so they are on their own and have to organise to defend themselves. 242921-242914-19196180
Extremely limited employment for a very few people. Get rich quick for even less. Fracking will not bring social or economic benefits to those in need
242921-242914-19197304

There are none. Fracking is a boom and bust industry. It is incompatible with our climate change obligations under the legally binding Paris agreement and it is totally unnecessary in terms of energy security or continuation of supply. 242921-242914-19193636

I hope that locally produced gas will displace coal from electricity generation and thus reduce UK CO2 emissions, as has happened in the USA. I hope locally sourced gas will gradually improve the UK's energy security. I hope local economies will benefit from new economic activity in their area, including new jobs and a share of tax revenue.
242921-242914-19198240

Energy security Wealth for the UK
242921-242914-19200632

Yes. Economic benefit. Tax revenues and jobs
242921-242914-19201100

none whatsoever
242921-242914-19200609

yes, local clean gas with a lower carbon footprint and increase energy security. more jobs, increased house prices.
*242921-242914-19201*635

Reduced imports of gas improve wealth and health of our nation
242921-242914-19207685

No. Already the communities near the Chelford sand quarry, Knutsford PEDL are suffering stress. The Sibelco planning application states 5 new jobs will be created over 12 years. That is not enough of a justification to the community. Sure they will increased pay business rates to council but they already do...you can't miss what you never had...I'm worried the landscape will change beyond repair.242921-242914-19240080

Community benefits (eg. Ineos community Payments/shale gas wealth fund) Opportunities for local firms (contractors, accommodation providers, local services and shops) Taxes to local council. National benefits (decrease imports of gas, overall tax take nationally etc)
242921-242914-19289847
#
Cheaper energy
242921-242914-19964384

It might make some more employment in the area. Perhaps fuel prices in the area could be cheaper to offset reduced house prices?
242921-242914-19947537

Fuel security for the UK
242921-242914-20092380

Fuel security for the UK
242921-242914-20092380

Yes it will provide jobs and it will Also allow
Us to have our own resources so we will
Not have to go to other countries to obtain these gases
242921-242914-20131024

Gas supply ensured
242921-242914-20144460

It will just be another energy source which is under the UK ownership and will reduce the reliance on gas lines from other states.
242921-242914-20305762

Question 9. How important do you think it is to have a range of energy sources?

Our sources are very secure - as stated by the Oxford Energy Institute. The UK already has infrastructure in place to readily import hydrocarbons - we have conventional gas imported by pipe from Norway. The UK has an import paranoia and a dreadful energy strategy. We should import hydrocarbons until carbon zero technologies mature and once we can rely upon these we will have a completely secure supply, and most of all - it would tackle climate change. There is no need to frack. To avoid catastrophic climate change we should keep all new reserves of fossil fuels in the ground. Energy demand and demand for gas in the UK is actually declining and if we invest in carbon zero energy - it will continue to fall. 242921-242914-19193259

Wind provision has just overtaken coal in UK energy provision; Solar has overtaken other means in Europe and is leading in Africa and Asia. Today's news was about the use of a lagoon in Swansea bay provided the impacts on wildlife such as birds and fish can be addressed and understood. The key issue is to address Climate change as an urgent matter which means moving away from fossil fuels and Sustainable Development taking into account Social, Economic and Environmental impacts. 242921-242914-19194869

According to recent figures, the UK sources almost 20 percent of its gas from Russia. It also sources a significant portion from Qatar. Imports will grow in the future as North Sea production declines. You can always get gas, the question is how much will you pay for it and how much do you want to be beholden to foreign governments. Also, importing gas is much more harmful to the environment than using homegrown gas because of fugitive emissions, transportation, and liquification energy (for LNG).The grid is not stable now, there is not security of supply. Heavy investment in renewables will make the problem worse at this point. 242921-242914-19196112

Not at all secure. As an ecological economist I cannot even begin to express myself in this framework of yours. For example it does not address intermittancy for renewables which is a major problem. Nor does it give any place for the most important and urgent priority of all - which is massive energy saving and energy efficiency work. (Incidentally I do not

have any belief in the effectiveness of carbon capture and storage - another example of optimism bias and hubris by engineers...
242921-242914-19196180

Not secure
242921-242914-19200632

probably very insecure

242921-242914-19194224

Very poor
242921-242914-19201100

there is enough conventional gas to see us through transition to renewables. Shale gas is a Ponzi scheme ,
242921-242914-19200609

not very, we import of 50%
242921-242914-19201635

At whim of foreign powers; unreliable. Renders us vulnerable.
242921-242914-19245410

Very secure. Research indicates that far from being an issue of supply, the biggest threat to energy security, and the biggest cause of power loss is the ageing cable and pipe infrastructure 242921-242914-19204065

The need to invest in renewables cannot be ignored if we want to save the planet for future generations and ourselves 242921-242914-19212032

Not secure at all. Supplies are finite, and sources in other countries are subject to political unrest between nations. The impact of current energy production can no longer be ignored e.g. climate change.
242921-242914-19954084

Not so secure need as many alternatives as possible rather than nuclear
242921-242914-19960468

Not really. Nuclear power stations make me nervous, what with the various disasters that have occurred around the world, and we don't seem to invest in ways that are not damaging. 242921-242914-20110527

Appendix G Questionnaire Analysis and Evaluation

No	Question	Analysis Difficulties or Positive Aspects	Questionnaire Evaluation
1	Have you heard about Hydraulic Fracturing	Would people be likely to fill it in if they hadn't heard about it? So, does that naturally mean people who haven't heard about it won't fill it in. although by answering 'no' it can still take you Q9.	Yes/No Closed Question. The title and explanation of the research appeared to have captured the interest of those who opened the questionnaire. All but one person who opened it continued to completion.
1a	Where do you get your information from?	Maybe too much information for people to list.	Open Question. Respondents were willing and able to provide a wide range of sources of information, so the concerns from the author were unfounded. It offered the respondents the opportunity to share from where they gathered their information.
2	Are you familiar with the Hydraulic Fracturing Process?	Although similar to Q1, it is important to establish the difference between whether respondents understand about the process as opposed to just having heard about it. If respondents hadn't heard of hydraulic fracturing, they wouldn't be familiar with the process.	Yes/No Closed Question. Over two thirds said they were familiar with the process. However, those who were not familiar with it, still continued to answer the rest of the questions. So not deterred by giving a negative answer at this point.

Appendix G cont Questionnaire Analysis and Evaluation

No	Question	Analysis Difficulties or Positive Aspects	Questionnaire Evaluation
2a	Where do you get your information from?	Maybe too much information for people to list.	Open Question. Respondents were willing and able to provide a wide range of sources of information, so the concerns were unfounded. Question 2 did not appear to differentiate markedly from Question 1.
3	Have you attended any official consultation process?	Possibly not many official consultations have as yet taken place. However, it will be interesting to see what respondents say and establish what they class as official consultation process.	Yes/No. Closed Question The question did not establish what respondents classed as official consultation. Perhaps an example of what constitutes a formal consultation might have gathered more accurate information.
3a	Please give details of formal consultations attended.	To give support to the previous question of whether formal consultations have been attended or whether there are other events related to hydraulic fracturing which respondents may perceive as formal consultations.	Open Question for comments. See comments above.
3b	Do you feel you can trust any formal consultation processes?	To gain some measure how useful formal public consultations are in conveying information about hydraulic fracturing.	Yes/No Closed question. Extremely informative information gathered.

Appendix G cont Questionnaire Analysis and Evaluation

No	Question	Analysis Difficulties or Positive Aspects	Questionnaire Evaluation
3c	Please state why you do OR don't trust any formal consultation process	To assess the levels of trust.	Open question for comment. Extremely informative information gathered.
4	Hydraulic Fracturing is often referred to as 'Fracking' – how does this make you feel?	To allow on reflection whether the word itself might influence people's attitude to the actual process.	Open-ended question The question elicited . quite strong feelings against the word so appears successful in gathering informative responses.
5	Do you live, work, attend an educational facility or pursue leisure activities near a proposed Hydraulic Fracturing site?	This question was asked to establish how near or far people were to a potential site as to whether they did or didn't like the idea of hydraulic fracturing because it was close to them or whether it was more about getting on the band wagon.	Closed question. Ambiguous in retrospect. Should have been another question asking people if they knew where the nearest activity or proposed activity was and followed up with the mileage/activity charts.
5a	Please mark relevant distances relating to whether you live, work, attend an educational facility or pursue leisure activities.		Multiple choice question.

Appendix G cont Questionnaire Analysis and Evaluation

No	Question	Analysis Difficulties or Positive Aspects	Questionnaire Evaluation
5a cont	If you marked any of the above distances for any activity please state how this makes you feel.		Open-ended question. Question was successful in gathering information.
6	Health is defined in a broad, non-medical way by the World Health Organisation as *'a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.'* Considering the definition, what do you think, see or feel that the Social Health Impacts on communities or individuals might be from Hydraulic Fracturing?	Respondents' understanding of a very conceptual definition. Are respondents so very focused on the medical health impacts that they haven't had opportunity to consider what they may see as Social Impacts	Open-ended question. There was frequent emphasis on the medical health issues but any concerns that the respondents might not understand the concept of social health were unfounded. A question that provided a great amount of rich contextual information.

Appendix G cont Questionnaire Analysis and Evaluation

No	Question	Analysis Difficulties or Positive Aspects	Questionnaire Evaluation
7	Do you have any concerns or issues if Hydraulic Fracturing goes ahead near you?	This question was asked to identify any specific concerns or issues people may have.	
8	Do you think there are any opportunities or benefits if Hydraulic Fracturing goes ahead near you?	An opportunity to state any positives or benefits if hydraulic fracturing took place near to them.	
9	How important do you think it is to have a range of energy sources?	This question was included to ascertain a generic understanding of respondents' insight into the UK's energy sources. Given shale gas exploration is so contentious it seemed appropriate to gauge how much respondents actually knew about alternatives or different sources.	
9a	Taking into account what you might have read or heard, how secure do you think our current energy sources of Gas and Electricity are?	Open Question for Comments.	The last section of the question might have been confusing and perhaps would have been better placed as the first part of the question. Nevertheless, the information gathered was still of value.

Appendix G cont Questionnaire Analysis and Evaluation

No	Question	Analysis Difficulties or Positive Aspects	Questionnaire Evaluation
10	Would you consider being involved in further independent community consultation, such as a focus group, as part of this research?	Given that there appeared to be some resistance to focus groups, in the original data gathering plan, this question was asked to either verify or nullify that resistance.	Closed question. Successful in gathering a number of positive responses to be researched further. Information for author's future use.
Extra	A selection of demographic data questions was asked.	To determine the constitution of the respondents.	Closed question Useful and interesting results. .
Final	If you have any further comments to add about the subject matter or the questionnaire.	Asked in case the author had overlooked anything respondents would have expected to be asked.	Open-ended question. No further comments were added.