



European Union Network for the Implementation
and Enforcement of Environmental Law

Future Energy Needs and the Regulation of the Subsurface

*Environmental Protection and the management of risk from the use of the
subsurface as an energy resource.*

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Introduction to IMPEL

The European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) is an international non-profit association of the environmental authorities of the EU Member States, acceding and candidate countries of the European Union and EEA countries. The association is registered in Belgium and its legal seat is in Brussels, Belgium.

IMPEL was set up in 1992 as an informal Network of European regulators and authorities concerned with the implementation and enforcement of environmental law. The Network's objective is to create the necessary impetus in the European Community to make progress on ensuring a more effective application of environmental legislation. The core of the IMPEL activities concerns awareness raising, capacity building and exchange of information and experiences on implementation, enforcement and international enforcement collaboration as well as promoting and supporting the practicability and enforceability of European environmental legislation.

During the previous year's IMPEL has developed into a considerable, widely known organisation, being mentioned in a number of EU legislative and policy documents, e.g. the 7th Environment Action Programme and the Recommendation on Minimum Criteria for Environmental Inspections.

The expertise and experience of the participants within IMPEL make the network uniquely qualified to work on both technical and regulatory aspects of EU environmental legislation.

Information on the IMPEL Network is also available through its website at: www.impel.eu



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<p>Executive Summary</p> <p>This paper has been produced to report on the two day IMPEL workshop held in the UK on 25/26 February 2020. The workshop provided a forum for the examination of the development of new energy sources, with reference to regulation and environmental protection.</p> <p>Several of the workshops focused on recent work in the UK around shale gas and with specific case studies about the work undertaken at the Preston New Road hydraulic fracturing site in Lancashire UK. The regulatory work undertaken in relation to shale gas will find new applications in the emerging energy sectors, as such the other workshops focused on new and emerging energy issues and potential methods of regulation.</p> <p>Several other themes were discussed during the day in the context of the regulatory roles of the various organisations present and where there may be gaps in legislation, policy or expertise. The workshops were attended by environmental regulators from Estonia, Turkey, the Netherlands and the UK (Wales, Scotland and England) and by representatives from the British Geological Survey.</p>	
<p>Disclaimer</p> <p>This report is the result of a project within the IMPEL network. The content does not necessarily represent the view of the national administrations or the Commission.</p>	



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IMPEL 2020 Geothermal, Ground Source Heat, Micro Seismic Monitoring and Produced Water Reinjection

Chapter 1 Introduction

1.1 Project Overview

This paper has been produced to report on the two day IMPEL workshop held on 25/26 February 2020. The workshop provided a forum for the examination of the development of new energy sources, with reference to regulation and environmental protection

Several of the workshops focussed on recent work in the UK around shale gas and with particular case studies about the work undertaken at the Preston New Road hydraulic fracturing site in Lancashire UK. The other workshops focussed on new and emerging energy issues and potential methods of regulation.

It is important to understand how the subsurface can be beneficially used as a resource for future energy demands, and to be aware of the potential risks to the environment and people from such activity. This project aims to use the experience of mitigating risks from fossil fuel exploration and exploitation to focus on how several other areas of potential energy use can be regulated and monitored to ensure the adoption of best practice by the industry.

This expands on work undertaken by the IMPEL Oil and Gas Regulation Team to better understand the onshore oil and gas industry with particular reference to the shale gas industry. There is an added focus on potential expansion in other areas of energy production and the management of onshore oil and gas fields with an emphasis on climate change and increased public interest.

These themes were explored at the IMPEL workshop which was held near Nottingham (UK) on the 25th and 26th February 2020.

The workshops were attended by environmental regulators from Estonia, Turkey, the Netherlands and the UK (Wales, Scotland and England) and by representatives from the British Geological Survey.

The first day was held at the offices of the British Geological Survey (BGS) (<https://www.bgs.ac.uk/>). Founded in 1835, the British Geological Survey (BGS) is the world's oldest national geological survey and the United Kingdom's premier centre for earth science information and expertise. The BGS provides expert services and impartial advice in all areas of geoscience.



The second day incorporated a site visit to the IGas Welton Gathering Centre (<https://www.igasplc.com/>) to look at how produced water is separated and re-injected into the subsurface. IGas is a leading British oil and gas explorer and developer, producing c.2200 barrels of oil equivalent per day from over 100 sites across the UK.

1.2 Questionnaires

Prior to the event a questionnaire was circulated to the IMPEL members to establish what sub surface energy activities are permitted in different member states and how they are regulated. The responses to the questionnaires were used to inform the programme of workshops. The discussions at the workshops provided an opportunity for member states to share their experiences around issues of:-

- Legislation, regulation, jurisdiction and communication.
- Sharing of good practice.
- Expertise, resources and future challenges.
- Thoughts around how to ensure society transitions to a lower carbon future state of operation.

The responses to the questionnaires are located in **Annex 1**. The information requested in the questionnaires related to the regulation of the following areas of interest.

- Geothermal activities
- Ground source heating and cooling activities.
- The reinjection of produced water from oil and gas activities.

Supplementary questions were asked around each theme and these included permit requirements, types and techniques of monitoring undertaken in relation to seismicity and groundwater quality (including temperature) the remit of the regulatory authorities, new and emerging techniques and the influence of research.

1.3. The Project Workshops

The emphasis of the project was on evidence, what we have learned from regulating the onshore shale gas industry and the challenges we face in the regulation of the sub-surface. There was a particular focus on areas of energy production which are likely to expand in the future. The day included workshops on:-

- The role of the British Geological Survey: Evidence and Understanding the Subsurface.



- Reinjection of produced water at Onshore Oil and Gas sites.
- Use of micro seismic data to inform regulatory decisions and interventions.
- Ground Source Heating and Cooling.
- Geothermal Energy.

The presentations from the workshop are included in **Annex 2**.

2. Chapter two Workshops

2.1. Workshop 1: Shale Gas Research at the BGS and Environmental Monitoring and Risk Assessment.

Our hosts from the British Geological Survey (BGS) gave two presentations regarding Shale Gas Research at BGS and a presentation about how environmental monitoring and risk assessment has been used to introduce the delegates to information about the UK distribution of Shale and roles of the BGS. This was particularly focussed on the role of the BGS in collecting and using evidence to improve understanding of the subsurface. Copies of the presentations are included in Annex 2.

Discussion points included:-

- How much shale gas/oil is there in the UK?
- What are the geological controls on extraction?
- What are the impacts of extraction?
- The need to develop an evidence base for policy making- both in UK, EU and internationally
- Importance of baseline and the need for good data especially for understanding methane related issues.
- Using evidence to support public engagement and information sharing.
- Using base line to monitor changes in methane and groundwater quality.
- Also data collection for air quality and seismicity at Preston New Road.
- Evidence to prove emissions from Preston New Road.



2.2. Workshop 2 Reinjection of Onshore Oil and Gas produced water

Representatives from the Environment Agency's Geoscience Operations Team and Oil and Gas Programme gave a presentation regarding the regulation of and the potential issues around the reinjection of produced water at onshore oil and gas sites. A copy of the presentation is included in Annex 2.

Comments and questions from the discussion about produced water re-injection:-

- The Netherlands currently operate a 5 year evaluation to check for any damage in the reservoir and whether there is any salt layer being dissolved by the process.
- This is made available to the public. They posed the question of whether re-injection is still the best available technique.
- Could produced water be cleaned or treated and discharged to surface water or reused?
- Evaluation in the Netherlands includes seismic monitoring.
- The oil-company NAM does do an evaluation study on the effects of injection every 6 years, which is very extensive. The main report on the last evaluation is over 700 pages and is in Dutch. I therefore recommend not to include this report as an annex to the report of the workshop but to supply a link to the NAM website. Documents can be downloaded from <https://www.nam.nl/techniek-en-innovatie/waterinjectie-in-twente/downloads-waterinjectie-twente.html>. Under the heading "Herafweging verwerking productiewater Schoonebeek" select the "Eindrapport met samenvatting Herafweging verwerking productiewater Schoonebeek – december 2016". The website is best accessed using Chrome or Firefox as browser.
- On the same webpage, under the heading "Diverse onderzoeken en rapportages aan SodM" there are a number of technical reports in English on:
 - Halite dissolution
 - subsidence
 - Induced seismicity.
- Use of the EU Non Statutory Guidance [Hydrocarbon Guidance](#) supports this approach in Netherlands and Wales.



2.3 Workshop 3 Use of micro seismic data to inform regulatory decisions in hydraulic fracturing

A representative from the Environment Agency's Groundwater and Contaminated Land team from the Cumbria and Lancashire Area gave a presentation about the use of micro seismic monitoring in regulating hydraulic fracturing at the Preston New Road site in the UK. A copy of the presentation is included in Annex 2.

Comments from the discussion about the use of micro seismic monitoring and the collaborative working between government departments and the work undertaken to communicate with the public are highlighted below.

- In regulatory terms in order to demonstrate compliance with EU regulations (mainly the water framework directive) a shale gas operator needs to be able to demonstrate the extent of their hydraulic fracturing operations in the sub-surface. Micro seismic monitoring techniques currently offer the most reliable scientific results to demonstrate this provided the system is optimally designed. At this point in time hydraulic fracturing was a new process to UK regulators. As such it was important for the Environment Agency to be able to define the technical detail that was needed to inform our requirements for environmental monitoring.
- Seismicity related to the site was monitored and regulated by a group of organisations working together this included: - British Geological Survey, the Oil and Gas Authority, the Health and Safety Executive and the Environment Agency. These organisations were in constant contact during hydraulic fracturing at the Preston New Road site.
- A Hydraulic Fracture Plan Review Committee made up of representatives from the various regulatory bodies was used to review the proposals for and the monitoring of hydraulic fracturing to ensure we were in the best situation to examine the changes in the site conceptual model and therefore risks to the environment.
- The regulatory bodies communicated with the public by issuing joint briefings from the Environment Agency, Health and Safety Executive and the Oil and Gas Authority. When hydraulic fracturing was occurring these briefings were issued every day-**See Annex 3**

We seek suggestions to improve this process and to apply it to other industries that may make seismic impacts and require to be regulated.



2.4 Workshop 4 Ground Source Heating and Cooling.

A representative from the Environment Agency's Groundwater and Contaminated Land team from the East Midlands Area gave a presentation about the use and regulation of ground source heating and cooling systems and raised the issue of how changes in temperature could be regulated. A copy of the presentation is included in Annex 2.

Comments from the discussion about the use and regulation of Ground Source Heating and Cooling Systems:-

- 80/68/EEC only controls releases of listed substances whereas the WFD requires controls to all inputs of all pollutants (substances liable to cause pollution). This represents a potentially much broader range of inputs (not simply current activities) and a broader suite of substances (not just listed substances) than originally defined in, and therefore controlled by, the Groundwater Directive (80/68/EEC).
- A key question is whether heat is a pollutant? It is not currently included as a pollutant in the UK under the Environmental Permitting Regulations but it is hoped that this will be added to the regulations during 2020/21. Do we need to regulate heat and if so, which regulatory body should do it? It is included under WFD but on a permit the maximum allowed temperature change is 10°C with a maximum discharge temperature of 25°C
- For the purposes of this Directive the following definitions shall apply:
- "Pollution" means the direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems, which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment.
- <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32000L0060&from=EN>
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 Article 2 Definitions
- Monitoring water quality could need to be examined more closely. Currently do not ask the operator to monitor this as they are only altering the water temperature. As such we are unaware whether this change of temperature changes the chemical makeup of the water.
- In the Netherlands each system needs to be registered. So far they are not aware of any interactions between systems. They operate on a 'first come, first served' basis, so subsequent



permits have to ensure they create no impact on existing permits. This applies both for water resources and also temperature

- Scotland have experienced groundwater geochemical changes, with one scheme having to close as a result.

NRW and SEPA confirmed both Scotland and Wales have limited uptake and have a small number of small-scale closed loop systems in operation. Both organisations view heat as a pollutant in groundwater under the Water Framework Directive.

2.5 Workshop 5 Geothermal Energy- Regulation and Risk

A representative of the Environment Agency's Environment and Business Groundwater Team gave a presentation about the regulation of geothermal energy projects. A copy of the presentation is included in Annex 2.

Comments from the discussion about the use and regulation of Geothermal Energy:-

General Comments

- Legislative Requirements include:-
- Groundwater investigation consent.
- Abstraction licence for $>20\text{m}^3/\text{day}$
- EPR Permit for discharging any excess fluids to surface or groundwater.
- Time limited 12 years, and requirement to re-apply if no development has started after 5 years.

Specific issues relating to the United Downs site at Carnon Down in Cornwall

- No springs, streams, rivers or surface features
- No natural groundwater – at 80m below the surface the ground water encountered is from the former United Mines Adit system and specifically the County Adit.
- No water being removed from the system – no discharge off site.
- No water being added – all water used will be from the fault zone.
- Seismic monitoring is part of the planning consent from Cornwall County Council



Further Questions and Comments about the sector

- Who would regulate seismicity in UK? Currently there is no lead organisation for this type of site.
- Need to learn from the shale gas transfer to geothermal (need for Hydraulic Fracture Plan, responsibilities of different regulators)
- Will regulation be a barrier to uptake of low-carbon tech? (E.g. Geothermal, hydrogen etc.)
- Who gets access to subsurface resources? How to control competing demands.
- We are interested in protecting historically important amenity spa waters? E.g. Bath, Taff's Well, Matlock, Harrogate etc.
- Protection of drinking water springs and other public supply (e.g. Buxton)
- What is risk of extreme drilling risks: CO₂ / Gas pockets, blowouts, mud volcano?
- Can we expect more district scale geothermal schemes?
- Significant uptake on geothermal schemes in both Turkey and the Netherlands. Sibel Ozsayin provided a copy of the application/permission procedure flow diagram followed in Turkey and Arie Konijnenburg confirmed the schemes in the Netherlands were shallower than the Cornish scheme (2-3 km deep) and that these schemes were used to heat greenhouses for crop growth. Kuldar Rikma confirmed there were no similar schemes in Estonia.
- The representative from Natural Resources Wales supplied the following information regarding geothermal schemes in Wales:-
- Below is a link to a primary school that is heated by a hot water spring near Cardiff.

<https://www.sustain-recruitment.com/blog/2020/01/primary-school-becomes-britains-first-to-be-geothermal-powered>

- There is also a scheme to use mine water to heat homes near Bridgend that has been proposed, see links below.

<https://wwtonline.co.uk/news/6-5m-awarded-for-uk-s-first-large-scale-mine-water-energy-project>

<https://www.bbc.co.uk/news/uk-wales-south-east-wales-42702581>

Here is a link to the English version of the document now used to assess seismic risks in geothermal projects in the Netherlands:



[https://www.kasalsenergiebron.nl/content/user_upload/Kennisagenda -
_Defining_framework_for_Seismic_Hazard_Assessment_in_Geothermal_Projects - Technical Report -
_161005.pdf](https://www.kasalsenergiebron.nl/content/user_upload/Kennisagenda_-_Defining_framework_for_Seismic_Hazard_Assessment_in_Geothermal_Projects_-_Technical_Report_-_161005.pdf)

In general: there is a very interesting research program going on in the Netherlands called KEM (<https://www.kemprogramma.nl/>) with a lot of research on induced seismicity and subsidence.

3 Chapter Three

3.1 Research, Future Policy and Best Available Technique

Several other themes were discussed during the day in the context of the regulatory roles of the various organisations present and where there may be gaps in legislation, policy or expertise and these included:-

- What new evidence projects and policy support to regulation do we require
- What Best Available Techniques (BAT) do we require?
- Subsurface Monitoring - BAT for subsurface monitoring, and research now to develop the future BAT.
- Which organisation leads on regulating seismicity and does it work with any other government or commercial organisations in this role?
- Do we recommend collaboration between agencies to assess environmental risk from seismicity?
- Micro seismic monitoring techniques for non-shale applications.
- Seismic events (e.g. through fault reactivation)
- Construction & maintenance to minimise environmental risk
- Re-purposing Oil and Gas boreholes for new energy production purposes
- Production of naturally occurring radioactive material (NORM)
- Heat generation from mine waters.



- The UK needs a revised updated guidance note on geothermal regulation, currently there is some guidance that dates from 2011 but it needs updating. Ground stability and Ground Source Heat Pumps (subsidence/heave)
- Negative Impact on natural Geothermal Water Resources and Quality
- Temperature as a pollutant.
- Amenity issues (Traffic/Noise/Vibration)
- Climate Change and the transition from fossil fuel to lower carbon techniques
- Clear regulatory processes for industry to follow.
- Community of information to inform the public
- BGS Science briefing Papers are available at <https://www.bgs.ac.uk/research/ScienceBriefingPapers/home.html>
- **Link to current applicable guidance Annex 4.**

3.2 Communicating Effectively About using the Subsurface

We discussed the theme of social acceptability of some subsurface schemes and highlighted the importance of clearly communicating with the public about environmental risks and how these could be mitigated.

A clear message and strategy will be required if we are to effectively and successfully engage with the public over these emergent issues.

Key to this will be the need for collaborative cross disciplinary working with all relevant regulators with clear regulatory remits.

3.3. Site Visit

The second day of the workshop included a visit to the Onshore Oil and Gas Gathering Centre at Welton in Lincolnshire. The event was hosted by IGas (<https://www.igasplc.com/>) and allowed delegates to look at how produced water is separated and re-injected into the subsurface. IGas is a leading British oil and gas explorer and developer, producing c.2200 barrels of oil equivalent per day from over 100 sites across the UK.



3.4. Results and Conclusions

Although at the present time we may not see a return to the hydraulic fracturing techniques associated with shale gas, we may see an expansion in other uses of the subsurface. These are methods designed to assist in mitigating climate change and to help move society to a low carbon future and include techniques of energy provision and carbon capture and storage.

These techniques will require regulation, monitoring and control to ensure that the use of the subsurface in this way does not negatively impact groundwater quality and resources or cause uncontrolled seismic events.

Section 3.1. of this report lists a number of suggestions for future research, Best Available Techniques and future policy to ensure these potential activities and their operation can be better understood, better regulated and better engineered to ensure they deliver sustainable beneficial outcomes for society.

The regulatory bodies and organisations active across Europe will be key in assisting with this transition by providing knowledge and expertise. This will help develop consistent regulatory approaches with potentially multinational operators, enable the sharing of expertise and the identification of new technology and approaches and how these may fit into the regulatory framework.

Finally, clear and understandable communication about any new uses of the subsurface will be essential in helping society understand how our regulation protects the environment and how we work with other regulators to ensure the move towards a lower carbon future is carried out safely, in the right place and with a minimised risk of pollution.



Annexes



Annex I. Completed Questionnaires



Copy of
IMPEL_Questionnair



Annex II. Presentations and Notes



Geothermal SScott
250220.pdf



IMPEL2020_PWReinjectionLS.pdf



HOUGH 25
February 2020_IMPEL



IMPEL_240220.pdf



Ground Source
Heating and Cooling at Preston New Road



Seismic Experience
at Preston New Road



Annex III. Preston New Road Public Briefing



PNR Regulators'
Joint Brief 56 - 12 Nc



Annex IV. Guidance

- BGS Science briefing Papers are available at <https://www.bgs.ac.uk/research/ScienceBriefingPapers/home.html>

- Seismic Risk Papers



SRA_Koekoekspold
er.pdf



Quickscan_Induced
_Seismicity_potential



Defining
framework for Seisr