



Environmental regulations for deep geothermal energy

Communication on intermediate results

GEOENVI work package 4

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INTRODUCTION

The objective of the GEOENVI project is to answer environmental concerns in terms of both impacts and risks, by first setting an adapted methodology for assessing environment impacts to the project developers, and by assessing the environmental impacts and risks of geothermal projects operational or in development in Europe.

The aim of the work package 4 is to map and analyse the current status of environmental regulations and practices for deep geothermal energy development and engage with stakeholders and decision-makers to develop recommendations for improving them. In this brochure, we would like to provide an update of the main intermediary results from this work package and provide an outlook towards next steps.

In brief our main first results are:

1. A report which gives a comprehensive mapping of environmental regulations applicable to deep geothermal energy in each of the GEOENVI national case study countries: Belgium, France, Iceland, Italy, Hungary, and Turkey. For each country, this report includes a general overview of the geothermal sector, a mapping of main definitions, classifications, permitting and licensing processes applicable. In addition, an overview of international, European and country specific regulations on the various impacts and risks considered in the GEOENVI project is given. As such the document forms a main stepping stone for working towards policy recommendations.

See below for the report summary and <https://www.geoenvi.eu/publications/decision-making-process-mapping/> for the full report.

2. A first round of national workshops, reaching out to some 150-160 participants across Europe, from policy, industry, research, and civil society organizations. The main aim of the first round was to inform country-respective stakeholders about the GEOENVI project and to capture their first feedback. Main results include an overview of the main impacts and risks that according to these stakeholders are of highest relevance in the different GEOENVI countries, and first insights in main common challenges for environmental regulations and social acceptance the GEOENVI project can address in more detail.

See below for a more detailed description of the results of the first round of national workshops.

On analysing the different aspects highlighted in the mapping of environmental regulations and the workshop results, we focused our attention on a list of *cross-cutting topics* (see Box 1) where we see highest potential for sharing best practices across countries and improving environmental regulations.

Our next steps are:

- Zooming in on the series of cross-cutting topics originating from the mapping and first workshop round
- Identify best practices among GEOENVI countries for the different cross-cutting topics resulting in a series of draft recommendations
- Discussing the draft recommendations with our stakeholders in our next workshop round
- Compilation of a final set of recommendations based on the workshop results

In a parallel work stream (work package 5) we will furthermore engage with market stakeholders to update and adopt the GEOENVI Life Cycle Assessment (LCA) tools.

Hope to see you again in our next round of workshops!

The GEOENVI team.

Box 1: Cross-cutting focus topics (provisional list)

- Seismicity
- Gas emissions to the atmosphere
- Aquifers' interferences
- Geothermal liquid waste
- Complex licensing and delays
- Accounting for nature of individual projects in environmental impact assessment
- Dealing with uncertainty
- Sharing credible and relevant information about environmental impacts and risks
- Creating local benefits
- Organizing public participation

MAPPING ENVIRONMENTAL REGULATIONS

In our first report (<https://www.geoenvi.eu/publications/decision-making-process-mapping/>) we analyse each of the GEOENVI national case study countries (Belgium, France, Iceland, Italy, Hungary, and Turkey) to gain a better overview of similarities and differences among national level geothermal environmental regulatory practice. After a general country overview, we analyse how the environmental regulations around deep geothermal energy are set-up in terms of definition, classification, and resource ownership. We find that definitions and rules for ownership are largely similar, but that classifications of different types of geothermal resources vary significantly. A mapping of permitting and licensing processes consequently addresses the type of permits required, permit durations, exclusivity arrangements etc. An interesting observation is the number of authorities involved in permitting that differs among countries. Moreover, Environmental Impact Assessment is present in each country, but the way it is incorporated in the overall permitting procedure differs.

Zooming in on environmental regulations, we provide an overview of international and EU regulations on the different environmental impacts and risks identified under work package 2. One observes that impacts and risks are generally covered under a variety of regulatory themes, see Table 1. Consequently, national level regulations in each of the GEOENVI case study countries were described in terms of applicable legislation, thresholds, required mitigation measures and arrangements for monitoring (see the [full report](#) for detailed country reports). Main observations are:

- Noise and vibration appear to be well regulated, as an industrial sector, both for workers and surrounding residents. Visual impacts and landscape are less strictly regulated, but generally treated in Environmental Impacts Assessments (EIAs), with the Tuscany region in Italy hosting the most developed regulations in this respect. Concerning dust and smell, various specific legislations and guidelines are in place.
- Possible degassing is already generally well controlled by air quality regulation, often with reference to the relevant EU directives for EU member state countries.
- Concerning the possibility of ground surface deformation and seismicity, guidelines for monitoring, prevention and mitigation are present in most countries and best practices are implemented by project developers and operators.

- Impacts and risks on the underground fluid, as well as reservoir chemical modifications, appear generally well regulated as part of national legislation on ground water quality and thoroughly addressed in permitting processes. However, for aspects of reservoirs' pressure decline and thermal changes, regulation is difficult to define.
- Effects of surface operation has a variety of dimensions: energy consumption, water consumption, air emissions. The case of France illustrates how such impacts and risks are regulated via, amongst others, reporting procedures and the voluntary compliance to ISO standards.
- Waste production appears generally well regulated as part of national waste legislation, including waste classifications, and special rules for dealing with hazardous waste.
- Leaks due to surface installations and operations is a specific topic treated in the EU Pressure Directive 2014/68/EU. Although in the scope of this report, limited national level legislation has been retrieved, the French case shows how the Pressure Directive is transposed to the national level, involving a variety of mitigation and monitoring measures, such as design requirements, risk assessment, and inspection protocols.
- Regarding liquid and solid surface waste from underground sources, national level legislation typically includes mitigating measures to prevent blow-out, also from the rationale of the safety of workers, and measures to avoid the effusion of liquid chemical fluids and geothermal brine.
- General regulatory frameworks for radioactivity are in place in the different countries in the context of public health. Depending on the relevance of the issue of radioactivity in countries and regions, deep geothermal projects must comply to specific regulations concerning e.g. the characterization and treatment of possible radioactive waste.

	Water quality	Air quality	Waste	Noise and vibration	Landscape	Soil quality	Radioactivity	Pressure equipment	Liability
Surface disturbance (vibration, noise, visual, land occupation, dust)		X		X	X				
Degassing		X							
Ground surface deformation						X			X
Seismicity						X			X
Interconnection of aquifers and disturbance of non-targeted aquifers	X								
Reservoir physical and chemical modifications	X								
Effects of surface operations	X	X							
Waste production from surface operations			X						
Leaks due to surface installations and operations								X	
Liquid/solid effusion and waste	X	X	X			X			
Radioactivity							X		

Table 1: Overview of main environmental regulatory themes (columns) for each potential environmental impact and risk (rows)

FIRST ROUND OF NATIONAL WORKSHOPS

The mapping of environmental regulations can be considered as a starting point. Remaining questions include:

- To what extent are national legislations consistent with EU legislation? On what aspects would harmonization be required?
- Are regulatory frameworks sufficient for mitigating the impacts and risks at hand, or possibly too strictly applied? What are main regulatory gaps? Are these problematic?
- How are legislations applied in practice? Which informal aspects come into play?
- Which elements of national regulations and guidelines can be considered best practices that can be shared among countries?

To address those questions in greater depth, the views of policy-makers, practitioners and other stakeholders are important to include, eventually leading to the formulation of recommendations on environmental regulations. To this end, three rounds of workshops are foreseen in the GEOENVI project.



Workshop impression

A first round of workshops has been carried out, reaching out to some 150-160 participants across Europe. Mostly policy, industry and research, but also societal groups. The main aim

of the first round was to inform our stakeholders about the GEOENVI project, but also to get a feeling for relevant challenges for environmental regulation and social acceptance that the GEOENVI project can address in more detail. Therefore, a mix of presentations, plenary discussion, and focus groups was adopted. Also, a survey was carried out among the workshop participants to ask for their opinion on the most relevant impacts and risks, and main challenges they see for the regulatory framework, public perception and participation.

	City	Date	Organiser	Participants
Italy	Rome	17 april 2019	COSVIG+CNR+ ENEL GP + RG + CSGI	70
Belgium	Brussels	5 feb 2020	VITO	14
Hungary	Interviews Budapest	nov/dec 2019 26 feb 2020	MFBSZ	12
France	Paris	16 oct 2019	BRGM + ESG + ARMINES	14
Turkey	Izmir	15 oct 2019	JESDER+DEU	21
Iceland	Reykjavik	21 jan 2020	OS+ISOR+GEO RG	23

Table 2: Overview of participation for the first round of national workshops

Main impacts and risks: survey results

Table 3 summarizes the impacts and risks that were considered arising most concern according to the experts participating in the survey. A broad distinction can be made among:

- Those topics broadly considered of main relevance across a number of countries, for example surface disturbance, degassing, seismicity, interconnection of aquifers, and liquid/solid effusion and waste.
- Those topics of main relevance in specific countries, for example radioactivity and the effects of surface operations.

Interestingly, all topics are mentioned at least once for being an impact or risk of main relevance.

	Belgium	France	Hungary	Iceland	Italy	Turkey
Surface disturbance (vibration, noise, visual, land occupation, dust)	X (noise / traffic)	X (for the public)	X (inhabited areas)	X	X (landscape, incidents and troubleshooting in wells or plants)	X (agricultural areas)
Degassing			X (GHG → CO2, CH4)	X (GHG, H2S)	X (GHG, H2S)	X (GHG)
Ground surface deformation		X				
Seismicity	X	X		X		
Interconnection of aquifers and disturbance of non-targeted aquifers	X	X	X (drilling technology)	X	X	X (ground water)
Reservoir physical and chemical modifications			X			
Effects of surface operations		X				X
Leaks due to surface installations and operations					X	X
Liquid/solid effusion and waste			X (thermal water discharge at surface)	X	X	X
Radioactivity	X					

Table 3: Main environmental concerns in the different countries according to experts. A bold **X** indicates that the concern was considered most important.

Main challenges: workshop outcomes

Main regulatory challenges and issues of social acceptance emerging from workshop discussions were clustered into a series of cross-cutting topics. These topics included:

Seismicity

Seismicity is a major concern, particularly in Belgium and France, as well as in nearby countries like Germany, the Netherlands and Switzerland. Managing this risk is challenging due to its high uncertainty and potentially high societal impacts. There is a potential for sharing best practices across countries on e.g. seismic networks and monitoring (c.f. Switzerland / France), traffic-light protocols, environmental liability regulation, thresholds, and contingency plans. See also 'Communication and social acceptance'.

Complex licensing and delays

Some countries report on long and complex licensing processes, for example in Italy, Turkey, Hungary and Iceland, with the latter reporting on a recent example where the licensing process for a powerplant took 10-12 years. Reasons for complexity may include: the involvement of multiple organizations in the licensing process (c.f. Hungary, Turkey), and the need for multiple licenses (c.f. Hungary).

Making environmental regulations more specific and adapted

Depending on the country at hand, there may be specific regulatory gaps and / or ways to make existing environmental regulation more specific and adapted for deep geothermal. In Belgium, for example, regulatory frameworks are still under development mainly in Wallonia. Also in countries and regions with longer experience with deep geothermal energy, specific issues remain like the regulation for closed loop systems in Flanders, mineral extraction from geothermal brine (i.e. lithium) and managing the end of the exploitation in France, and geothermal concession for depths shallower than 2500 m and the use of inhibitors in the reinjected water in Hungary. In Italy, there is a need for guidelines and best practices to characterize environmental performance, for example by applying LCA methodologies, more precise rules for environmental monitoring, and promoting the cascade use of heat.

Accounting for nature of individual projects

A challenge is matching a generic regulatory framework and EIA procedures with the specific nature of individual deep geothermal projects (c.f. Belgium, France, Turkey), and the different types of environmental impacts and risks that may apply.

Dealing with uncertainty

Deep geothermal projects often involve a variety of uncertainties. This relates to the exploration phase – where uncertainty in the quality and profitability of the geothermal resource may require flexibility to the operators (c.f. France) – as well as to follow-up stages where environmental permits should be updated based on environmental impact monitoring results (c.f. Hungary). In general, policy-makers need to better accept that in deep geothermal projects uncertainty is inherent to research and development (R&D) (c.f. Belgium), and regulation and legislations on R&D studies may need to be developed (c.f. Turkey). Finally, uncertainty also plays a role in the formulation of regional energy and territorial policies (c.f. Italy).

Communication and social acceptance

Communication and social acceptance is a broader topic to address. Besides seismicity, main issues of public perception are nuisance and noise (c.f. Belgium, Hungary), and smell from emitted hydrogen sulphide (c.f. Iceland, Turkey). Sub-topics of relevance in the partner countries include:

- Information sharing: Making sure relevant information is shared with the general public, also to balance often inadequate information from the media and internet. This includes information about environmental topics (for example on the effect of hydrogen sulphide in Iceland) or the current well-established status of regulation, as in France.
- Trust: Trust is needed between the public, operator, and regulator (c.f. Iceland, France). Local authorities or independent scientific committees may play an important role to link the operator and the local population.
- Positive communication: This entails showing success stories from similar types of projects and a focus on the main purpose and benefits of deep geothermal (c.f. Belgium). Also, it's important to acknowledge that good as well as bad experiences are not necessarily applicable to all projects (c.f. Belgium, France), but only to projects that

are comparable, because they share, for example, the same general technological and geological features.

- Creating local benefits: This may be an important trigger for social acceptance (c.f. Turkey, Belgium, Iceland), also ensuring that geothermal narratives are more coherent with vocations of territories (c.f. Italy).

Public participation

The organization of public participation appears relevant to address. For example, in France there is a need to broaden the scope of the public inquiry, involving a larger variety of stakeholders at different scale levels sufficiently early in the process, with a stronger role for local authorities. An additional challenge is dealing with limited information availability. Lessons may be learned from experiences of public participation for similar technology types (e.g. wind).



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