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GeoPLASMA-CE
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Development Fund

CATALOGUE OF REVIEWED QUALITY STANDARDS, CURRENT POLICIES AND REGULATIONS

Deliverable: D.T2.4.2

Project partner: LP-GBA

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Abbreviations

CLS	Closed-loop system
OLS	Open-loop system
RES	Renewable energy source
SGE	Shallow geothermal energy
SGES	Shallow geothermal energy system

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1. INTRODUCTION

1.1. General description of the addressed deliverable

Activity A.T2.4: Elaboration of quality standards for planning, construction and monitoring of geothermal sites

Description of deliverable D.T2.4.2: Catalogue of reviewed quality standards, current policies and regulations

The application form states:

"The results of D.T2.4.1 will be evaluated at a comparative analysis with involvement of stakeholders. This results in a catalogue (English language) of quality standards, national regulations and current policies including identified deficiencies."

The catalogue gives an overview of quality standards, national regulations and current policies concerning shallow geothermal energy systems (SGES). Regarding these topics, experiences show big differences between Central European countries. This starts with the execution of licensing procedures where the numbers of work steps and required documents differ. Furthermore, defined quality standards and the approach for special conditions, like artesian aquifers, differ from country to country. A significant lack of knowledge was identified in some countries when talking about requirements for SGES. Those different approaches complicate a uniform handling within the European Union and even within a country. Therefore, a common management concept would be advantageous for enhancing this technology and could alleviate its current reputation as an energy source that is complicated and difficult to implement and use. This report presents the current situation, identifies deficiencies and provides first attempts for a uniform management concept adaptable for all countries, by discussing possibilities and overall demands for SGES. Additionally, a stakeholder survey underlines the presence of identified deficiencies, provides the opinion of practical experts to get an overview of the status and requirements in different countries. A partner survey evaluated the importance of different quality standards.

The overall aim is to provide help and information to make sure that geothermal systems work as economically and technically satisfying facilities and that the operation guarantees a long lifetime without disruption and adverse environmental impact.

Moreover, we present a management process loop for shallow geothermal energy use. This process loop presents all work steps that must to be considered while planning and operating shallow geothermal energy systems. At the same time, it represents a very simple and basic management concept and can be used as a base for first steps in simplification and harmonization of shallow geothermal energy systems.

The catalogue addresses all stakeholders and users of shallow geothermal energy systems and represents the last step in a row of deliverables that assess the present situation for SGES in Central Europe. Based on these outcomes we will provide recommendations and minimum quality standards that cover the requirements of all partner countries in March 2019 (→ D.T2.5.1 – Catalogue of success criteria for a sustainable management of shallow geothermal use).

For further information, we recommend the GeoPLASMA-CE deliverables:

- D.T2.4.1 Summary of national legal requirements, current policies and regulations of shallow geothermal use

- D.T2.4.3 Knowledge exchange workshop on legal requirements, procedures and policies
- GeoPLASMA-CE: Catalogue of requirements
- D.T1.1.2: Catalogue of requirements for the web based decision support and information tool

1.2. Process loop related to the management of SGE use

Evaluating the procedures, policies and standards of the six Central European countries Poland, Austria, Slovakia, Slovenia, Germany and the Czech Republic (see also GeoPLASMA-CE deliverable D.T2.4.1) revealed that the current, common management procedure for shallow geothermal use can be best displayed as a process chain (Figure 1). The following work steps are identified:

- Planning/Design… means, amongst others, the evaluation of the location and facility design according to quality standards for installation and operations. In addition, it may include the preparation of the documents for licensing. This presupposes knowledge about legal regulations of SGES and a technical knowhow to implement the state of the art.
- Licensing… means the evaluation of submitted SGES design under consideration of the legal regulation and the state of the art.
- Installation… Quality assurance during the installation of SGES is very important to avoid (technical) problems and their subsequent impact, e.g. additional financial burden related to technical troubleshooting, inefficient operation or environmental damage.
- Operation… is up to the user. The mode of operation and associated limits should be specified during the planning/design and the licensing.

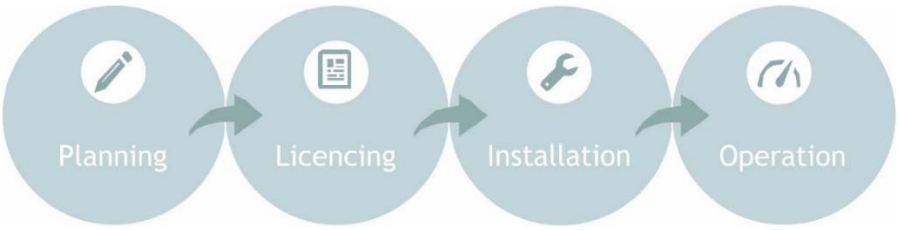

Figure 1: Process chain reflecting the current management procedures for shallow geothermal energy systems in the GeoPLASMA-CE countries.

The chain symbolizes the common perception of a shallow geothermal project: A linear process where steps are performed one after the other, and where installations are considered individually rather than in their context of neighbouring installations and other groundwater utilizations. The process ends with the commissioning of the installation. Monitoring and feedback – either to optimize system efficiency, to plan future installations or to monitor environmental impact - are not reflected in the process chain, as they are not common. Consequently, planned shallow geothermal usages do not profit from previous experiences. A lot of knowledge is lost or available only to a small number of persons.

In reality, all work steps are connected. Certain topics are relevant, with different points of view, in more than one stage of this process. The process chain also neglects the fact that the process is not completed at the commissioning stage of an individual installation. This renders a linear process chain unsuitable for defining the steps required for successful planning, installation and operation of shallow geothermal systems.

The inclusion of “Monitoring” and the introduction of “Information systems” as a binding part of the management process will enhance the management procedure and ensure an integrated approach for the management of shallow geothermal energy systems. Mandatory monitoring will provide in situ data, which

should be administrated in public information systems. It is then available to planners and provides input for the design of further installations. Consequently, the structure of the extended management process must become cyclical (Figure 2). The cyclical structure and the implementation of an information system also facilitate the provision of information on legal frameworks, policies and guidelines/standards that reflect the state of the art. This may help to generate a unique planning/design base and enhance the quality of shallow geothermal energy installations.

Although the process loop does not accurately reflect the multitude of connections between the individual process steps either, it is a more suitable illustration than the process chain. The overlapping illustration of the work steps indicates those connections and the closed structure symbolizes the unity of the single work steps.

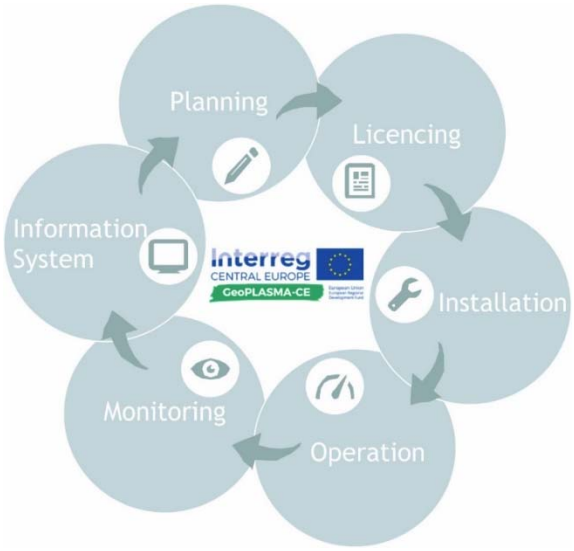

Figure 2: The GeoPLASMA-CE process loop for an integrated approach for the management of shallow geothermal energy systems.

Planning	Licensing	Installation	Operation	Legal framework and licensing procedure (Chapter 2.2)
				Geographical and geological conditions (Chapter 2.3)
				Quality standards (Chapter 2.4)
				Abandonment (Chapter 2.5)
				Monitoring (Chapter 2.6)
Information system (Chapter 2.7)				

Figure 3: Matrix illustrating the cross-connection of topics concerning shallow geothermal energy use. The columns represent stages in the process loop for which the topics listed to the right are relevant. Information systems as a universal tool adopt an individual position.

The management loop related to the regulation and management of shallow geothermal use deals with various thresholds and technical terms, which either are defined differently or lack any definition in the countries participating in the GeoPLASMA-CE project. The GeoPLASMA-CE-team identified the most important thresholds and technical terms. Most of them can be grouped to two or more work steps of the management loop. Those thresholds and technical terms can be grouped into several topics. Figure 3 groups topics into the different work steps of the management loop.

1.3. Methods

In addition to the evaluation of existing results from former deliverables (see chapter 1.1), a partner questionnaire and a stakeholder survey were performed by the GeoPLASMA-CE team.

1.3.1. Stakeholder survey

The intention behind the stakeholder survey was to gain an impression of the general situation of shallow geothermal energy in the GeoPLASMA-CE countries. We avoided detailed questions about specific technical or legal issues and concentrated on the stakeholders' opinion towards the existing situation. The stakeholder survey was executed on a country-by-country basis. Outcomes of the survey are implemented in this catalogue. For details regarding individual countries, please refer to ANNEX 1-6 of this document.

1.3.2. Partner survey

The partner survey collected opinions of project partners concerning individual quality standards and general questions related to the implementation of shallow geothermal energy. Outcomes of the survey are shown in this catalogue.

General questions concerned the legal framework, the distinction between installation sizes and parameters for information systems.

Quality standards had to be assigned one of three possible priority categories by each partner (Figure 4).

Category 1	This topic is crucial for the planning/installation/operation of SGES. A legally binding regulation would be favourable
Category 2	This topic is important for the planning/installation/operation of SGES. A recommendation for the course of action should be provided in guidelines, state of the art or any other technical documents.
Category 3	This topic has less importance for the planning/installation/operation of SGES.

Figure 4: Priority categories for quality standards.

Following project partners with different areas of main activities were involved:

- LP-GBA – Geological survey of Austria
- SGIDS – Sate Geological Institute of Dionyz Stur (PP06)
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- LfULG – Saxon State Office for Environment, Agriculture and Geology (PP04)
- CGS – Czech Geological Survey (PP05)
- PGI-NRI – Polish Geological Institute (PP08)
- AGH UST – AGH University of Science and Technology (PP09)
- GeoZS – Geological survey of Slovenia (PP07)
- BVG – German Geothermal Association (PP02)

2. CATALOGUE

2.1. Main definitions for shallow geothermal energy systems

Definitions are crucial to ensure that we are all on the same page when talking about shallow geothermal energy use - especially as countries of the European Union with the same base for a legal framework and aims. Within the GeoPLASMA-CE project, it was identified that

- there are three important basic terms for shallow geothermal energy
- there is no common definition.

2.1.1. Shallow geothermal energy

Defining the term „shallow geothermal energy“ ensures legal certainty and provides a common base for the evaluation and comparison of statistics.

The term “geothermal energy” is generally defined in scientific literature, standards and in some countries within legal regulation. Generally geothermal energy is defined as “*the heat energy with the source from residual heat of the Earth and radioactive decay of the rock material in the Earth crust*”. Very shallow ground-coupled installations which predominantly exploit solar energy (energy piles, ground collectors) do not come under this definition.

None of the GeoPLASMA-CE partner countries has a binding definition of the term „shallow geothermal energy”. A depth limit for the distinction between shallow and deep geothermal energy is commonly used. This varies between countries (in GeoPLASMA-CE countries from 100 to 400 m) and is derived from technical standards and other non-binding guidelines.

The Czech Republic and Slovakia do not define shallow geothermal energy by depth. In the Slovakian legal frame, geothermal energy (and its licensing and permission processes) is connected to geothermal water which is defined as groundwater with a temperature higher than 20°C. There is no legally clear definition of shallow geothermal energy available at all in the Czech Republic.

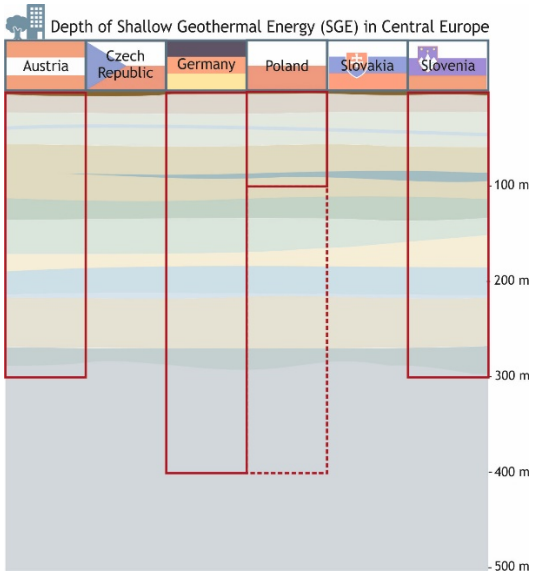


Figure 5: Graphical representation of the depth limits defining shallow geothermal energy in most GeoPLASMA-CE partner countries.

A suitable definition – for example using depth limit, underground temperature or energy extraction as defining criteria – should be elaborated.

GeoPLASMA-CE recommendation

DEFINING the term "shallow geothermal energy" provides legal certainty and allows meaningful analysis of statistics. A suitable definition – for example using depth limit, underground temperature or energy extraction as defining criteria – should be elaborated.

For legal clarity, this definition should distinguish between applications with a dominant solar component (e.g. ground collectors) and those requiring access to the deeper underground via drilled wells.

2.1.2. Ownership

With an increasing density of shallow geothermal installations and insufficient information about existing installations, the risk of mutual influence and reduced efficiency of installations is increasing. Currently, there are no clear recommendations for the resolution of conflicts arising from such mutual influence.

The ownership of geothermal energy itself is not regulated in any of the GeoPLASMA-CE partner countries. Ownership of geothermal energy is closely related to ownership of the underground and of the groundwater. These may belong to the state, the municipality, the general public or the property owner.

In fact, not the ownership of geothermal energy is crucial but the awarding of exploitation rights. Access to geothermal energy is often dealt by a "first come, first serve" approach. The license may contain stipulations that preclude or limit thermal impact on neighboring properties.

In GeoPLASMA-CE partner countries, and unlike other underground resources such as minerals and groundwater, geothermal exploitation rights are not covered by comprehensive management plans of the subsurface. GeoPLASMA-CE suggests allocating geothermal energy quotas to properties or surface areas.

GeoPLASMA-CE recommendation

OWNERSHIP of and ACCESS RIGHTS to geothermal energy should be clarified and subject to a spatially comprehensive management document. This should be anchored in the legal system of the countries.

2.1.3. Installation size

EU directive 2009/28/EC, Article 13, clause 1f) requires the simplification of the licensing procedures for small geothermal installations. A definition for "small" is not given, though, allowing individual interpretation and implementation for each member state. A distinction between "small" and "large" installations would allow lightening legal and financial obligations, e.g. regarding monitoring, for small usages.

The applicability and impact of simplified licensing procedures for small installations, however, is not self-evident in the case of shallow geothermal energy. Since the environmental risks involved do not depend on installation size, the majority of the regulations and restrictions will apply in equal measure to both small

and large installations. The partner survey (see Table 4 and Table 5) indicated only a very small number of parameters for which exceptions for small installations were deemed to be acceptable.

A definition of the term “small” is not available in all GeoPLASMA-CE partner countries, and varies between, and sometimes even within, those countries that do have a definition. The definition is usually based on the installed peak capacity. In some countries, the definition is not satisfactory. For example, in Poland, “small” installations are smaller than 30 kW whereas the term “large” applies to installations larger than 100 kW, leaving installations of 30-100 kW in a legal grey zone.

Although it might be feasible to use different criteria for the distinction between “large” and “small” installations, such as the intended purpose of the system (e.g. an installation serving a single residential building is “small” whereas an installation supplying industrial buildings or a block of flats is “large”). A common definition based on the peak capacity is advisable due to its simplicity.

GeoPLASMA-CE recommendation

An INSTALLATION SIZE representing the distinction between “large” and “small” installations should be defined by selecting appropriate peak capacity criteria.

It has to be carefully evaluated which regulations (if any) should depend on installation size.

2.2. Legal framework and licensing procedure

2.2.1. Legal framework

The partner countries have highly different levels of legal requirements (figure 5) for the installation and operation of SGES.

Document	Partner countries
Water act	SI, SK, PL, DE, CZ, AT
Mining act	SI, PL, DE, AT (if depth > 300 m, not applicable for SGES)
Construction act	SI, PL, CZ
Geological act	SK, DE, CZ
Environmental protection act	PL
Act on support of renewable resources	SK, PL
Law on spatial planning	PL
Decree on water protection area (local level)	SI, SK, DE, CZ, AT
Decree on flood areas (local level)	SK, CZ
Land use local regulations	PL

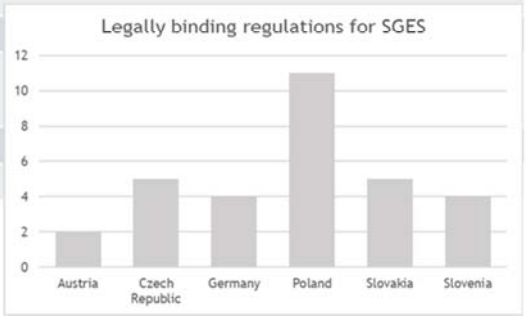


Figure 6: Summary of legally binding documents of GeoPLASMA-CE countries

The most important fact is that none of those acts were originally meant to regulate the use of geothermal energy stored or obtained from the geological environment.

Information for the use of geothermal energy and the implementation of installations is mostly obtained by guidelines, rule sheets, standards or other, similar documents. All countries provide such documents (see table 1), but with significant differences in scope and range.

In general, those documents reflect the state of the art and are favourable for planning and installation. Nevertheless, some countries report that the documents are not well known and that guidelines from other countries are used. A possible reason for this could be that guidelines are only mandatory when they are mentioned in legally binding documents.

Stakeholders in all participating countries were asked about the level of legal regulation in their country. With the exception of Saxony, Germany, all countries rated the level as lower than just right (see figure 7). Comments revealed that stakeholders from all countries criticize the difference between theory and practice in their country. This reflects the implementation of the legal framework rather than the legal framework itself. Stakeholders demand more harmonization within different regions of their country as well as uniform planning principles. In this context, all stakeholder rate guidelines as the most helpful tool for the implementation of shallow geothermal energy systems. A legally binding status for these documents is favourable since the possibility of enforcement increases compliance.

Table 1 : Summary of regulation and guidelines for the use of SGES present in the GeoPLASMA-CE countries. The summary includes an assessment of the documents by the country representatives.

GeoPLASMA-CE partner country and representative	Documents	Assessment of GeoPLASMA-CE country representative
Austria – LP GBA	OEWAV rulesheet 207	A good document. Since it was published in 2009 a few adjustments and revisions are appropriate: e.g. update of some methods (calculations methods), practical advices, quality criteria for numeric simulations, advice and good practice for data collection
Germany – PP02 BVG	VDI norms	The level of regulation is quite high and good. Nevertheless, it is assumed that sometimes they are not strictly followed but drilling companies sometimes are using an approximated value of 50 W/m for dimensioning of the borehole heat exchangers.
Saxony (GER) – PP04 LfULG	VDI norms	Sources are sufficient and useful, however, they are not supervised or enforced (e.g. VDI 4640, DVGW W120, DIN, guidelines/information brochures of the geologic surveys of the individual federal states).
Czech Republic – PP05 CGS	"Tepelná čerpadla pro využití energetického potenciálu podzemních vod a horninového prostředí z vrtů" of Act No. 67/2013.	The methodical guideline for installation of SGE is a useful document, but not legally binding and not well known to experts, public and authorities.
Slovakia – PP06 SGIDS	Technical standards are for installation of the heating and cooling infrastructure, F-gases handling. No guidelines specific for installation of geothermal energy systems. Some installers proceed by the VDI 4640 standards.	
Slovenia – PP07 GeoZS	At the moment draft of national directives for drilling in SGE (up to 300m) exist, other are EU standards/guidelines	
Poland – PP08 PGI-NRI and PP09 AGH UST	PORT PC, 2013	Yes - "Guidelines for designing, implementing and receipting installations with heat pumps" (PORT PC, 2013)

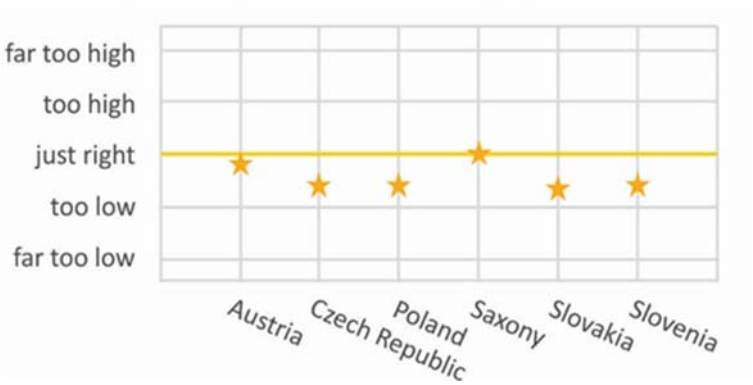


Figure 7: Stakeholders' opinions regarding the legal regulation in general.

GeoPLASMA-CE recommendation

A legal basis for the regulation of geothermal use is essential for a sustainable and efficient use. Regulations should relate to the execution and requirements for licensing procedures, qualifications for active parties and must demand the technical execution according to the state of the art.

The latter could be handled as a norm for technical quality standards.

The call for guidelines summarizing all relevant topics for the implementation of shallow geothermal energy systems underlines the importance of those documents. Since the legal basis is complex and often scattered, GeoPLASMA-CE recommends general guidelines summarizing the whole range of topics as an important tool for the safe and easy realisation of shallow geothermal projects and as an instrument for their promotion.

2.2.2. Licensing procedure

Licensing procedures are based on the legal framework and are very different between GeoPLASMA-CE countries. This concerns the number of responsible authorities, including the number of steps within a procedure, as well as the duration until permission is granted and the number of documents required. Some countries also have different procedures for both the use of the geothermal energy and the associated installations. Differences were investigated in the GeoPLASMA-CE deliverable D.T2.4.1. The results were compared with the measures from the European Renewable Energy Directive "2009/28/EC on the promotion of the use of energy from renewable sources" (OJ L 140, 5.6.2009, for more information also see D.T2.4.1). In order to reduce administrative barriers and enhance future methods for licensing procedures, the directive dictates six measures to be implemented into the administrative procedures for renewable energy systems by EU member states:

1. One-stop shop (one responsible authority for the execution of a licensing procedure. This authority should also be easy to identify by applicants)
2. Online application
3. Maximum time limit for procedures
4. Automatic permission after deadline passed
5. Facilitated procedures for small-scale projects
6. Identification of geographic sites suitable for the exploitation of renewable energy sources

The GeoPLASMA-CE comparison shows mixed results for all countries as well as between open loop and closed loop systems. While countries like Austria and Germany have a high level of implementation, Slovakia has not implemented any measures yet. In general, the level of adaption of the measures is higher for closed loop systems than for open loop systems.

The level of adaption of the measures can be explained by the different legal framework and along with the level of experience in the individual countries. Besides that, the EU directive is designed for all types of renewable energy. Therefore, some parameters are not useful for shallow geothermal energy systems to this extent. The EU directive only demands a replacement of the licensing process with a notification system for small installations if this is compatible with applicable law. However, a simplified process can lead to

undesirable influence on the groundwater quality. Since groundwater is of strategic importance as drinking water supply in many countries, the replacement of the licensing procedure with a mere notification is not recommended for SGES.

Other measures require significant changes in the current practice of most countries. One-stop-shop procedures are only easy to adapt when the responsibility is clear or when only one law is applicable for the regulation of shallow geothermal energy systems. The latter is not the case in most countries where the legal requirements are scattered between different laws. Time limits or procedures are often a matter of personnel. In this context, the stakeholder survey revealed that the quality of executive personnel for the licensing procedure is a significant problem. Stakeholders observed issues regarding the technical skills of licensing authorities and claim that the procedure often strongly depends on individuals and not on the legal frame.

In their comments regarding licensing procedures, stakeholders from all countries indirectly requested the implementation of the Renewable Energy Directive. They criticized the lengthy permitting procedures for permissions (measure 3 of the Directive) and problematic consultations because of unclear responsibilities (call for one-stop shop). They all mentioned uniform planning principles and information systems as a tool to facilitate all licensing procedures.

In GeoPLASMA-CE we will propose a licensing scheme and supporting tools that can be adapted to every legal base and which will help to fulfil the renewable energy directive. A recommendation will follow in D.T2.5.1.

GeoPLASMA-CE recommendation

Licensing procedures should be adapted to comply with the measures requested in EU directive 2009/28/EC.

2.3. Special geographical and geological conditions

Special geographical and geological conditions, including protected zones and areas of public interest, represent one of the first topics considered while planning SGES or submitting a license application. In areas with special geological conditions or protected zones precise work and knowledge in drilling and installation is important (see Table 2). Furthermore, licensing can limit the installation of SGES in areas with special geographical and geological conditions. Obligations can be challenges, but being aware of these conditions and using protective measures can ensure a safe realisation.

GeoPLASMA-CE recommendation

INFORMATION SYSTEMS displaying special geological and geographical conditions (e.g. conflict maps) can enhance the planning/design of SGES and provide valuable information for drilling companies concerning the drilling equipment.

For GeoPLASMA-CE we compared well-known special geographical and geological conditions where the installation of SGES can be difficult (see also PK Geothermie, 2011; Stober and Bucher, 2014).

The regulation of the installation of SGES in special geological and geographical conditions can be, depending on the country, executed on a national, regional or local level. Besides laws, guidelines or rule sheets are the main and more detailed instruments for the regulation. These documents are not legally binding, but recognised as state of the art. Therefore, these recommendations play a decisive role in planning/design and the licensing processes.

The regulations for the handling of special geological and geographical areas are very different in GeoPLASMA-CE countries. For example, the installation of SGES in artesian aquifers is not allowed in Slovenia (for open-loop systems) and parts of Austria. It is conditionally allowed in Austria, Czech Republic, Saxony and Slovakia. In Poland, there is no regulation for artesian aquifers. Since the impact of geological occurrences doesn´t change at political borders, such different methods of handling artesian aquifers or other issues have no objective reason. Looking closer, restrictions often result from previous experiences of inadequate response to issues arising from these special conditions. The appointment of experienced and qualified staff is important for the safe and sustainable construction of a SGES.

GeoPLASMA-CE recommendation

EXPERIENCED and QUALIFIED personnel in all work steps related to the implementations of a geothermal energy system support a safe and sustainable operation!

Table 2: Special geographical and geological conditions during the installation of shallow geothermal energy systems. Summary of possible consequences and associated recommendations and actions

Geographical and geological topics	Potential consequences for the following components of the environment:				Recommendations and actions
	Groundwater (GW)	Underground/soil	Environment	SGE-System	
Artesian aquifers	Depression, rise of GW, mixing of different groundwater bodies	Soil wetness	Flooding of properties, mud deposition Impact on water-dependent ecosystems - wetlands	More complicated borehole installation due to overpressured conditions	Possible: Limitation of drilling depth Selection of drilling equipment
Very shallow depth to groundwater table		Soil wetness around reinjection site	Influence on biotic components (plants)		Appropriate dimension (flow rate/permeability) of injection well (1.5 – 2 x dimension of extraction well)
Two or more groundwater storeys	Depression, rise of GW, mixing of different groundwater bodies	Ground heaving, depression, soil wetness or dry soil			Limitation of drilling depth or seal of annulus in area of aquiclude/aquitard
Mineral water resources	Impact on existing use (extraction rate, physico-chemical composition)		Contamination of mineral water resources	Scaling of OLS, corrosion of both OLS and CLS	Appropriate selection of grouting material
Thermal water resources	Impact on existing use (extraction rate, physico-chemical composition); Change of chemical equilibrium due to thermal impact	Precipitation or dissolution	Thermal pollution of thermal water resources	Heat damage to material Increased corrosion levels	Select heat resistant and corrosion resistant materials Expert survey to exclude negative impact on existing usages
Gas occurrences	Change of physico-chemical composition by degassing	Gas release	Health issues	Damage to certain materials due to gas diffusion Blow-out	Drilling fluid density selected to ensure overbalanced conditions HSE procedures in place (sensors, training etc.)
Mining areas	Depression, mixing of different groundwater bodies, release of hazardous materials such as heavy metals	Depression, slumps, extensive collapse of subsurface	Pollution of surface waters	Loss of drilling fluid Instability or loss of drilling rig, loss of wellbore due to sloughing	

Contaminated soil	Pollution of groundwater due to ingress of hazardous materials		Release of hazardous gas	Damage to materials due to chemical incompatibility (e.g. hydrocarbons)	
Evaporites	Change of chemical composition	Solution along with depression and slumps; uplift due to swelling of anhydrite		Drilling hazard / higher drilling cost due adapted materials	
Swellable rocks		Uplift due to swelling (of anhydrite)		Drilling hazard (sloughing, swelling) Higher drilling costs due to inhibitive drilling fluid materials and higher disposal volumes	
Karst areas	Depression, mixing of waters, pollutant input	Depression, slump		Lowering of heat extraction capacity, drilling hazards: Loss of drilling fluid, water influx, grouting/sealing difficult due to loss of grouting material	
Water protection area	Contamination, thermal impact on drinking water		Changed thermal conditions - impact on microbiological quality parameters	Contamination of drinking water - consider forbidding all drilling	Implement appropriate restrictions (e.g. materials, minimum distances)
Nature protection area		Very localized soil contamination (e.g. pH change) and ground disturbance	Disturbance of fauna or flora during drilling process	Drilling may be subjected to additional conditions	Consider restrictions during seasonal activities (e.g. breeding) Restrictions on drilling fluid materials and noise levels
Landslide area	Breach: Contamination with heat carrier fluid	Instability, movement		Drilling hazard, potential loss of well/installation	
Faults and highly fractures areas	Depression, rise of groundwater table, mixing of different groundwater bodies	Depression, slump		Drilling hazard (e.g. sloughing, ledges), loss of drilling fluid, grouting/cementing unsuccessful	Well planning (dip/azimuth)

Looking at possible consequences resulting from special geographical and geological conditions, an assessment of the following points is advisable while planning an SGES:

- Are there any special geographical or geological conditions in the area of the planned SGES?
- Are there any known incidents with other SGES in the surrounding area?
- Are any previous incidents known?
- Which actions promote a safe installation (e.g. limitation of drilling depth) and operation?
- Are there any legally binding restrictions because of protected areas?

This assessment must be done during the planning/design stage and should be verified during the licensing process. Relevant information should be made publicly accessible, e.g. represented in maps available through a web portal. GeoPLASMA-CE provides such maps for the pilot areas at http://portal-stage.geoplasma-ce.eu.

Recommendations in Table 2 help realizing SGES even in these areas and may prevent harsh restrictions.

GeoPLASMA-CE recommendation

Special geographical and geological situations require a case-specific conscientious assessment during planning/design. In this context, a licensing procedure or at least a notification of the responsible authorities is essential.

Exceptions are protected areas (e.g. water or nature protection areas). In these areas, the precautionary principle is recommended. This means that all or certain activities should not be allowed regardless of possible mitigation measures.

2.4. Quality standards for open-loop and closed-loop systems

Quality standards and technical standards pursue a dual purpose: Ensure satisfactory functioning of the SGE installation, and protect the environment, including other groundwater users.

The contents and extent covered by standards varies significantly between the countries participating in the GeoPLASMA-CE project. Similarly, the legal status of these standards varies; they can represent a legal obligation, an officially recommended guideline or simply available information. The levels of the standards, i.e. the minimum criteria to be met, vary likewise.

This deliverable evaluates the existing standards in the partner countries and collects partners' opinions regarding the need for regulation of particular parameters or issues. The aim is to prepare a basis for recommendations towards joint minimum standards applicable to all countries, i.e. harmonized across the EU. These recommendations will be issued in the deliverable *"DT2.5.1: Catalogue of success criteria for a sustainable management of shallow geothermal use"*.

2.4.1. Standards are good - compliance is better

In a first step, stakeholders in all participating countries were asked about the level of technical standards in their country. In each country, the level was perceived as too low, especially in Slovenia, Poland and the Czech Republic (figure 8). Comments revealed that compliance with existing standards is a major problem, even in countries where the technical standards were judged quite close to satisfactory.

Figure 8: Stakeholders' opinions regarding technical standards.

In most countries, stakeholders criticized a lack of qualified personnel. However, when asked their opinion regarding certification of planners, designers and installers of SGE systems, their answers showed a differentiated picture. Around 40% of respondents do not think that certification will significantly improve the quality of SGE installations (figure 9). Comments from individual stakeholders express dissatisfaction with existing certification schemes for drilling companies. In particular, lack of control exerted by the authorities and absence of consequences for non-compliance are seen to devalue such existing certification schemes.

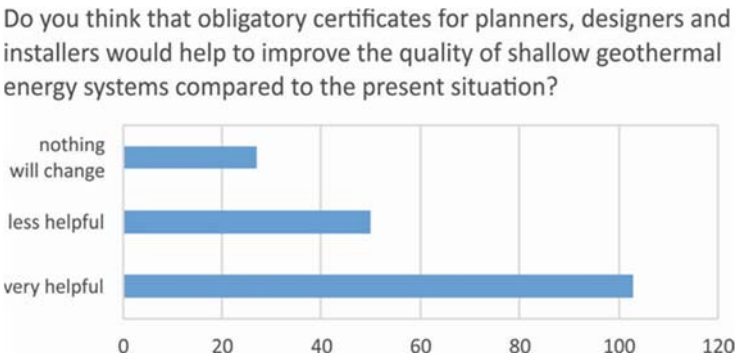


Figure 9: Stakeholder survey regarding certification of personnel.

In a second step, the question of certification was posed to the GeoPLASMA-CE partners. They were asked whether, in their opinion, certification should be mandatory (category 1), recommended (category 2) or does not require either (category 3). The answers are depicted in table 3, with each cross representing one partner's answer. The "summary" column indicates the majority answer.

Table 3: Partner survey regarding certification of personnel. Each cross represents a partner's answer. Category 1: regulation required, category 2: recommendations required, category 3: no regulations or recommendations required.

General standards for OLS and CLS		Category 1	Category 2	Category 3	Summary
Measures for the qualification as planner/designer?	Small scale	xx	xxxx	x	
	Large scale	xxx	xxx	x	
Measures for the qualification as driller?	Small scale	xxx	xxxx		
	Large scale	xxxx	xxx		

Analysing the results from both stakeholders and partners, it becomes clear that certificates are seen to be the most powerful tool to guarantee a quality standard for the implementation of shallow geothermal energy systems. Although differences are not great, it is noticeable that certification for drilling personnel is deemed more important than certification for planners / designers and that the need for certification appears to become greater with installation size. Thus, a few questions arise: What is the main driver for the introduction of a certification scheme - the immediate financial impact or long-term quality control and environmental protection? Are answers overly influenced by negative experiences with existing certificates?

More detailed information on the certificates themselves and also on the responsible issuing authorities is needed to elaborate strategies for the use of certificates.

GeoPLASMA-CE recommendation

Partners' responses allow the preliminary conclusion that certification should be recommended, but not become mandatory for the planning or implementation of an SGE system.

The certification scheme should include both drillers and planners/designers, and compliance should be monitored and enforced.

2.4.2. Technical standards – closed-loop systems

GeoPLASMA-CE partners were presented with a list of technical parameters relating to either open-loop systems or closed-loop systems. The significance of the individual parameters is covered in "*Annex 7 – Comparison of Current Quality Standards in Central Europe";* the annex also details how these parameters are currently specified in each partner country, including their legal status.

As before, partners were asked to indicate whether each particular parameter should be regulated (category 1), whether recommendations regarding this parameter should be issued (category 2), or if neither regulations nor recommendations were deemed necessary (category 3). Each cross represents the opinion of a GeoPLASMA-CE partner (table 4), independent of current practice in the respective country.

Regarding closed-loop systems, partners saw a need for regulation of only three parameters: Filling of the annulus between BHE and borehole wall; leakage test of ground loop and refrigerant tubing; and submission of a borehole drilling report. For the majority of parameters, including those crucial for system efficiency (e.g. minimum distance to other SGE installations), partners indicated that non-binding recommendations would suffice. In the partners' opinion, only four parameters require neither regulations nor recommendations, and with one exception, this only applies to small installations. These four parameters are all related to the data used to design an installation: Thermal properties of the underground; groundwater analysis; taking core samples; and performing a numerical simulation.

For a number of parameters, e.g. distances between installations, or from SGE installations to buildings or neighbouring properties, partner comments indicated that the specification of an absolute value is not regarded as the most suitable approach to preventing negative impact. Rather, it is argued that these parameters depend on local (hydro-)geological conditions and rock properties, and a case-by-case decision should be used. However, in order to take such an approach, numerical modelling is required, and partners did not opt for mandatory modelling. This contradiction needs to be resolved.

In general, the input from individual partners needs to be expanded and detailed prior to extracting specific recommendations for each parameter.

2.4.3. Technical standards – open-loop systems

Regarding open-loop systems, only one parameter, numerical simulation of small-scale open-loop systems, was thought not to require regulations or recommendations (see table 5).

Partners saw a greater need for regulation, which also extended to covering small-scale installations, and would like to see recommended minimum standards for almost all other parameters.

Even more so than for closed-loop systems, partners stressed the importance of local subsurface conditions for the specification of constraints such as minimum distances between installations. If this is to be reflected in the recommendations issued by GeoPLASMA-CE partners in the report "DT2.5.1: Catalogue of success criteria for a sustainable management of shallow geothermal use", the status of numerical modelling and pumping tests should be reconsidered.

GeoPLASMA-CE recommendation

Non-binding recommendations should be elaborated for the majority of technical parameters.

Mandatory minimum standards should be elaborated for a smaller number of parameters.

Very few parameters should remain open to individual consideration.

Table 4: Partners' responses to CLS parameter survey. Each cross represents a partner's answer. Category 1: regulation required, category 2: recommendations required, category 3: no regulations or recommendations required.

General standards for Closed Loop Systems (CLS)		Category 1	Category 2	Category 3	Summary
Taking core samples necessary	Small scale	x	xx	xxxx	
	Large scale	xx	xx	xxx	
Thermal response test required	Small scale		xx	xxxxx	
	Large scale	xx	xxxx	x	
Groundwater analysis necessary	Small scale		xxx	xxxx	
	Large scale		xxxxx	xx	
Numerical simulations required	Small scale		x	xxxxxx	
	Large scale	x	xxxx	xx	
Minimum distance to other heat exchangers of the same installation [m]	Small scale	x	xxxxxx		
	Large scale	x	xxxxxx		
Target value for the average operating temperatures of the heat carrier fluid [°C]	Small scale	x	xxxx	xx	
	Large scale	x	xxxx	xx	
Design (dimensioning) of closed loop systems	Small scale	x	xxxxx	x	
	Large scale	x	xxxxx	x	
Minimum distance to neighbouring CLS [m]	Small scale	x	xxxxxx		
	Large scale	x	xxxxxx		
Minimum distance to neighbouring OLS [m]	Small scale	x	xxxxxx		
	Large scale	x	xxxxxx		
Minimum distance to buildings [m]	Small scale	x	xxxxxx		
	Large scale	x	xxxxxx		
Minimum distance neighbouring plot [m]	Small scale	x	xxxxxx		
	Large scale	x	xxxxxx		
Regulations for the backfilling of the BHE	Small scale	xxxxx		xx	
	Large scale	xxxxx		xx	
Leakage test of ground loop and refrigerant tubing	Small scale	xxxxxxx			
	Large scale	xxxxxxx			
Borehole drilling report required	Small scale	xxxxx	x		
	Large scale	xxxxx	x		

Table 5: Partners' responses to OLS parameter survey. Each cross represents a partner's answer. Category 1: regulation required, category 2: recommendations required, category 3: no regulations or recommendations required.

General standards for Open Loop Systems (OLS)		Category 1	Category 2	Category 3	Summary
Simplified analytical designing (dimensioning) of open loop systems	Small scale	x	xxx	xx	
	Large scale	x	xx	xxx	
Numerical simulations required	Small scale		xx	xxxxx	
	Large scale	xx	xxx	xx	
Groundwater analysis necessary	Small scale	x	xxxxxx		
	Large scale	xxx	xxxx		
Minimum distance to neighbouring CLS [m]	Small scale	x	xxxx	x	
	Large scale	x	xxxxx		
Minimum distance to neighbouring OLS [m]	Small scale	x	xxxxxx		
	Large scale	x	xxxxxx		
Minimum distance to buildings [m]	Small scale		xxxxx	x	
	Large scale	x	xxxxx	x	
Minimum distance to neighbouring plot [m]	Small scale	x	xxxxxx		
	Large scale	x	xxxxxx		
Minimum distance between pumping and reinjection well [m]	Small scale		xxxxxxx		
	Large scale	x	xxxxxx		
Type of demanded reinjection (soakaway or well)	Small scale	x	xxx	x	
	Large scale	xx	xx	x	
Accepted drawdown at neigbouring installations [cm]	Small scale	xx	xxxx		
	Large scale	xx	xxxx		
Temperature difference between extracted and reinjected water [°C,K]	Small scale	xxx	xxx		
	Large scale	xxx	xxx		
Pumping test obligatory	Small scale	xx	xxx		
	Large scale	xxx	xx		
Absolute allowed temperature range of the reinjected water (min. and max. of the reinjected water) [°C]	Small scale	xxx	xxx		
	Large scale	xxxx	xx		
Reinjection of used groundwater	Small scale	xxxx	xxx		
	Large scale	xxxxx	xx		
Extraction of groundwater for open loop systems	Small scale	xxxx	x		
	Large scale	xxxx	x		

2.5. Abandonment

The duty of care for groundwater is the first priority when installing and operating a shallow geothermal energy system. This principle must also be the top priority when talking about dismantling those systems. It must be ensured that after the system is abandoned, no negative impact can occur to the groundwater.

Half of the countries in GeoPLASMA-CE consider abandonment in guidelines or legal binding documents. Since groundwater protection is the topmost priority, a legally binding duty for the abandonment of shallow geothermal energy systems is recommended. Quality standards for the procedure should be available in the state of the art, respectively through guidelines.

Most important steps for the procedure are:

- Evaluation of subsurface contamination and restoration of subsurface in good environmental quality,
- Deconstruction of subsurface installations and backfilling of installation pipes by natural material (e.g. sand, gravel, soil),
- Prevention of groundwater contamination by surface water,
- Prevention of connection between different aquifers,
- Extraction of heat carrier fluids from circulation pipes,
- Backfilling of circulation pipes (liquid-tight),
- Notification of liquidation to responsible public authority.

A near-term notification to public authorities is essential when abandoning shallow geothermal energy systems. On one hand the system won´t be listed as active any longer and therefore no interferences with other installations are hindering newly planned systems. On the other hand, reasons for the abandonment could be useful information for future systems.

GeoPLASMA-CE recommendation

Abandonment of shallow geothermal energy systems requires legally binding requirements and a notification to the responsible authority. Information could be used for planned and future installations.

2.6. Monitoring

The matter of installation monitoring (and the related topic of information systems) is currently not regulated in any of the GeoPLASMA-CE partner countries. Monitoring may be mandated as part of the licensing process, but the particular conditions triggering a requirement for monitoring as well as the individual stipulations (parameters to record, time intervals for measurements etc.) are based on case-by-case decisions.

For this reason, fundamental aspects of monitoring and information systems are addressed in detail without giving recommendations at this point.

2.6.1. Definition of terms

The term “monitoring” denotes the (long term) observation of a process and the systematic recording of relevant measurements which can be used to characterize and, if required, to optimize this process.

In connection with shallow geothermal energy installations, the term “monitoring” is not precisely defined and can refer to

a) system efficiency, by monitoring the operating parameters of the installation,

b) environmental impact, by monitoring the subsurface conditions near the installation,

c) quality assurance, by monitoring the entire drilling, completion and installation process.

Monitoring system efficiency is focused on operating parameters, conditions and usages (delivered heat, hot water consumption, electricity consumption etc.). Sensors are installed inside the building and cost little. Usually, the data are privately owned and used to identify technical issues, optimize the system and reduce running costs. The beneficiary of system efficiency monitoring is thus primarily the owner of the installation.

Monitoring environmental impact is focused on parameters relating to the subsurface, e.g. underground temperature, groundwater chemistry etc. Sensors require downhole installation, usually located in separate observation wells placed up- and downstream of the installation. This involves significant costs to the installation owner. The data are used to quantify the impact of the installation and are mainly used to ensure compliance with legal obligations (hazard mitigation) and determine or avoid conflict with neighbouring uses. The beneficiaries of environmental impact monitoring are therefore primarily the local authorities and the general public or nearby users.

In a broader sense, monitoring may be understood to include quality assurance (QA) not only during the operation, but also during the drilling and completion stages, i.e. supervision, certification and other controls to enforce compliance with technical standards and legal obligations. The purpose of QA monitoring is primarily to ensure compliance with legal and technical obligations and to provide legal certainty to the owner.

Since documentation of the drilling and installation stages are not long-term tasks, and since most project partners were not in favour of it, monitoring of the drilling and completion stages will not be discussed but will be briefly included in chapter 2.7 *Information System*. Therefore, in the context of this deliverable, the term “monitoring” refers to both system efficiency monitoring and environmental impact monitoring, depending on the context.

2.6.2. System efficiency monitoring

Monitoring operating parameters to optimize system efficiency can bring a significant reduction in running costs, but is often perceived as a financial burden to owners. Therefore, even simple monitoring systems are rarely installed unless they are prescribed by the licensing authorities.

Monitoring was not among the topics raised during the stakeholder questionnaire, but the partner survey revealed the prevailing opinion that **small installations** should either be exempt from monitoring systems, or should be obliged to install only electricity meters. The value of this is limited to flagging up technical problems or a lower efficiency than predicted, i.e. to indicate a need for more comprehensive (short term/remedial) monitoring.

Regarding **large systems**, most partners advocated obligatory monitoring of electricity consumption and heat production. If the electricity meter is placed appropriately, these two parameters are sufficient to derive the seasonal performance factor (SPF) and determine whether the installation achieves planned efficiency levels. In case of underperforming installations showing very low inlet temperatures of carrier fluid it also allows pinpointing design error as the root cause of low efficiency, though more comprehensive analyses are not possible.

The benefits of system efficiency monitoring can be transferred from the installation owner to local authorities and planners if the data is recorded in a publicly accessible central information system. This is desirable as it can be used to plan future installations, validate models and, over time, provide long-term experience important to investors.

2.6.3. Environmental impact monitoring

Partners directly or indirectly referred to aspects of environmental impact monitoring in connection with **large installations** (both open- and closed-loop) and suggested recording of heat extraction and/or downhole temperatures in a central information system (see chapter 2.7). This serves the purpose of quantifying thermal impact on groundwater and can be used by planners for designing future installations, and by authorities.

For **open-loop systems**, suggestions have been made to capture extraction rates and groundwater levels throughout the life time of the installation and regardless of installation size. The motivation behind this is mainly groundwater protection and compliance with regulations. However, this information can also be used to levy fees for groundwater use and to determine impact of drawdown/build-up on other groundwater uses.

Depending on legislation in the individual partner countries, data captured during environmental impact monitoring and reported back to the licensing authorities may still be owned privately; the licensing authorities thus may not be allowed to release this data publicly. However, they may use it to determine appropriate constraints or measures during future licensing processes. If data protection and ownership issues are resolved and the data were recorded in a public information system, it could be very valuable to planners.

2.6.4. Summary and preliminary conclusions

Recommendations regarding monitoring of shallow geothermal energy installations will be given in deliverable DT2.5.1 *Catalogue of success criteria for a sustainable management of shallow geothermal use*.

- The term “monitoring” is not well defined when applied to SGE installations; it does not refer to specific parameters or purposes.

- Main purposes for monitoring of SGE installations are system efficiency control and environmental impact assessment.
- Monitoring of the drilling and completion stages was not seen as a necessity or as practicable by most GeoPLASMA-CE partners.
- Costs for installing an efficiency monitoring system are often perceived as a disproportionate financial burden to the installation owner. Potential financial benefits (e.g. reduced running costs due to system optimization, early detection of technical issues) are of lesser importance to owners.
- Benefits of environmental impact monitoring (environmental protection, planning criteria…) are not expressed in monetary terms.
- Monitoring data is usually privately owned and not publicly accessible.
- Access to monitoring data, in particular those data relating to environmental impact assessment, would be very valuable to planners of SGE installations.

2.7. Information system

The stakeholder survey indicated a need for basic data and information for both the planning and the drilling phases of shallow geothermal projects. General information, e.g. relating to geology, geothermal potential and water protection zones, should be provided to public and be easily accessible. In several countries, requests for access to archive data maintained by the geological surveys were voiced; these archives contain offset data such as drilling reports and geological profiles. In addition to geoscientific and land-use data, stakeholders frequently expressed a need for information regarding existing geothermal installations. Preferably, all information should be provided in a single information system for each country, accessible via an online portal.

The GeoPLASMA-CE partner questionnaire addressed this need to supply planners with both geoscientific and installation-specific data via a central information system. Since none of the GeoPLASMA-CE partner countries currently operates a comprehensive information system tailored to shallow geothermal energy use and containing detailed information about individual installations, the questionnaire did not cover this topic in depth but was limited to collecting suggestions for parameters to be provided by such a system. Partner responses covered a very large bandwidth of parameters for inclusion, ranging from the bare necessities to a very detailed documentation of the entire drilling and installation process. Nevertheless, all partners implicitly agreed to a common main goal of such an information system for shallow geothermal energy: To provide planners and drilling contractors with the necessary information to design and realize an efficient geothermal installation in a safe manner. In this respect, GeoPLASMA-CE differs significantly from the approach of the EU project “ReGeoCities” which elaborated a detailed suggestion for an information system. That system, however, followed a different purpose and was mainly aimed at calculating energy savings and reductions in greenhouse gas emissions; the motivation for such a system can be traced back to national status reports relating to EU climate goals.

The information suggested by the GeoPLASMA-CE partners can be grouped in two categories:

1. Public geoscientific and spatial planning information relating to the subsurface and to land-use conflicts,
2. Usually restricted information regarding the location and operating parameters of existing geothermal installations.

Examples for data of the first category mentioned by the partners were:

- Geological information and rock properties, such as thermal conductivities,
- Hydrogeological information, such as aquifer thickness and groundwater chemistry,
- Land use and conflict maps depicting hazards such as presence of artesian groundwater or contaminated soil,
- Potential maps, e.g. geothermal gradient, subsurface temperature or heat capacity,
- Suitability maps.

Information of this category is already available online in many countries, although to varying extent. The addition of further maps is expected to be uncritical and not too difficult to implement.

Information of the second category mentioned by the partners includes parameters such as:

- Location and max. depth of the installation,
- System type,

- Max. installed capacity and heat extraction rate,
- Max. flow rate of open-loop systems.

Since information of the second category is affected by private ownership, data protection rights and cooperation with many individuals and companies, its inclusion into an information system presents a number of fundamental questions:

- Should participation be voluntary or linked to the licensing process?

  Voluntary data registration will likely result in very low participation and data density; mandatory registration, however, raises issues regarding privacy rights, control and enforcement of data delivery.

- How can comprehensive data coverage be achieved for systems already in operation?

  Contacting a large number of installation owners requires large investments in terms of time and personnel, and compliance will be very difficult to enforce. However, the large number of installations already present in some countries provides important information, in particular regarding the planning of installations in densely populated areas where mutual influence of installations is more likely and cannot be neglected.

- Will only static data be captured or time lines with regular data point intervals?

  A single data delivery after commissioning the installation is easier to organize and there are tools to enforce compliance (e.g. subsidies, tax relief etc. will only be granted if data delivery has been completed). However, actual usage data and, where available, monitoring data, is very valuable for planning and optimization purposes.

- Who is responsible for the collection and provision of data?

  Legally, the owner of the installation, usually identical to the license applicant, owns the data. Therefore, the installation owner is responsible for timely data delivery. However, it may be expedient to mandate data delivery by the planner or the installation contractor, as their expertise will reduce the likelihood of incorrect or incomplete data being provided.

- How can data provision be enforced?

  Control and enforcement is very resource intensive. Unless the licensing process allows imposing financial penalties in case of failure to submit data, or the installation qualifies for grant money or tax relief which can be withheld, there are few options to enforce data provision.

- How will the data be transferred to the information system?

  In order to minimize workload, the system would have to be fully automatic and online. One option is an online form based on a suitable platform as to facilitate incorporation into GIS databases.

- Who will maintain the information system and provide user support services?

  Clearly, the geological surveys are most suitable for providing and maintaining much of the content. However, local authorities directly involved in the licensing process are in a better position to collect data and enforce data delivery.

- Which parameters will be captured?

This will depend largely on the purposes of the information system, i.e. if it is utilized for planning purposes only, or additionally for tracking of environmental data or for documenting the drilling and installation process.

- Who will have access to the information system?

  Due to the sensitive nature of some data, a system with several tiers of access rights could be implemented. For example, access to locations and parameters of existing locations can be restricted to accredited companies (e.g. planners, drilling contractors), contact details can be made available to authorities, but everyone would have access to geoscientific and land use data.

- How will data protection rights be fulfilled?

  A disclaimer may be incorporated into the licensing process. Otherwise, each licensee has to be contacted individually for written permission.

The realization of the information system is likely going to differ according to the requirements and legal situation of each country. Parameters suggested for inclusion in the information system should therefore be considered as minimum requirements for such a system to be effective. Each country or region has the possibility to add further parameters for their own specific purposes. For example, if the abovementioned quantification of environmental effects is desired, the suggestions of the project “ReGeoCities” should be implemented; if documentation of the drilling and installation process is required, detailed information regarding grouting material, casing scheme and groundwater levels can be added; if ground collectors are to be included, additional parameters and system types can be defined.

Recommendations regarding the implementation of an information system will be given in the GeoPLASMA-CE project report “DT.2.5.1: Catalogue of success criteria for a sustainable management of shallow geothermal use”.

For more information, please refer to the individual partner questionnaires in appendices 1-6, previous project reports “DT.1.1.2: Catalogue of requirements for the web based decision support and information tool” and “DT.2.1.2: Catalogue of requirements”, the upcoming project report “DT.2.5.1: Catalogue of success criteria for a sustainable management of shallow geothermal use” and the reports of the Intelligent Energy Europe project “ReGeoCities”.

3. ANNEX

ANNEX 1	Stakeholder survey on quality standards, current policies and regulation – Results Austria
ANNEX 2	Stakeholder survey on quality standards, current policies and regulation – Results Czech Republic
ANNEX 3	Stakeholder survey on quality standards, current policies and regulation – Results Germany
ANNEX 4	Stakeholder survey on quality standards, current policies and regulation – Results Poland
ANNEX 5	Stakeholder survey on quality standards, current policies and regulation – Results Slovakia
ANNEX 6	Stakeholder survey on quality standards, current policies and regulation – Results Slovenia
ANNEX 7	Comparison of current quality standards in Central Europe

Interreg CENTRAL EUROPE
GeoPLASMA-CE
European Union
European Regional
Development Fund

ANNEX 1

STAKEHOLDER SURVEY ON QUALITY STANDARDS, CURRENT POLICIES AND REGULATIONS

RESULTS AUSTRIA

ANNEX 1 - D.T2.4.2 09 2018

Geologische Bundesanstalt
LANDESAMT FÜR UMWELT, LANDWIRTSCHAFT UND GEOLOGIE
Freistaat SACHSEN
CZECH GEOLOGICAL SURVEY
GeoZS Geološki zavod Slovenije
AGH University of Science and Technology
geoENERGIE Konzept
GiGa infosystems
Bundesverband Geothermie
City of Ljubljana

1. **Which is/are your field/s of activity?**
    a. Planning/Design
    b. Licencing (applicant)
    c. Licencing (authority)
    d. Installation
    e. Drilling
    f. Operation and Service
    g. Information systems and/or databases
    h. Research/NGO
    i. Other:

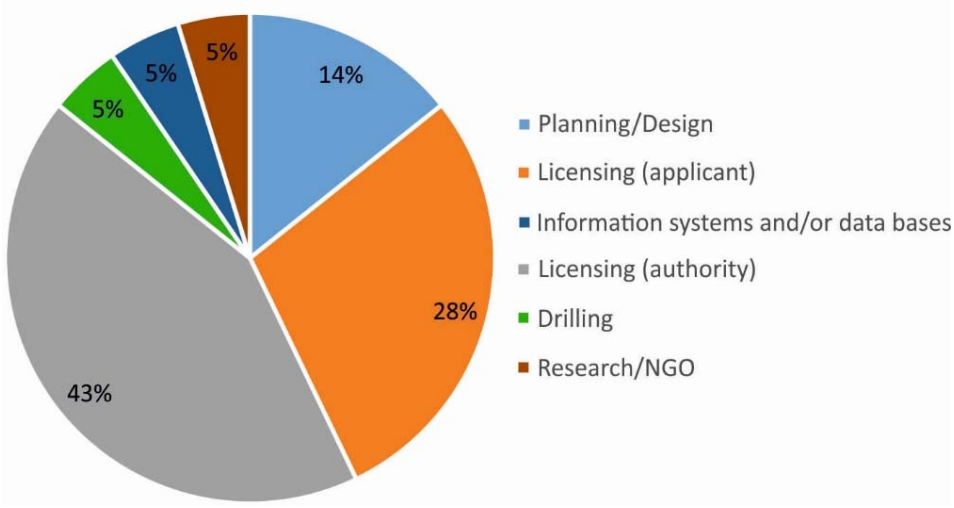


Figure 1: Participants of the online stakeholder survey in Austria

Comment: Most answers were received from the group of "Licencing (authorities)" followed by "Licencing (applicant)" and "Planning/Design". These three make up more than three quarters of all answers. Considering the similar work field of planners and applicants, answers of those two groups were summed up for the analysis of selective questions and compared with answers from authorities, which are on the opposite side of the licencing procedure.

2. What is your opinion concerning the level of technical standardization for shallow geothermal systems in general?

a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

b. I am not familiar with this topic

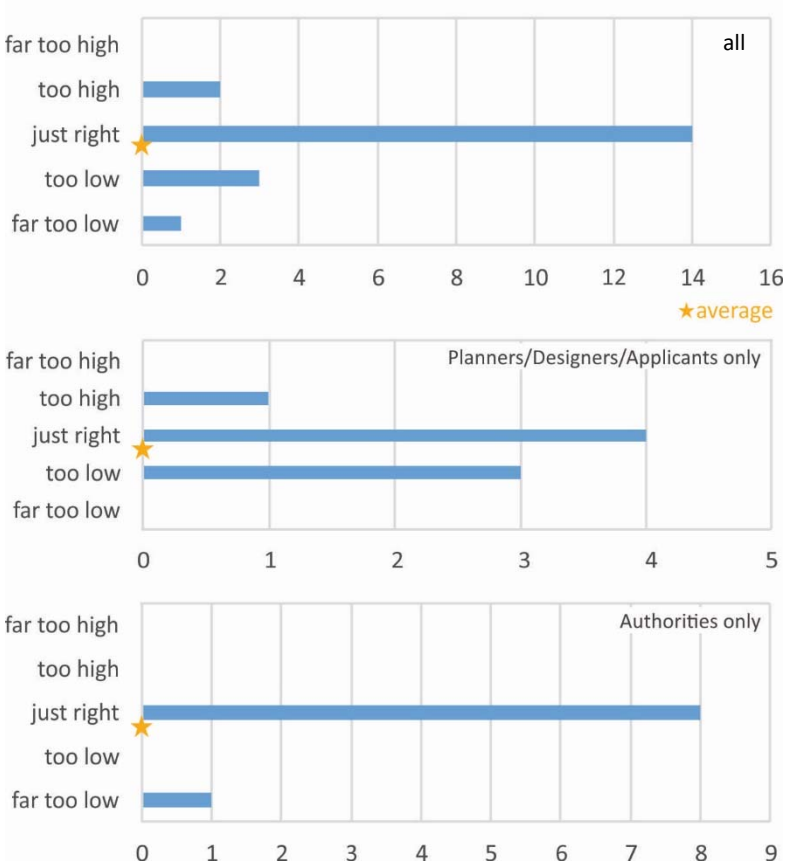


Figure 2: Analysis of question 2 of the online stakeholder survey in Austria reflecting the opinion towards the current technical standardization for shallow geothermal energy.

Comment: No participant rejected this question nor answered with "I am not familiar with this topic". More than two thirds of the participants think that the level of technical standardization is just right. Other answers tend to rate the standards too low and only two answers rate them too high. Comparing the answers of authorities with those of applicants and planners/designers, the last mentioned group show a slightly more critical opinion to the current technical standardization.

3. What is your opinion concerning the level of legal regulation for shallow geothermal systems in general?

a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

b. I am not familiar with this topic

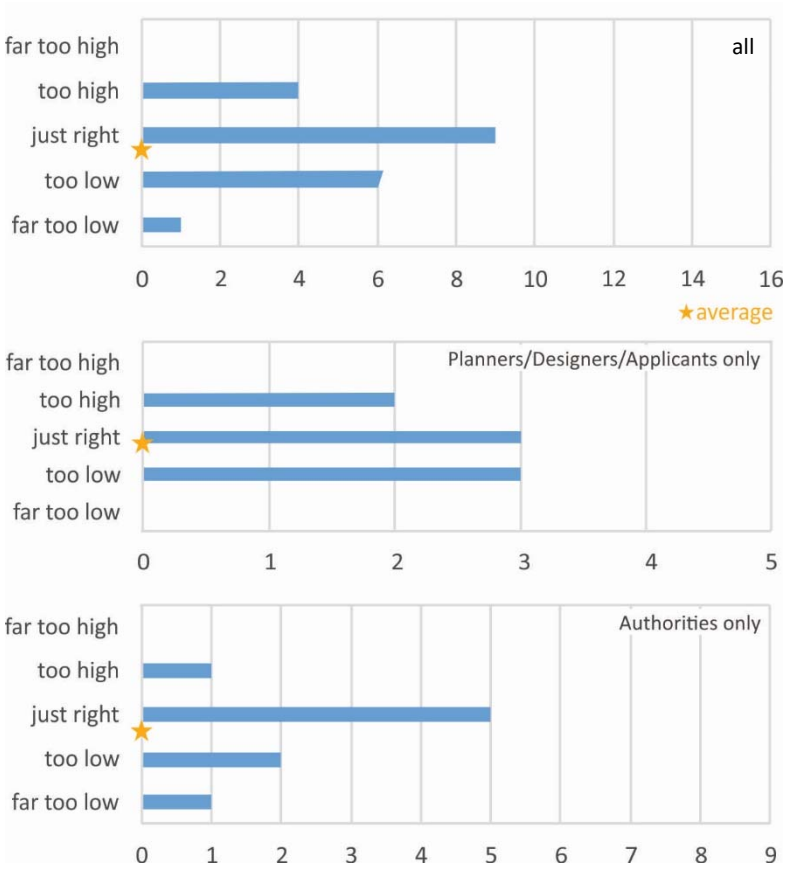


Figure 3: Analysis of question 3 of the online stakeholder survey in Austria reflecting the opinion towards the current legal regulation for shallow geothermal energy.

Comment: No participant rejected this question nor answered with "I am not familiar with this topic". Nearly half of the participants think that the level of technical standardization is just right. Most other answers tend to rate the standards too low rather than too high. There are no differences between the answers of authorities and those of applicants and planners/designers.

4. **What kind of problems do you have in your field of activity concerning shallow geothermal projects?**

Original answers Austria:

Table 1: Problems concerning shallow geothermal energy projects in Austria. Answers are grouped to deduced keywords and the associated field of activity.

Answers	Keyword	Field of activity
Unstable boreholes	Technical issues	Drilling
	Qualification of personnel	Drilling
Threats through artesian aquifers	Technical issues	Drilling
	Information supply	Information system/databases
Insuffiecient boundaries of the application	Licencing	Licencing
Not drillable areas due to lack of underground information	Information supply	Information system/databases
Planners with lack of skills in hydrogeology	Qualification of personnel	Planning/Design
No quality control of drillings and backfilling - to expensive and difficult to do	Technical issues	Drilling
	Monitoring	Licencing/Monitoring
Quality of installation of boreholes insufficient	Qualification of personnel	Drilling
To less geological information (to less assistance by authorities) in the national states coming along with bad dimensioning of systems	Information supply	Information system/databases
To long time till permission	Licencing	Licencing
Planners with lack of skills in general	Qualification of personnel	Planning/Design
Operators are not aware of their responsiblity	Qualification of personnel	Operation
To detailed simulations required	Requirements	Licencing
No uniform calculation-method (respective software) for the different geothermal systems present	Requirements	Licencing
		Planning/Design
Bad comparability of installations	Information supply	Information system/databases
Less data monitoring	Monitoring	Licencing/monitoring
Problems with neighbours	Acceptance	Operation
Lack of installation quality	Qualification of personnel	Drilling
		Installation
Big differences between results of numerical simulations and in-situ data/measured values (e.g. Calculations and pumping tests)	Requirements	Planning/Design
Inconsistent realisation of laws/guidelines already at local scale	Qualification of personnel	Licencing
Permitting prcedure and permission dependend on responsilbe person	Qualification of personnel	Licencing
Lack of standards		ALL
Less or no information about geothermal potentials	Information supply	Information system/databases
Uncontroled drilling (without notification to the authority)	Requirements	Licencing
Short circuit of aquifers	Qualification of personnel	Drilling
	Technical issues	
Pollution	Qualification of personnel	Drilling
	Technical issues	

Analysis Austria:

In total 25 different problems were identified with this survey (table 1). For analysis, each problem was then described with a single word. In total seven answers can be associated with seven keywords (table 2, figure 4). In addition, all answers were grouped to their associated field of activity (table 2, figure 5). Table

1 and 2 don´t display the frequency of single problems in the survey. This is shown in figure 4 and 5 were problems were analysed in relation to the keywords and their field of activity.

Table 2: Left: Keywords deduced from problems occurring in shallow geothermal projects. Right table: present fields of activity

Keywords
Topics controlled by authorites only - Licensing
Qualification of personnel in general
Acceptance of geothermal systems
Technical Issues
Requirements in general
Informations supply
Monitoring

Field of activity
Planning/Design
Licensing
Installation
Drilling
Operation
Information systems and/or data bases

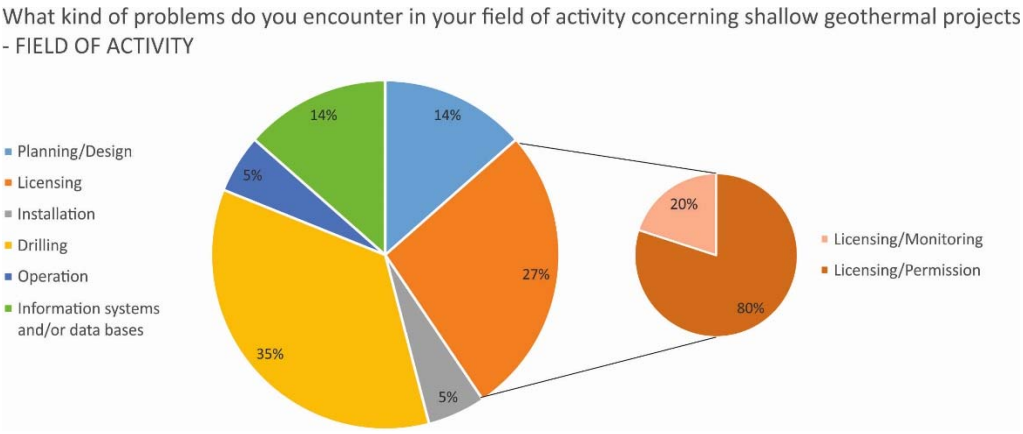


Figure 4: Analysis of problems with shallow geothermal energy projects related to the field of activity.

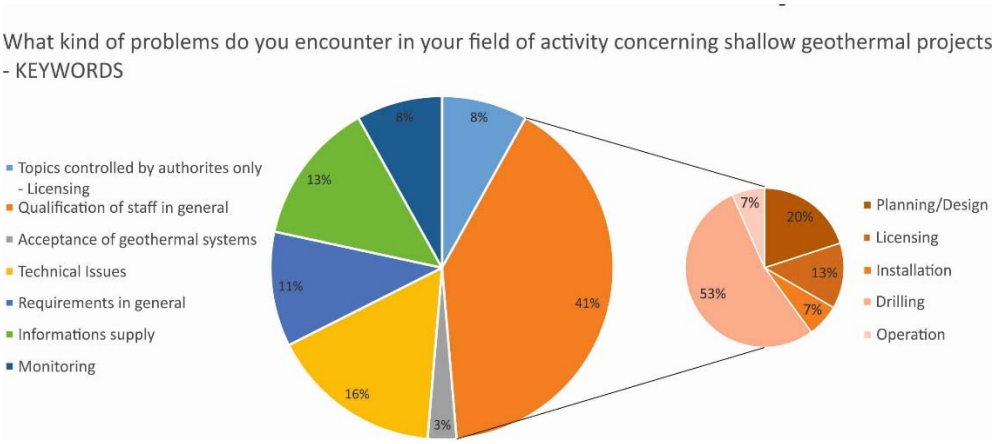


Figure 5: Analysis of problems with shallow geothermal energy projects related deduced keywords.

Comment: First of all this analysis does not consider the participants field of activity. It shows which field of activity is mentioned related to problems and topics of these problems. Most problems were identified in the field of drilling. The most mentioned problem was the lack of qualification of staff. Again, the field of is drilling the most mentioned one.

5. **Which information or standards do you know that <u>are</u> helpful in your field of activity concerning shallow geothermal projects**?

Original answers Austria:

Table 3: Existing helpful information concerning shallow geothermal energy projects in Austria. Answers are grouped to deduced keywords.

Answers	Keyword
Former drillings (position, report)	Basic information
Ehyd	Basic information
GIS applications of the national states (Wasserportal Bgld, GIS-Bgld, NÖ Atlas, Wärmepumpenatlas Salzburg, Wasserbuch)	Basic information
ÖWAV RB 207 (+ Arbeitsblatt 45)	Technical documents
Guidelines national states	Technical documents
SIA	Technical documents
ÖNORM	Technical documents
VDI	Technical documents
EN378	Technical documents
TRT	Field measurements
Temperature measurements	Field measurements
Modelling software	Calculation tools
Potential maps	Basic information
Technical know how present, documentation/controlling of the implemantion of this knowledge is difficult	Other

Analysis Austria:

Keywords
Basic information
Technical documents
Field measurements
Calculation tools
Other

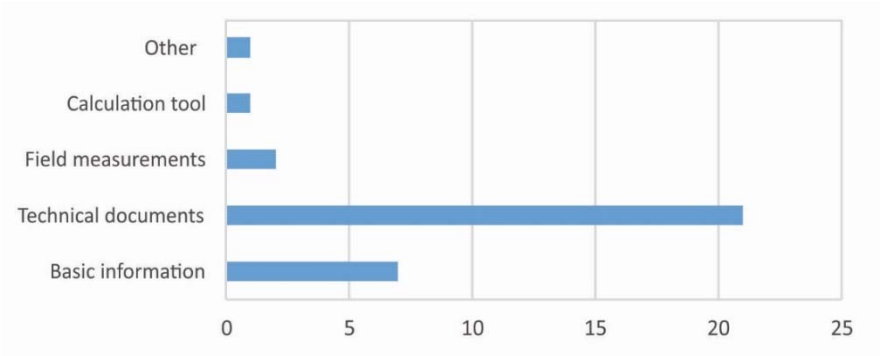


Figure 6: Analysis of helpful information or tools for shallow geothermal energy systems in Austria. Keywords are deduced from answers given by stakeholders from diverse fields of activity.

Comment: The most helpful tool for geothermal energy projects are existing technical documents for geothermal energy. The most mentioned document here is the Austrian "*ÖWAV Regelblatt 207*". Other documents are the German *VDI* or the *SIA* from Switzerland. Both last mentioned documents build the base for the "*ÖWAV Regelblatt 207*". National guidelines concerning shallow geothermal energy are also mentioned often in this context. A further useful tool are the GIS applications of the national states (e.g. *"Wasserbuch"*).

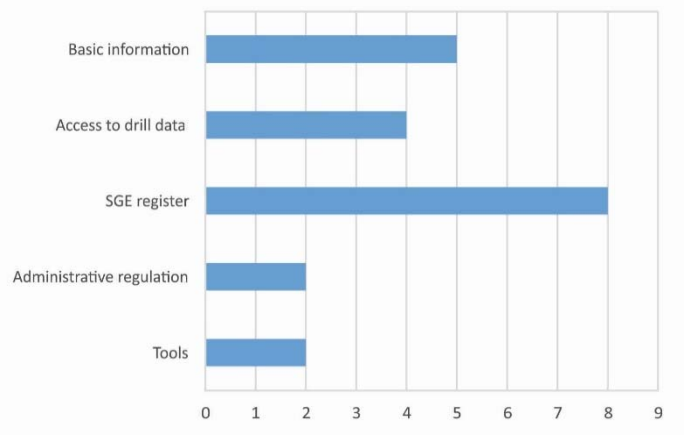
6. **Which information or standards would be helpful to you in your field of activity concerning shallow geothermal projects? Should this information be open to public?**

Original answers Austria:

Table 4: Information that would be helpful for shallow geothermal energy projects in Austria. Answers are grouped to deduced keywords.

Answers	Keyword
Open source database of completed geothermal systems (including measurements and reference values for upcoming installations and heat extraction rates)	SGE register
Access to drill data (on national, regional and local level) (e.g. GBA, Trinkwasserversorger, OMV)	Access to drill data
Groundwater/aquifer information	Basic information
temperature	
actual extraction	
Knowledge of projects which are in planning phase	SGE register
TRT	Tools
Temperature measurements	Tools
Open source data of thermal conductivity	Basic information
Potential maps (for open and closed loop) including no go areas	Basic information
Stricter regulations for planners/designers - point out to the need of professionals	Administrative regulation
Uniform planning principles	Administrative regulation

Analysis Austria:



Keywords
SGE Register
Access to drill data/statewide drill data base
Basic information
Tools
Administrative regulation

Figure 7: Analysis of information and tools that would be helpful for geothermal energy systems projects in Austria. Keywords are deduced from answers given by stakeholders from diverse fields of activity.

Comment: There is a big need of a shallow geothermal energy register in Austria. Such a register should include data from existing geothermal systems to provide reference values for upcoming installations. Similar to a SGE register also access to drilling data is mentioned as helpful tool for geothermal energy projects. Potential maps and information to underground parameters like temperature or thermal conductivity provide further mentioned helpful information or standards. In addition, possible improvements of the administrative regulation were mentioned in this context.

7. **Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?**
    a. Very helpful
    b. Less helpful
    c. No influence

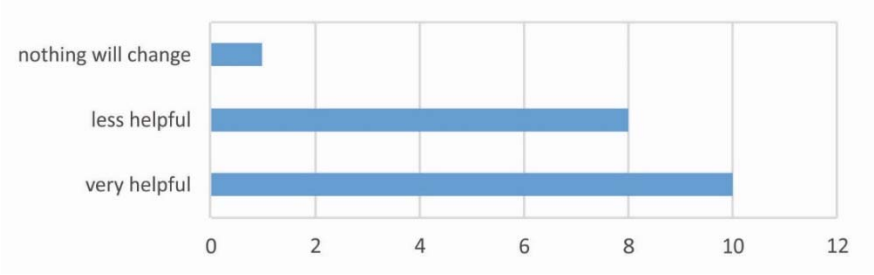


Figure 8: Results question 7: Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?

Comment: Half of the participants think that certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems. On the other hand, the other half thinks they are less helpful. A comments concerning this questions says this question couldn´t be answered without a description of this certificates. Since a big group believes in their usefulness, it is worth thinking about details for the elaboration of such certificates.

8. **How many years are you active in the field of geothermal energy?**
    a. < 2
    b. 3-5
    c. 6-10
    d. 11-20
    e. > 20

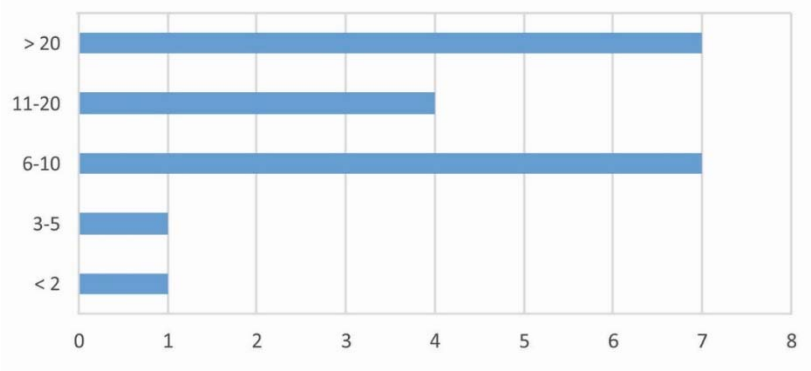


Figure 9: Results question 8: How many years are you active in the field of geothermal energy?

Comment: Most participants are longer than 6 years active in the field of geothermal energy. This calls for a good quality of the answers since a long experience definitely enhances the percipience for problems.

9. Place for your remarks, recommendations and ideas

No expert opinions were given to these questions. One comment concerned question 7 and is mentioned in this section of the document.

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ANNEX 2

STAKEHOLDER SURVEY ON QUALITY STANDARDS, CURRENT POLICIES AND REGULATIONS

RESULTS CZECH REPUBLIC

Annex 2 - D.T2.4.2 09/2018

Geologische Bundesanstalt
LANDESAMT FÜR UMWELT, LANDWIRTSCHAFT UND GEOLOGIE
Freistaat SACHSEN
CZECH GEOLOGICAL SURVEY
GeoZS Geološki zavod Slovenije
AGH University of Science and Technology
geoENERGIE Konzept
GiGa infosystems
Bundesverband Geothermie
City of Ljubljana

1. **Which is/are your field/s of activity? (Multiple choices are possible)**
    a. Planning/Design
    b. Licencing (applicant)
    c. Licencing (authority)
    d. Installation
    e. Drilling
    f. Operation and Service
    g. Information systems and/or databases
    h. Research/NGO
    i. Other:

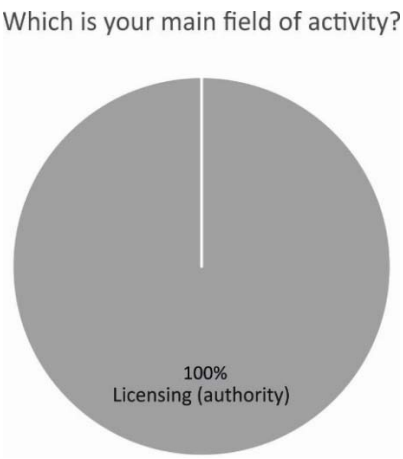

Figure 1: Participants of the online stakeholder survey in the Czech Republic

Comments: All answers were received from the group of "Licencing (authorities)".

2. What is your opinion concerning the level of technical standardization for shallow geothermal systems in general?

a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

b. I am not familiar with this topic

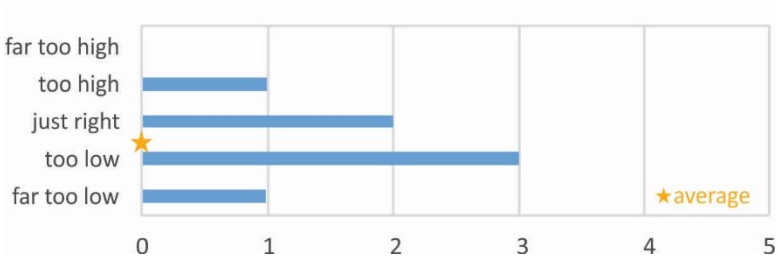

Figure 2: Analysis of question 2 of the online stakeholder survey in the Czech Republic reflecting the opinion towards the current technical standardization for shallow geothermal energy.

Comments: No participant rejected this question nor answered with "I am not familiar with this topic". More than a third of the participants think that the level of technical standardization is just right. Nearly two thirds think that the level is too low or far too low. Only one participant rates them too high. With an average value of 2.4, the average opinion tends to rate the level too low.

3. **What is your opinion concerning the level of legal regulation for shallow geothermal systems in general?**

a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

b. I am not familiar with this topic

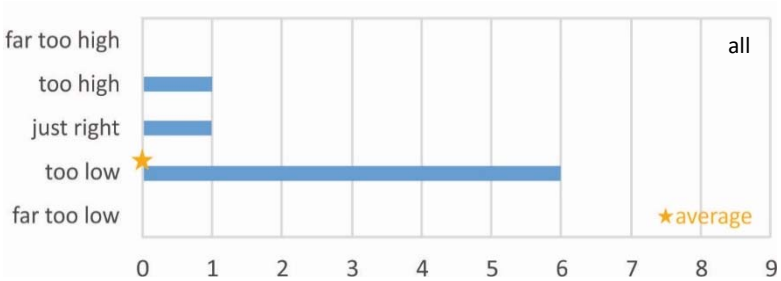

Figure 3: Analysis of question 3 of the online stakeholder survey in the Czech Republic reflecting the opinion towards the current legal regulation for shallow geothermal energy.

Comments: No participant rejected this question nor answered with "I am not familiar with this topic". Three quarters of the participants think that the level of legal regulation is too low. This also reflects the average opinion in this survey. Only two participants rate them just right or rates too high.

4. **What kind of problems do you have in your field of activity concerning shallow geothermal projects?**

Table 1: Problems concerning shallow geothermal energy projects in the Czech Republic.

Answers
Not good public knowledge
None
Nothing special, just few installations - spa area
The approval for the drilling is obtained after the boreholes are already drilled
Legal requirements are not well organized (very scattered within the legal system)
Many ongoing governing procedures at the same time at many different instiutions
Drilling companies get penalties for unallowed drilling --> they do not pay --> they transfer the company to a new company under another name
Low public knowledge
Bad experiences related to shale gas
The documents that are legally required for the permit are being issued after the installation is finished as the public does not know the correct precedure
Problematic hydrogeologic consultations, there should be some authorisation, that might be canceled according to the praxis

Comments: Stakeholders' answers indicate that applicable regulations are scattered throughout the legal catalogue and that relevant information is not presented clearly. The stakeholder feedback has to be evaluated based on the fact that during the licensing process, several authorities have to provide (binding) statements simultaneously while others only have the possibility to provide non-binding recommendations. Furthermore, the authorities involved in the licensing process differ depending on the chosen well approval process. Therefore, even the authorities themselves may struggle with regards to the correct licensing procedure, in particular because SGE installations are currently quite rare.

5. **Which information or standards do you know that <u>are</u> helpful in your field of activity concerning shallow geothermal projects**?

Table 2: Existing helpful information concerning shallow geothermal energy projects in the Czech Republic.

Answers
legal requirements set by ministries
does not know
territorial concept of the Hradec Kralove regional authority
legal requirements set by ministries
documents related to the legal acts
basic legal requirements

Comments: Within the local authorities the most useful documents were issued by the regional authority of the Hradec Králové region or by ministries. However, the lack of practice of individual authorities seems to be in some cases limiting.

6. **Which information or standards would be helpful to you in your field of activity concerning shallow geothermal projects? Should this information be open to public?**

Table 3: Information that would be helpful for shallow geothermal energy projects in the Czech Republic.

Answers
Standardized workflow
single general legal act or regulation regarding geothermal energy
energy strategy
does not know (3 x)

Comments: Well-arranged and comprehensive information on SGE installations can only be found on webpages of suppliers and the Czech heat pump association. A publicly accessible website or document with an official and standardized workflow would be welcomed.

7. **Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?**
    a. Very helpful
    b. Less helpful
    c. No influence

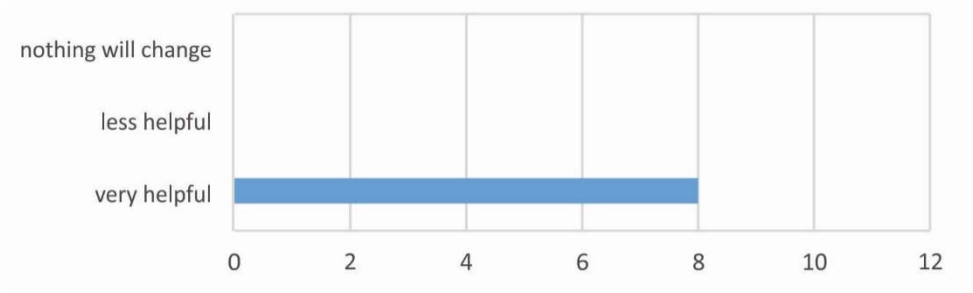

Figure 4: Results question 7: Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?

Comments: All participants think that certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems. The Czech heat pump association currently provides certification for installers of SGE but this is not mandatory, i.e. provided that the required paperwork is submitted during the licensing process, anyone can get the concession to install a heat pump.

8. How many years are you active in the field of geothermal energy?

a. < 2
b. 3-5
c. 6-10
d. 11-20
e. > 20

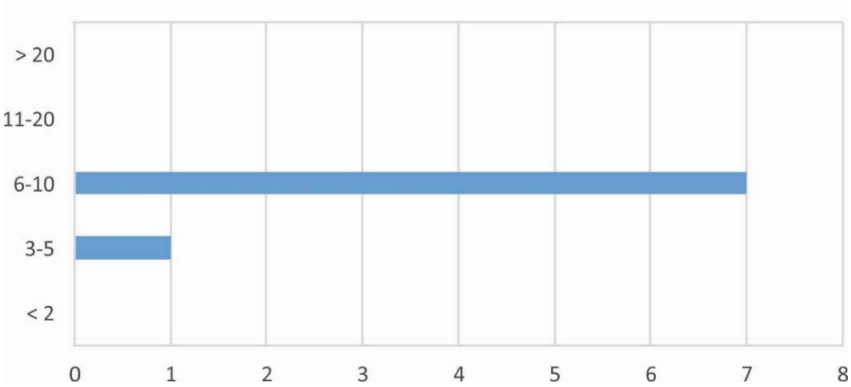

Figure 5: Results question 8: How many years are you active in the field of geothermal energy?

Comments: Even though most of the local authority representatives in this survey have been active in this field for a number of years, the expertise in the field of geothermal energy is fairly limited, since these are usually executive officers from the departments of water right, building or environment.

9. Place for your remarks, recommendations and ideas

No expert opinions were given to these questions.

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ANNEX 3

STAKEHOLDER SURVEY ON QUALITY STANDARDS, CURRENT POLICIES AND REGULATIONS

RESULTS GERMANY

Annex 3 - D.T2.4.2 09 2018

Geologische Bundesanstalt
LANDESAMT FÜR UMWELT, LANDWIRTSCHAFT UND GEOLOGIE
Freistaat SACHSEN
CZECH GEOLOGICAL SURVEY
GeoZS Geološki zavod Slovenije
AGH University of Science and Technology
geoENERGIE Konzept
GiGa infosystems
Bundesverband Geothermie
City of Ljubljana

1. **Which is/are your field/s of activity? (Multiple choices are possible)**
    a. Planning/Design
    b. Licencing (applicant)
    c. Licencing (authority)
    d. Installation
    e. Drilling
    f. Operation and Service
    g. Information systems and/or databases
    h. Research/NGO
    i. Other:

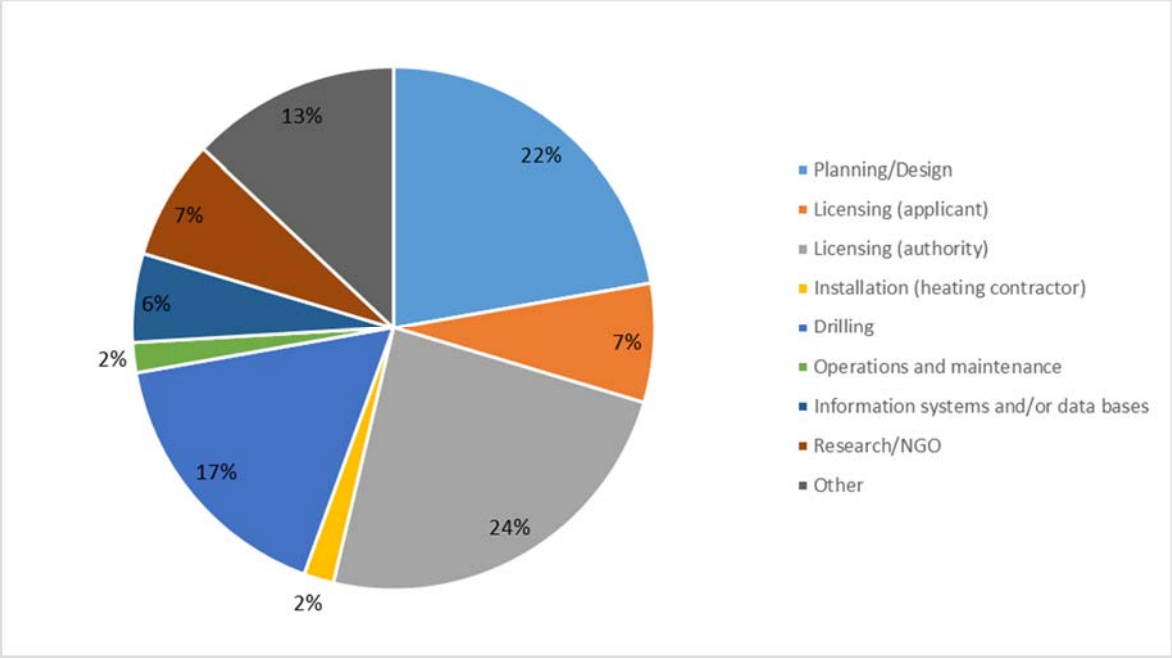

Figure 1: Participants of the online stakeholder survey in Germany.

Comments: 54 persons participated in the survey. Authorities and planners each contributed roughly a quarter of the answers. A sixth of the answers were provided by drilling contractors.

2. What is your opinion concerning the level of technical standardization for shallow geothermal systems in general?

a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

b. I am not familiar with this topic

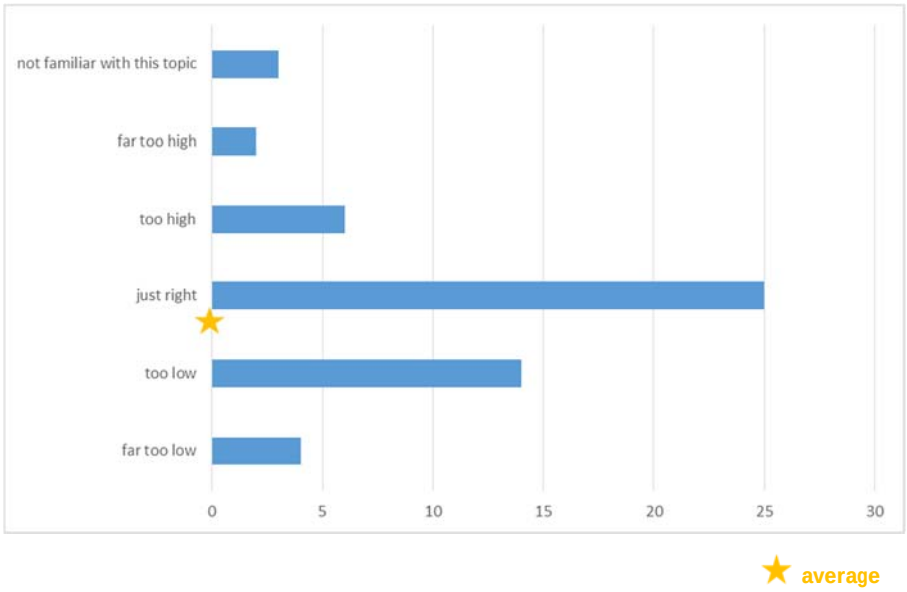

Figure 2: Analysis of question 2 of the online stakeholder survey in Germany reflecting the opinion towards the current technical standardization for shallow geothermal energy.

Comments: No participant rejected this question, and only two answered with "I am not familiar with this topic". On average, the level of technical standardization was viewed as slightly too low. Almost half of the participants believe that the level of technical standardization is just right, 25% think it is too low and 10% too high. Very few participants are of the opinion that the level of technical standardization in Germany is far too high or far too low. Looking at the field of activity of the participants, more than two thirds of authorities but only one third of drilling contractors believe that the level of technical standardization is just right.

3. What is your opinion concerning the level of legal regulation for shallow geothermal systems in general?

a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

b. I am not familiar with this topic

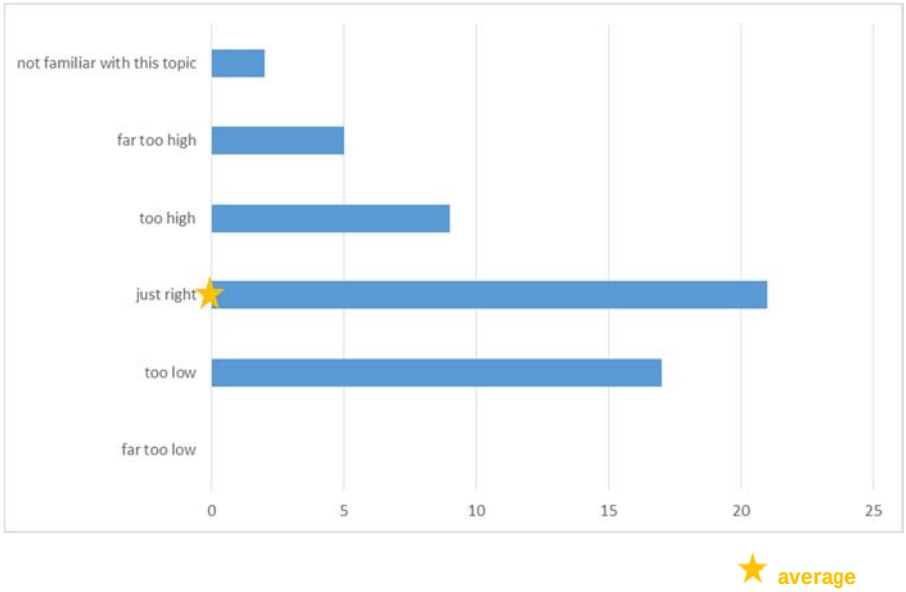

Figure 3: Analysis of question 3 of the online stakeholder survey in Germany reflecting the opinion towards the current legal regulation for shallow geothermal energy.

Comments: No participant rejected this question, and only two answered with "I am not familiar with this topic". On average, the level of technical standardization was viewed as exactly right. Looking at the field of activity of the participants, more than two thirds of authorities think that the standards are too low, whereas only a quarter of all other participants believe this.

4. What kind of problems do you have in your field of activity concerning shallow geothermal projects?

Table 1: Problems concerning shallow geothermal energy projects in Germany. Answers are grouped by deduced keywords. Number of instances each answer was given is indicated.

Answers	Keyword	Count
Coordination with other trades	Coordination with other trades	3
Interests of installation companies not sufficiently considered	Coordination with other trades	1
Acceptance	Acceptance	3
Requirement for notification not adhered to	Licensing	1
Regulations differ between regions	Licensing	5
Licensing	Licensing	5
Qualification of licensing authorities	Licensing	1
Technical obligations for licensing	Licensing	1
Time-consuming, restrictive licensing process	Licensing	2
Unclear responsibilities	Licensing	1
Incorrect technical realization	Qualification of personnel	3
Design	Qualification of personnel	1
Qualification of drilling companies	Qualification of personnel	5
Knowledge of drilling companies	Qualification of personnel	2
Deficient design	Qualification of personnel	3
Mutual influence of neighbouring installations	Technical Issues	1
Scaling/precipitation	Technical Issues	1
Lack of verification during installation	Technical Issues	2
Lack of monitoring	Technical Issues	1
Lack of basic information	Technical Issues	2
Pricing / economic feasibility	Economic viability	3
Price dumping	Economic viability	1

Table 2: Keywords used to group common problems in Germany.

Keywords
Coordination with other trades
Licensing
Qualification of personnel
Acceptance
Technical Issues
Economic viability

Comments: 49 of 54 participants answered this question. Of the problems indicated by participants, the vast majority can be traced back to two underlying reasons: Lack of qualification and issues relating to the licensing process. Technical issues were mentioned significantly less often.

5. **Which information or standards do you know that are helpful in your field of activity concerning shallow geothermal projects**?

Table 3: Existing helpful information concerning shallow geothermal energy projects in Germany. Answers are grouped to deduced keywords.

Answer	Keyword	Count
Swiss Norms (SIA)	Other technical procedures	3
DIN (EN15450)	Other technical procedures	5
Standard procedures	Other technical procedures	4
DVGW-Arbeitsblätter	Other technical procedures	6
VDI 4645	Other technical procedures	1
Web portal	Basic information	7
Drilling data archive	Basic information	2
Geological map	Basic information	4
Calculation tool	Calculation tool	1
Guidelines	Guidelines	12
BWP guidelines	Guidelines	1
Brochure	Other	1
Events	Other	1
Company website	Other	1
Presentations	Other	1
Work group	Other	1
Insurance	Other	1
Verification algorithm	Other	1
Manufacturer's presentation materials	Technologies	1
LAWA recommendations	Guidelines	2
Technological component	Technologies	1
VDI 4640	VDI 4640	22

Table 4: Keywords used to group useful available information.

Keyword
Other technical procedures
Basic information
Calculation tool
Guidelines
Other
Technologies
Guidelines
VDI 4640

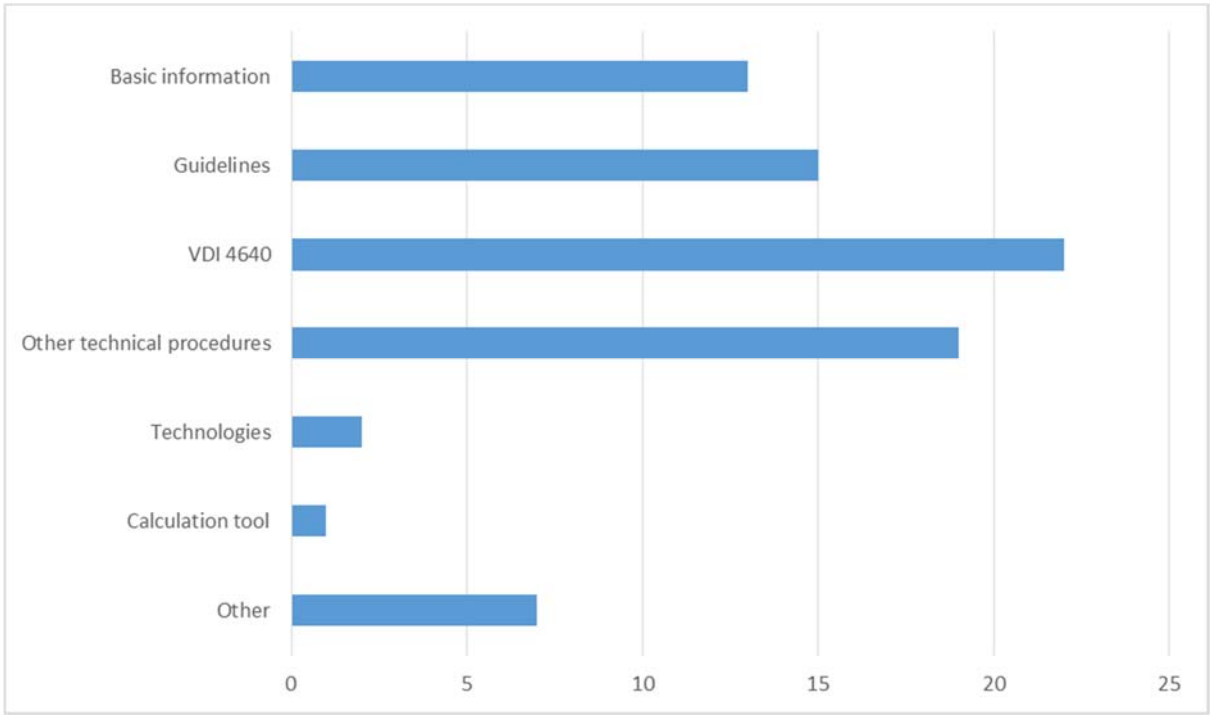

Figure 4: Analysis of helpful information or tools for shallow geothermal energy systems in Germany. Keywords are deduced from answers given by stakeholders from diverse fields of activity.

Comments: Nine participants skipped this question. Of those participants that answered, half named VDI 4640 as an important basis for their work. DVGW installation procedures, Swiss SIA norms and other German or European norms (DIN / EN) were also mentioned repeatedly. However, it was noticeable that a number of very diverse data sources are utilized.

6. Which information or standards would be helpful to you in your field of activity concerning shallow geothermal projects? Should this information be open to public?

Table 5: Information that would be helpful for shallow geothermal energy projects in Germany. Answers are grouped to deduced keywords.

Answer	Keyword	Count
Recommendations for inspections/controls	Administrative regulation	1
new VDI 4640 similar to SIA	Technical guidelines	1
harmonised regulations (nationwide)	Licensing	5
Information from mining authorities	Basic information	1
General information	Other	3
Clear, easy-to-follow licensing procedures	Licensing	1
Updated and easily accessible guidelines for each federal state	Licensing	3
Designation of development areas in which geothermal energy is not desired	Basic information	1
Integrated planning of all works from heat demand estimation to drilling and operation	Technical guidelines	1
Support relating to hazardous materials	Technical guidelines	1
Voluntarily provided information about existing installations	Other	1
Thermophysical properties of rocks	Basic information	5
Drilling reports	Basic information	1
Information regarding drilling risks and geothermal potential	Basic information	1
Standardized information systems forall federal states	Basic information	1
Efficiency calculations / system combination	Technical guidelines	1
Information regarding heat pump electricity tariffs	Other	1
List of competent contractors	Listing of qualified companies	2
Further education for personnel of authorities	Licensing	1
Empirical values of heat pump compressors	Other	1
Simple calculation tools	Tools	1
Information regarding restrictions	Basic information	1
Groundwater management	Licensing	1
Standardized service specifications	Other	1
Location appraisals and visualization of restrictions	Basic information	3
Publication of results of regional projects	Other	1
Access to stratigraphical information	Basic information	1

Table 6: Keywords used to group useful, missing information

Keyword
Basic information
Licensing
Technical guidelines
Administrative regulation
Tools
Listing of qualified companies
Other

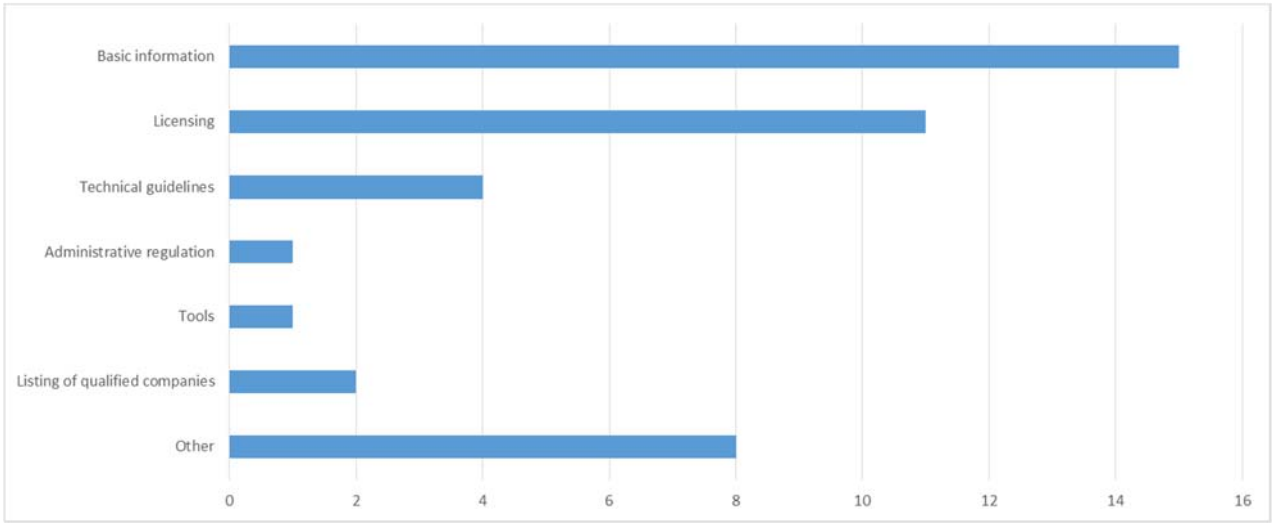

Figure 5: Analysis of information and tools that would be helpful for geothermal energy systems projects in Germany. Keywords are deduced from answers given by stakeholders from diverse fields of activity.

Comments: 44 participants answered this question. Of those, more than a third states a need for basic information such as land-use conflicts, restrictions, rock properties or drilling hazards. This could be made accessible in the form of digital data. A quarter of participants would welcome improvements to the licensing process. The main item is the standardization of the licensing regulations across all federal states and, failing that, clear guidelines for each state.

7. **Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?**
    a. Very helpful
    b. Less helpful
    c. No influence

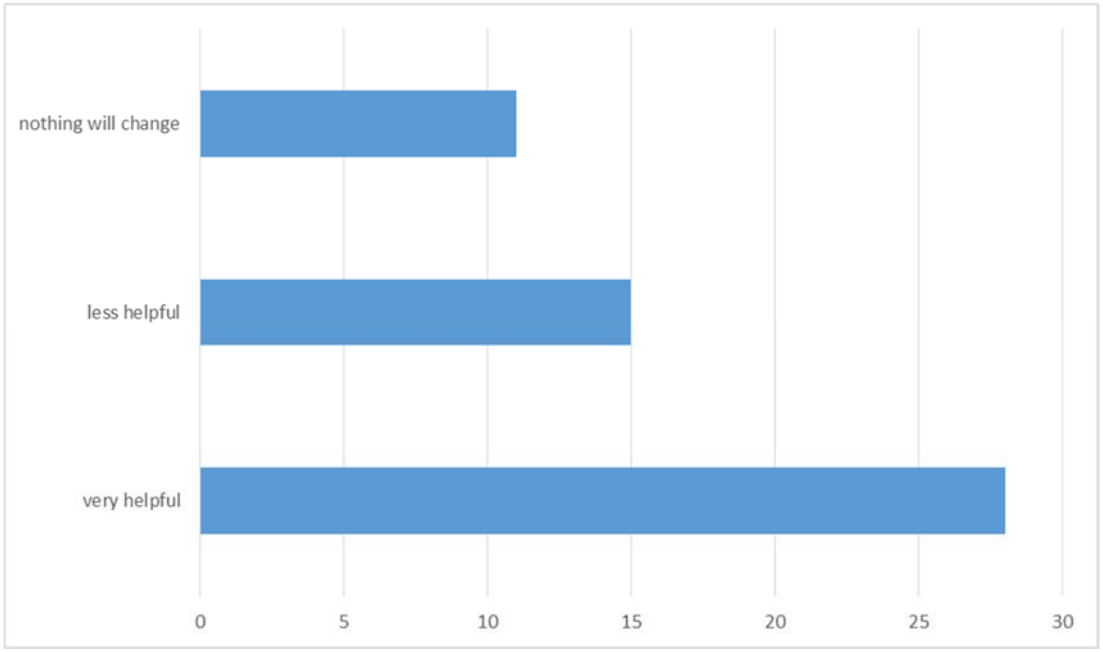

Figure 6: Analysis question 7: Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?

Comments: All participants answered this question. More than half think that certification will be very helpful for quality improvements whereas 20% believe it will make no difference. Notably, 2/3 of the drilling contractors but less than 1/3 of the authorities believe in the impact of certification.

8. How many years are you active in the field of geothermal energy?

a. < 2
b. 3-5
c. 6-10
d. 11-20
e. > 20

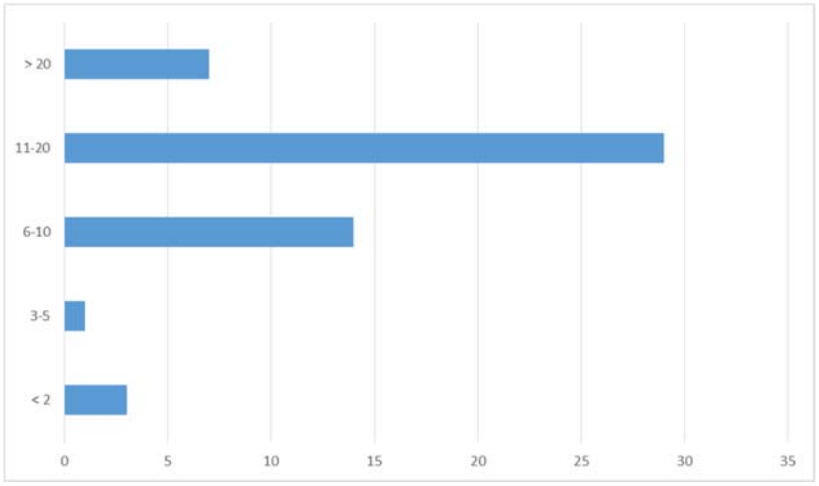

Figure 7: Analysis of question 8: How many years are you active in the field of geothermal energy?

Comments: Two thirds of the participants have been working with geothermal energy for more than 10 years.

9. Place for your remarks, recommendations and ideas

Table 7: Remarks, recommendations and ideas

Answer	Keyword
Guidelines for the quality assurance of boreholes deeper than 10 m should be compiled for Saxony.	Quality
Utilization of geothermal energy has become more complicated for owners, in particular since the drilling contractor has to be certified in order to be allowed to install borehole heat exchangers. Useless and often impractical restrictions which are arbitrarily imposed by the authorities discourage the use of geothermal energy.	Restrictions
Requirements for geothermal boreholes are much lower than comparable water wells. All of the problems experienced are caused by not adhering to applicable legal regulations. Companies which neither had nor have any technical qualification in the field of well construction received special permits. This was state-approved wage and price dumping. The legal requirement for registration in the official register for craftsmen was neither requested nor verified. This alone would have been sufficient to guarantee a high standard of the execution of the works. Separation of trades would be equally helpful. Drilling and installation of the heating have to be strictly separated. Heating contractors or architects are not required to erect a fully functional and satisfactory borehole heat exchanger. Standardized service specifications as common in well construction suffice to answer all questions. The relevant DIN norms exist for a long time and are continuously updated and adapted.	Standards
Certificationof drilling companies is necessary (DVGW, Zert Bau etc.). Repeatedly insufficient execution or violations should be punished consistently. Installation contractors and planners should be educated and trained well. A certifiction is of limited use.	Certification
The question about standards is confusing. Are ALL useful standards supposed to be listed? Question 7: In my opinion, this question should be asked separately for drilling contractors, installation contractors and planners. Certification for drilling companies is already mandatory in most federal states!	Certification
It has to be communicated that improved quality are of advantage or necessary both for the general public (groundwater protection) and the owner (longevity and efficiency of the system).	Quality
When establishing standards, theory and practice should be joined together. It should also be considered that installations have to remain economical.	Standards
The goal of standardizing requirement for geothermal installations is very important!	Standardized requirements
Uniform procedures already fail within the individual federal states since the water authorities act differently.	Standardized requirements
Due to the oftentimes low quality of executing drilling contractors it has to be feared that geothermal energy receives a very negative image in public since only correctly installed systems will function satisfactorily. More controls by authorities and certification bodies is urgently required.	Acceptance
For a welding certificate, persons are trained according to DVGW GW 330 but are then not working on site. The skilled workers require certification, not the managers. The same with DVGW W-120 certificate: Sometimes, unskilled/untrained workers perform the installation, install the connections and fill the system.	Lack of skilled personnel
Public image received lasting damage by incidents in the past. Public acceptance of shallow geothermal installations can only be achieved by increased public relations activities and demonstration wells.	Acceptance

Answer	Keyword
In my experience, design of geothermal systems should be performed by independent planners and not by heating contractors or drilling companies.	Planning expertise
Geological reports generated by geoscientists should be mandatory for all projects; experts should have certification and 5 years of work experience in the subject field; drilling companies and heat pump manufacturers should not be allowed to plan ground source systems.	Planning expertise
Change or better visibility of building planning would be necessary. Earlier cooperation with energy planners.	Cooperation
In my opinion there should be more controls. In order to avoid sending authority representatives to each and every site, photographic documentation in combination with a Skype video conference can be introduced to support critical operations. This is the current status of discussions in Thuringia amongst professional association, upper water authorities and geological survey. Furthermore, it is necessary to train administrative employees (e.g. GZB, Holger Born). It would be important to me to avoid cost-intensive restrictions which destroy the financial viability of shallow geothermal systems.	Controls

Comments: 22 participants used the opportunity to add remarks to the comments section of the questionnaire. Sixteen of these comments were related to shallow geothermal energy installations; they are listed in figure 8. Participants raised several topics and concerns. Several participants called for stricter controls and consequences for non-compliance with standards, regulations or restrictions. Three participants would like to see a separation of responsibilities, in particular relating to the design and planning which should be undertaken by qualified planners instead of drilling contractors or heating contractors. The issue of acceptance and public image was also raised.

Interreg CENTRAL EUROPE
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ANNEX 4

STAKEHOLDER SURVEY ON QUALITY STANDARDS, CURRENT POLICIES AND REGULATIONS

RESULTS POLAND

Annex 4 - D.T2.4.2 09 2018

Geologische Bundesanstalt
LANDESAMT FÜR UMWELT, LANDWIRTSCHAFT UND GEOLOGIE
Freistaat SACHSEN
CZECH GEOLOGICAL SURVEY
GeoZS Geološki zavod Slovenije
AGH University of Science and Technology
geoENERGIE Konzept
GiGa infosystems
Bundesverband Geothermie
City of Ljubljana

1. **Which is/are your field/s of activity? (Multiple choices are possible)**
    a. Planning/Design
    b. Licencing (applicant)
    c. Licencing (authority)
    d. Installation
    e. Drilling
    f. Operation and Service
    g. Information systems and/or databases
    h. Research/NGO
    i. Other: (including: heat pump owner, heat pump manufacturer, heat pump distributor)

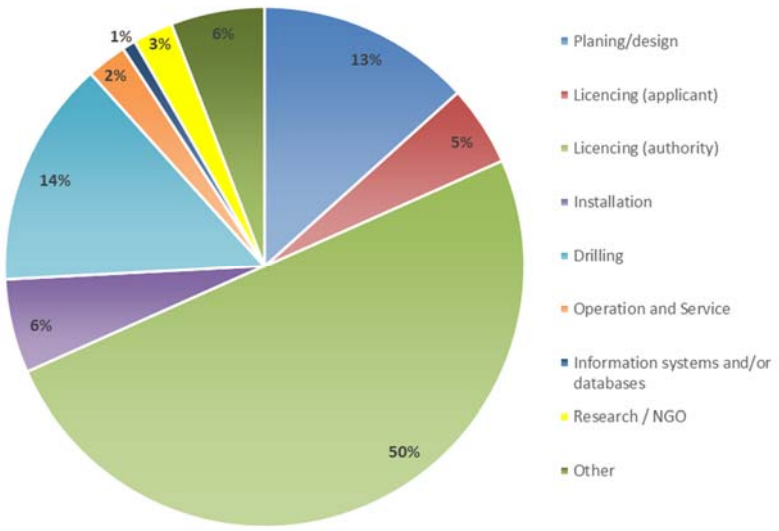

Figure 1: Participants of the stakeholder survey in Poland.

Comments: 120 persons participated in the survey. The survey was carried out in two approaches. First set of stakeholder surveys was distributed at the National Stakeholder Event in Poland on 22. May 2018. Feedback consisted of 39 filled questionnaires (mostly by GSHP designers, drillers and installers). PGI-NRI, AGH UST and PORT PC distributed the second set as an online questionnaire.

The group that was mostly reached are officials from geological authorities (Licensing-Authority – 50% of total survey feedback).

2. What is your opinion concerning the level of technical standardization for shallow geothermal systems in general?

a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

b. I am not familiar with this topic

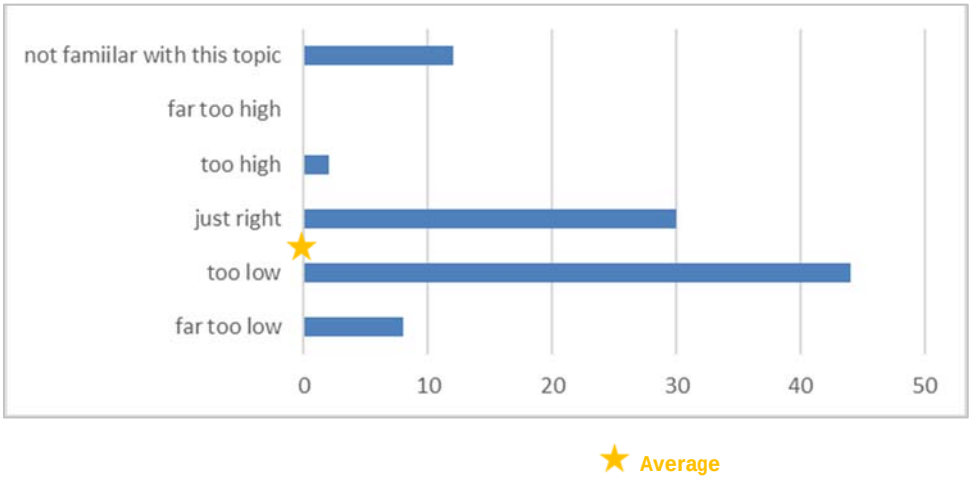

Figure 2: Analysis of question 2 of the online stakeholder survey in Poland reflecting the opinion towards the current technical standardization for shallow geothermal energy.

Comments:

24 respondents skipped this question. There were 96 answers for this question. 12 respondents were not familiar with this topic. Other 84 answers indicate, that the general opinion on the level of technical standardization for shallow geothermal systems is too low (46% of all answers and 8% for far too low). The average result reflects the status of polish GSHP market nowadays quite good. There is still a need to provide more standards and guidelines to the public, stakeholders and end-users.

3. What is your opinion concerning the level of legal regulation for shallow geothermal systems in general?

a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

b. I am not familiar with this topic

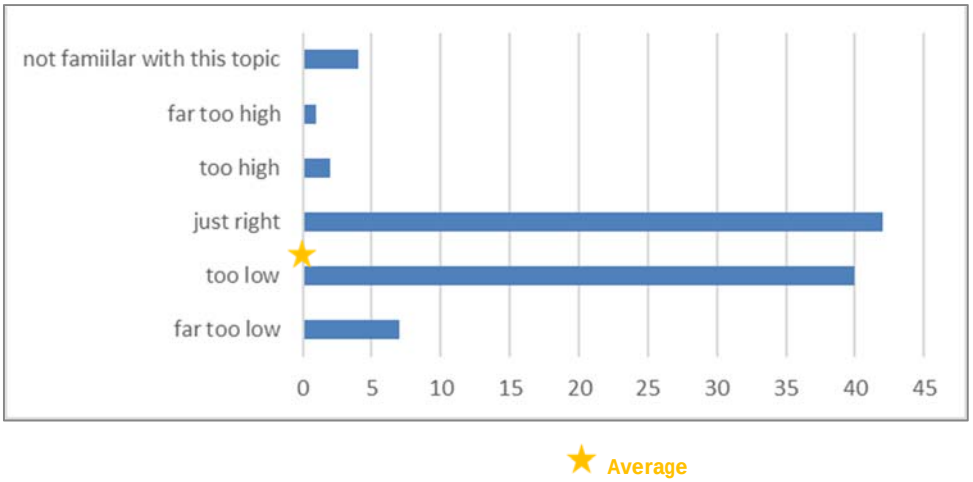

Figure 3: Analysis of question 3 of the online stakeholder survey in Poland reflecting the opinion towards the current legal regulation for shallow geothermal energy.

Comments: 24 respondents skipped this question. There were 96 answers for this question. Four respondents were not familiar with the topic. Other 92 answers indicated that the level of legal regulation in Poland is somewhere between just right and too low (respectively 44% and 42% votes). This duality of responses shows clearly that professional groups of GSHP designers, drillers and installers generally do not want too strict legal regulations, as they may by a barrier for market development. On the other hand, the geological authorities are pointing out to the fact, that there is a need to increase the level of legal regulations.

4. **What kind of problems do you have in your field of activity concerning shallow geothermal projects?**

Table 1: Problems concerning shallow geothermal energy projects in Poland. Answers are grouped by deduced keywords. Often used abbreviations: GSHP – Ground Source Heat Pump; BHE – Borehole Heat Exchanger

Answers	Keyword	Field of Activity
No easily available data regarding geological profile and thermophysical parameters of soils and rocks in the area of planned GSHP and BHE installation.	Information supply	Planning/design
The GSHP installers often do not have proper information on local geological conditions (either the geological information is not easily available or they do not want to take effort to reach this information). Also the GSHP installers lack the complete / holistic approach to the GSHP systems - they are focused only on the heat pump device and heating system, they do not care about optimal dimensioning of borehole heat exchangers (the ground source) or optimization of the whole system to meet the building needs (operation in heating and cooling modes).	Information supply	Research / NGO
The GSHP installers often do not have proper information on local geological conditions	Information supply	Drilling
The GSHP installers often do not have proper information on local geological conditions	Information supply	Planning/design
There is very limited access to the information about GSHP installations case studies, including especially energy performance, durability, and reliable companies.	Information supply	Licensing (authority)
Lack of easily available geological data dedicated for GHSP systems design. There is a big demand for shallow geothermal potential maps for the area of Poland, especially a version with heat-extraction-rate values.	Information supply	Planning/design
There is no database of GSHP and BHE designers and drillers.	Information supply	Licensing (authority)
Lack of easily available geological data dedicated for GHSP systems design. There is a big demand for shallow geothermal potential maps for the area of Poland, especially a version with heat-extraction-rate values.	Information supply	Licensing (authority)
No data on energy efficiency of soil.	Information supply	Other
No TRT measurements included in geotechnical site investigation plan documentations	Information supply	Installation
Not enough reliable and experienced BHE designers. High cost of BHE design and drilling reports.	Qualification of personnel in general	Licensing (authority)
Information barrier among the investors, designers, contract engineers and Quality Supervisors about the legal regulations regarding the GSHP and BHE installation.	Qualification of personnel in general	Licensing (authority)

Answers	Keyword	Field of Activity
Information barrier among the investors, designers, contract engineers and Quality Supervisors about the legal regulations regarding the GSHP and BHE installation.	Qualification of personnel in general	Drilling
Low quality of BHE design reports. Low quality of graphical appendixes (especially documentation map and cross sections).	Qualification of personnel in general	Licensing (authority)
The calculations of heat extraction of designed BHEs are often of low quality. In addition, the building demand vs. BHEs heat/cold extraction is often not properly balanced.	Qualification of personnel in general	Licensing (authority)
Limited knowledge about GSHP systems among geological administration officials. Too much influence of GSHP producers for technical specifications of heating/cooling devices prepared for the public pro-ecological, pro-renewables subsidies programmes.	Qualification of personnel in general	Licensing (authority)
Unfair practices - performing work contrary to the BHE project (bad backfilling of the ring space, connection of water-bearing horizons).	Qualification of personnel in general	Drilling
Unsatisfactory level of knowledge from local authorities on heat pumps and drilling process.	Qualification of personnel in general	Drilling
There should be more clear definition and description of environmental impact criteria. If they are not fulfilled, geological authorities should have the allowance to raise objection for BHE drilling.	Requirements in general	Licensing (authority)
Problems with environmental hazards regarding BHE installation (artesian groundwater level, mixing separate groundwater levels)	Requirements in general	Drilling
Some producers or resellers offer the heat pumps without any certification and testing of their products (quality issue).	Requirements in general	Other
BHE quality. As the market in Poland is mostly price-oriented, the quality of some BHE is low. Such BHEs can cause future environmental hazards (for example due to the low quality of sealing material) and cannot fulfil the legal regulations of Polish Geological Law.	Requirements in general	Operation and Service
There is limited information about new developments in circulation fluids.	Requirements in general	Other
Environmental impact on groundwater must be taken into account during design and drilling of BHEs.	Requirements in general	Licensing (authority)
Lack of geotechnical site investigation plan documentations	Requirements in general	Drilling
There are no detailed guidelines regarding the borehole spacing and their construction. Often the BHE drillings are performed without the notification to local geological authorities. Problems with BHE drilling reports submission after finalization of geological works. Geological authorities do not approve the BHE drilling reports in form of an	Technical Issues	Licensing (authority)

Answers	Keyword	Field of Activity
official decision. Their submission is only notified and the documents are archived.		
The measurement of temperature at the bottom of BHE profile is very uncommon.	Technical Issues	Licensing (authority)
There should be more clear definition and description of environmental impact criteria, which if they are not fulfilled, should allow the geological authorities to raise objection for BHE drilling. There are no detailed guidelines regarding the borehole spacing and their construction. Often the BHE drillings are performed without the notification to local geological authorities. Problems with BHE drilling reports submission after finalization of geological works. Geological authorities do not approve the BHE drilling reports in form of an official decision. Their submission is only notified and the documents are archived.	Technical Issues	Licensing (authority)
Problems with proper and correct design of the BHE drilling (regarding depth, diameter and spacing)	Technical Issues	Licensing (authority)
No information about the impact of BHE installation on mineral groundwater bodies.	Technical Issues	Licensing (authority)
Environmental constraints are not taken into account during design of BHEs. There are cases, when BHEs location is designed on the landslide areas. Such situations should be prohibited.	Technical Issues	Licensing (authority)
Low quality of geological profile description, especially in drillings with normal circulation of drilling fluid.	Technical Issues	Licensing (authority)
There is no reference materials regarding environmental impact of deep BHEs (exceeding 100 m depth) on nearby soil-rock massif, neighbouring wells and BHEs.	Technical Issues	Licensing (authority)
No available information if already drilled and operating BHEs can be covered with new constructions. Should the area of BHEs remain not developed or can be used for new construction projects?	Technical Issues	Licensing (authority)
No valid standards.	Technical Issues	Licencing (applicant)
Problems with interpretation of legal acts by geological authorities regarding decision if permitting procedure is necessary or only notification will be sufficient	Topics controlled by authorities only - Licensing	Other
Legal acts are not fully adequate to current state of GSHP market development in Poland, especially regarding open loop systems	Topics controlled by authorities only - Licensing	Research / NGO
One of the most common problems is avoiding the BHE design report preparation. The Investors are using the legal gap allowing them to avoid BHE design report if BHE depth is less than 30 m, but often the BHEs are of greater depth.	Topics controlled by authorities only - Licensing	Drilling

Answers	Keyword	Field of Activity
BHE design reports should be submitted and permitted within a limited (defined) period, e.g. 5 years. There are examples when the permitted BHE design report was used to block public investment (the development of public gas-pipeline).	Topics controlled by authorities only - Licensing	Licensing (authority)
Problems with BHE drilling works schedule. Often Investor is preparing necessary documents and BHE design report early in the investment process, to submit the documents for public subsidy or bank credit. In that situation, the Investor not knows the precise dates of drilling works. On the other hand, the geological authorities need to know the precise dates of BHE drilling in order to control and supervise the geological activities on their administrative area.	Topics controlled by authorities only - Licensing	Licensing (authority)
BHE design reports are not fulfilling the legal regulations.	Topics controlled by authorities only - Licensing	Licensing (authority)
The legal acts regarding BHE drilling are not strong enough to force the Investors to prepare and submit the BHE drilling reports.	Topics controlled by authorities only - Licensing	Licensing (authority)
The geological authorities have limited possibilities to affect the BHE designers to improve the quality and content of the BHE design reports.	Topics controlled by authorities only - Licensing	Planning/design
Problems with BHE drilling reports submission after finalization of geological works. Geological authorities do not approve the BHE drilling reports in form of an official decision. Only their submission is notified and the documents are archived.	Topics controlled by authorities only - Licensing	Licensing (authority)
Problems with BHE drilling reports submission after finalization of geological works. Geological authorities do not approve the BHE drilling reports in form of an official decision. Only their submission is notified and the documents are archived. The Investor submits the BHE design report, performs the BHE drilling and then is no feedback to the geological authorities in form of BHE drilling report. The current legal acts do not include any instruments to oblige investors to submit the BHE drilling reports to the local geological authorities.	Topics controlled by authorities only - Licensing	Licensing (authority)
BHE design reports are often not fulfil the legal requirements of Geological Law and accompanying ordinances.	Topics controlled by authorities only - Licensing	Licensing (authority)
The current legal regulations and guidelines should include more information about drilling of BHEs in protected areas, especially around drinking water wells.	Topics controlled by authorities only - Licensing	Licensing (authority)
In case of BHEs of more than 100 m depth in Poland, there are problems with preparation and permitting of Mining Operation Plan.	Topics controlled by authorities only - Licensing	Licensing (authority)

Answers	Keyword	Field of Activity
Polish Geological Law legal act and ordinance regarding BHEs design reports should be improved.	Topics controlled by authorities only - Licensing	Licensing (authority)
The BHE drilling is sometimes performed in location that differs from the location that was submitted in the BHE design report. There is a need of a legal instrument that will allow the geological authorities control the location of finalized BHE drillings	Topics controlled by authorities only - Licensing	Licensing (authority)
Legal regulations are not precise enough. There are no information in current legal acts regarding minimum spacing between BHEs, their distance from existing buildings and parcel borders.	Topics controlled by authorities only - Licensing	Licensing (authority)

Table 2: Keywords used to group common problems in Poland. The table shows counts of unique responses in each keyword category.

Keywords	Count
Topics controlled by authorities only - Licensing	17
Qualification of personnel in general	8
Technical Issues	10
Requirements in general	7
Information supply	10

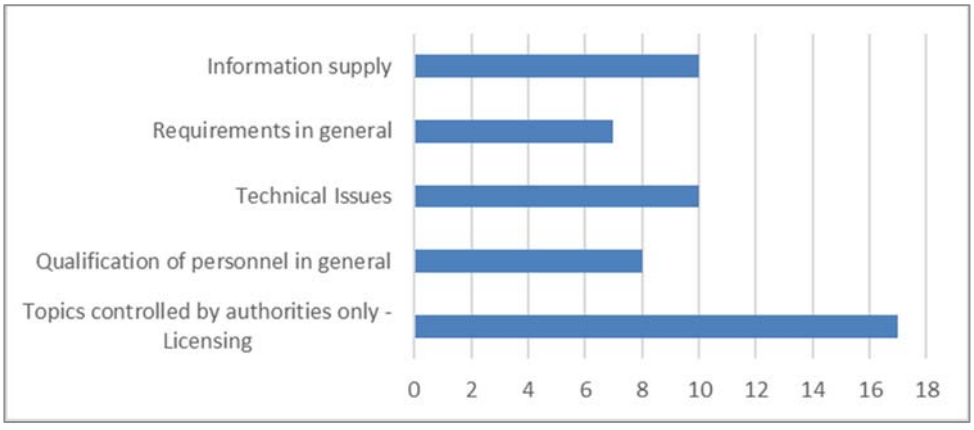

Figure 4: Analysis of question 4 of the online stakeholder survey in Poland reflecting the answers for question: What kind of problems do you have in your field of activity concerning shallow geothermal projects?

Comments: There were 56 answers for this question. Most problems refer to legal and licensing issues – BHE design reports and drilling reports are not submitted. This leads to loss of very important geological information and disallows the geological authorities to control if environmental issues or harzards connect with the installation of BHEs.

Main problem is with the submission of BHE drilling reports after finalization of geological works. Geological authorities do not approve the BHE drilling reports in form of an official decision. Only their submission is notified and the documents are archived. The Investor submits the BHE design report and performs the drilling. He is not bound to give feedback to the geological authorities in form of BHE drilling report. The

current legal acts do not include any instruments to oblige investors to submit the BHE drilling reports to the local geological authorities.

Another problems raised in the survey were the lack of national technical issues and guidelines available in polish language (technical issues), problems with general level of knowledge (qualification of personnel in general) and problems with access to databases or maps related to shallow geothermal energy systems (information supply).

5. **Which information or standards do you know that <u>are</u> helpful in your field of activity concerning shallow geothermal projects**?

Table 3: Existing helpful information concerning shallow geothermal energy projects in Poland. Answers are grouped to deduced keywords.

Answers	Keyword	Field of Activity
Polish Geological Law	Other	Drilling
German standards (VDI) translated into Polish language by PORT PC	Technical documentation	Planning/design
Problem - There is no obligation to use any standards. The Polish Geological Law not mentions any standard, so there is no legal obligation to use standards.	Technical documentation	Licensing (authority)
PORT PC GUIDELINES for BHE design, execution and approval. Problem - there is no other standards and guidelines for BHE. In case of PORT PC Guidelines, there is a need for update. Current version is from 2013.	Technical documentation	Planning/design
From the point of view of geological authorities more important than standards and guidelines are improved legal acts that could support geological authorities to raise objection for BHE drilling in cases of potential environmental hazards.	Legal regulations	Licensing (authority)
The information about thermal conductivity of soils and rocks, information about the interference between neighbouring BHEs (minimum spacing).	Basic information	Planning/design
Legal acts (Geological Law and ordinances)	Legal regulations	Licensing (authority)
PORT PC GUIDELINES are focused on design of ground source to meet the building energy needs. There is no information about the drilling technology (drilling fluids, backfill materials).	Technical documentation	Drilling
Geological profiles from Central Hydrogeological Database managed by Polish Geological Institute.	Basic information	Planning/design
Legal acts (Geological Law and ordinances), As standards are not obligatory the geological authorities officials often do not intervene in technical solutions	Legal regulations	Licensing (authority)
Kapuściński J, Rodzoch A, (2010) Geotermia niskotemperaturowa w Polsce i na świecie. Stan aktualny i perspektywy rozwoju, Uwarunkowania techniczne, środowiskowe i ekonomiczne. (Low-temperature geothermal energy in Poland and worldwide. State-of-the-art and perspectives for future development. Technical, environmental and economic conditions). Report for National Fund of Environmental Protection and Water Management, Ministry of Environment, Warsaw, Poland.	Basic information	Licensing (authority)
Legal acts (Geological Law and ordinances) The Construction Law, Water Law, Environmental Law, work safety regulations in mining	Legal regulations	Licensing (authority)

Answers	Keyword	Field of Activity
There is no information about the drilling technology (drilling fluids, backfill materials).	Technical documentation	Licensing (authority)
Problem - there is a need for guidelines for geological authorities regarding shallow geothermal energy. Current report published by Ministry of Environment - Kapuściński J, Rodzoch A, (2010) "Low-temperature geothermal energy in Poland and worldwide. State-of-the-art and perspectives for future development. Technical, environmental and economic conditions" is now outdated and needs an extensive update.	Technical documentation	Licensing (authority)
Standard EN14511: Air conditioners, liquid chilling packages and heat pumps for space heating and cooling, and process chillers with electrically driven compressors. Test methods	Tehnical documentation	Other
Professional literature and archival data regarding geology and geothermal energy	Basic information	Licensing (authority)
PORT PC Guidelines and technical specifications and guidelines from Heat Pump Producers (Manufacturers).	Technical documentation	Drilling
PORT PC Guidelines and technical specifications and guidelines from Heat Pump Producers (Manufacturers).	Technical documentation	Planning/design
Legal acts, maps of groundwater depth, shallow geothermal potential maps - professional version (average thermal conductivity values for predefined depths of BHEs)	Calculation tools	Licensing (authority)
There is a need for guidelines and handbooks for backfilling of BHEs and sealing of groundwater levels in the areas with artesian aquifers.	Calculation tools	Licensing (authority)
The materials gathered on Geothermal4PL website and training course in Chęciny in 2017 and during seminars for geological authorities officials organized in 2015.	Basic information	Licensing (authority)
PORT PC Guidelines and technical specifications and guidelines from Heat Pump Producers (Manufacturers). Geological information form Polish Geological Survey Resources.	Tehnical documentation	Licensing (authority)
Practical information from reliable and experienced BHE designers and drillers.	Basic information	Other
There is a need for guidelines and handbooks for backfilling of BHEs and sealing of groundwater levels	Calculation tools	Licensing (authority)
PORT PC Guidelines	Technical documentation	Licensing (authority)
Geological and Mining Law, Waste Law, Water Law, Construction Law.	Legal regulations	Drilling
Information available at Central Hydrogeological Database, Central Geological Database, German standards and guidelines.	Calculation tools	Installation
Thematic maps, Polish Hydrogeological Survey data, explanations to hydrogeological maps, archival documents.	Calculation tools	Drilling

Answers	Keyword	Field of Activity
Information obtained from the Ministry of Environment.	Basic information	Licensing (applicant)
No valid standards, only PORT PC guidelines	Technical documentation	Drilling
Geological and Mining Law	Legal regulations	Drilling
Argumentation for the use of ground-source heat pumps	Acceptance of geothermal systems	Installation
Constructing Law, Geological and Mining Law	Calculation tools	Drilling

Table 4: Keywords used to group useful available information. The table shows count of unique responses in each keyword category.

Keywords	Count
Basic information	7
Technical documentation	2
Calculation tools	6
Legal regulations	6
Acceptance of geothermal systems	1
Other	1

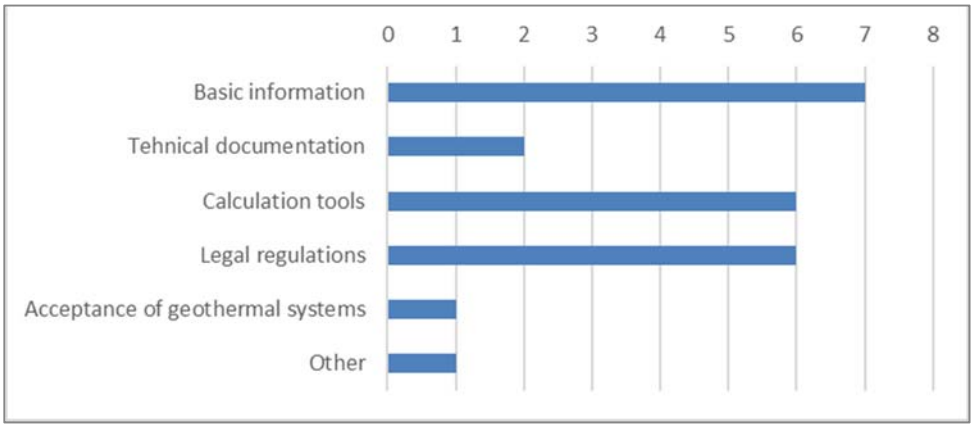

Figure 5: Analysis of question 5 of the online stakeholder survey in Poland reflecting the answers for question: Which information or standards do you know that are helpful in your field of activity concerning shallow geothermal projects.

Comments: There were 53 answers for this question (44% of respondents).

Most respondents were referring to basic information as the most helpful in their current activities in the field of shallow geothermal energy. Basic information means available handbooks or reports (especially those published by Ministry of Environment or available on the website of Geothermal4PL project).

Many respondents use the legal acts and accompanying ordinances in their SGE activities. Respondents also use the available standards and guidelines (e.g. EN14511 PORT PC). Geological profiles and thematic geological maps available at PGI-NRI website and web GIS browsers are used as well.

6. **Which information or standards would be helpful to you in your field of activity concerning shallow geothermal projects? Should this information be open to public?**

Table 5: Information that would be helpful for shallow geothermal energy projects in Poland. Answers are grouped to deduced keywords.

Answers	Keyword	Field of Activity
Compilation of technical solutions in the field of GSHP and their technical specifications that could allow Investors to choose the optimal one, most suitable for their project. Such information should be publicly available, so the Client could verify the solutions that are offered by the Contractor in the offer or in the public bid.	Tools	Other
Guidelines for open-loop systems including geological and hydrogeological issues.	Tools	Research / NGO
There is a need to update the Geological Law. Guidelines and handbooks are a useful tool, but the main driver to oblige Investors to submit the BHE drilling reports to the geological authorities and to the National Geological Archive can be only a legal act such as a Geological Law.	Administrative regulation	Drilling
There is a need for an easily accessible database of geological profiles and thermal parameters of soils and rocks for the areas of GSHP development. The best solutions would be a database covering the area of whole Poland.	Access to drill data / state-wide drill data base	Planning/design
There is a need for more guidelines and information about horizontal loops. The data should be publicly available.	Tools	Drilling
Handbook of good practices in shallow geothermal systems design.	Technical documentation	Licensing (authority)
The data about already existing and planned BHEs should be visible in a publicly available database. In such situation each land parcel owner would be aware of the potential impact of the neighbouring BHEs on his investment plans.	SGE Register	Licensing (authority)
The data about already existing and planned BHEs should be visible in a publicly available database. In such situation each land parcel owner would be aware of the potential impact of the neighbouring BHEs on his investment plans. Such system should be a GIS database publicly available via web browser.	SGE Register	Planning/design
There is a need for Guidelines that are mentioned in a valid legal act, for example in an ordinance regarding requirements for BHE design reports. Such guidelines should be publicly available and templates for such BHE design reports should be available for download on polish geological survey website, including metadata templates.	Technical documentation	Licensing (authority)
There is a need for Polish Standard regarding GSHP and BHE design, execution and approval.	Technical documentation	Planning/design

Answers	Keyword	Field of Activity
The data about already existing and planned BHEs should be visible in a publicly available database. In such situation each land parcel owner would be aware of the potential impact of the neighbouring BHEs on his investment plans. Such system should be a GIS database publicly available via web browser.	SGE Register	Research / NGO
Information that is more general should be available on drilling equipment used for BHE drilling. Such an information should be more general (not as detailed as technical specification) to familiarize the Investors and end-users with technology used in shallow geothermal energy systems. Such information should be public.	Basic information	Drilling
Geological profiles from Central Hydrogeological Database should be available in an easier and quicker way.	Access to drill data / state-wide drill data base	Planning/design
Handbook of good practices in shallow geothermal systems design, execution and approval. Such handbook should be related to valid national and European standards and publicly available.	Technical documentation	Licensing (authority)
Guidelines for backfilling of BHEs should be developed and then implemented as an obligatory and binding legal act. In such case, after embedding the guidelines in a legal act, the guidelines should be available publicly.	Technical documentation	Licensing (authority)
The publication of publicly available handbook or guidelines should be coordinated by Ministry of Environment.	Basic information	Licensing (authority)
Guidelines for backfilling of BHEs should be developed and then implemented as an obligatory and binding legal act. In such case, after embedding the guidelines in a legal act, the guidelines should be available publicly.	Administrative regulation	Licensing (authority)
There is a need for clear guidelines on BHEs spacing an interference.	Technical documentation	Licensing (authority)
Handbook of good practices in shallow geothermal systems design. Main issues covered in handbook should be: minimum distance from existing underground infrastructure, other BHEs, existing buildings, requirements for the circulation fluid, etc.).	Technical documentation	Licensing (authority)
There is a need for Polish Standard regarding GSHP and BHE design, execution and approval.	Technical documentation	Licensing (authority)
The drillers and BHEs designers should be certified.	Administrative regulation	Other
Templates of BHE design and drilling reports should be publicly available with accompanying metadata table templates.	Basic information	Licensing (authority)

Answers	Keyword	Field of Activity
Handbook of good practices in shallow geothermal systems design, execution and approval. Such handbook should be related to valid national and European standards and publicly available. Such handbook can have a role of national guidelines. Both horizontal and vertical loops in closed systems should be included.	Technical documentation	Licensing (authority)
There is a need for publicly available data on shallow geothermal potential and thermal parameters of soils and rocks in Poland. Such data should be publicly available.	Access to drill data / state-wide drill data base	Planning/design
There is a need for guidelines for geological authorities regarding shallow geothermal energy. In such guidelines, the areas with high potential for GHSP technology developments should be highlighted. Such document should be publicly available.	Technical documentation	Licensing (authority)
There is a need for Polish Standard regarding GSHP and BHE design, execution and approval. In such standards, the drilling technology for BHE should be described and issue of potential negative geoenviromental impact of BHE on soil/rock massif and groundwater levels should be clearly addressed. Such standard should be available publicly.	Technical documentation	Licensing (authority)
Problems with BHE drilling reports submission after finalization of geological works. Geological authorities do not approve the BHE drilling reports in form of an official decision. Only their submission is notified and the documents are archived. The Investor submits the BHE design report, performs the BHE drilling and then is no feedback to the geological authorities in form of BHE drilling report. The current legal acts do not include any instruments to oblige investors to submit the BHE drilling reports to the local geological authorities.	Administrative regulation	Licensing (authority)
Compilation of technical solutions in the field of GSHP and their technical specifications that could allow Investors to choose the optimal one, most suitable for their project. Such information should be publicly available, so the Client could verify the solutions that are offered by the Contractor in the offer or in the public bid.	Tools	Licensing (authority)
Handbook of good practices in shallow geothermal systems design, execution and approval. Such handbook should be related to valid national and European standards and publicly available. Such handbook can have a role of national guidelines. Both horizontal and vertical loops in closed systems should be included.	Technical documentation	Other

Answers	Keyword	Field of Activity
There is a need for BHE design and drilling guidelines, prepared in a similar matter as the guidelines for hydrogeological wells drilling.	Technical documentation	Licensing (authority)
The guidelines should be available with limited access.	Basic information	Drilling
There is a need for publicly available case studies of GSHP technology implementation with cost analysis and payback rate, which could be presented as an example to Investors and end-users.	Acceptance of geothermal systems	Licensing (authority)
There is a need for maps of areas, on which BHE drilling is prohibited or limited. Such information should be available publicly, in a GIS web browser.	Access to drill data / state-wide drill data base	Licensing (authority)
There is a need to update the Geological Law. Guidelines and handbooks are a useful tool, but the main driver to oblige Investors to submit the BHE drilling reports to the geological authorities and to the National Geological Archive can be only a legal act such as a Geological Law.	Administrative regulation	Licensing (authority)
There is a need for detailed guidelines regarding GSHP and BHE design, execution and approval. In such guidelines, especially an issue of potential negative geoenviromental impact of BHE on soil/rock massif and groundwater levels should be clearly addressed. Such detailed guidelines should be available publicly.	Technical documentation	Licensing (authority)
There is a need for update of PORT PC Guidelines.	Technical documentation	Other
Information and guidelines for people conducting and controlling the drilling process.	Technical documentation	Drilling
Technical guidelines defining average regional thermal parameters depending on the groundwater level and the specific thermal potential of soil. Information should be available only for a limited group due to possible deterioration of work standards by people not closely related to geothermal or geological field of knowledge.	Technical documentation	Planning/design
Public explanations of hydrogeological maps, access to the Central Hydrogeological Database profiles for a limited number of people because of the significant increase of the application time.	Access to drill data / statewide drill data base	Planning/design
Data on the groundwater aquifers and geology should be available only for professionals.	Access to drill data / statewide drill data base	Planning/design
Standards available for everyone	Basic information	Planning/design
Geotechnical site investigation plan should be obligatory, the obligation to cement holes, to close access to drilling	Administrative regulation	Drilling
Technical specification for BHE and other types of ground source	Technical documentation	Planning/design

Answers	Keyword	Field of Activity
Access to public information.	Basic information	Drilling
Guidelines for the GWHP companies.	Technical documentation	Other
Guidelines for the GWHP companies.	Technical documentation	Installation

Table 6: Keywords used to group useful, missing information

Keywords	Count
SGE Register	3
Access to drill data / statewide drill data base	6
Basic information	6
Tools	4
Administrative regulation	6
Technical documentation	20
Acceptance of geothermal systems	1

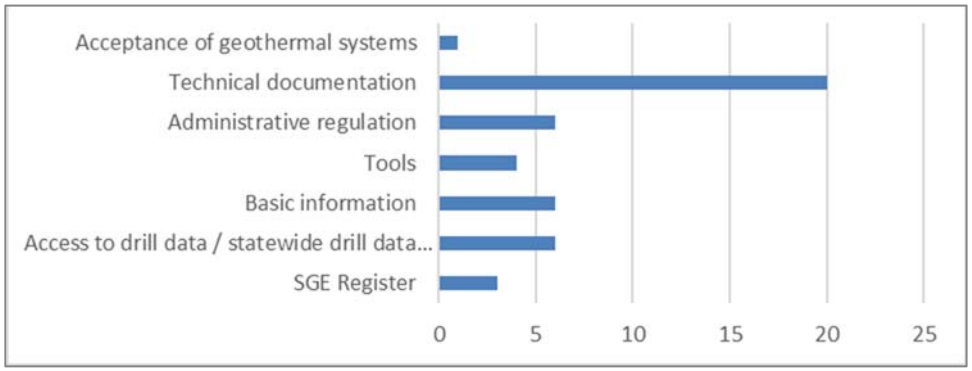

Figure 6: Analysis of question 6 of the online stakeholder survey in Poland reflecting the answers for question: Which information or standards would be helpful to you in your field of activity concerning shallow geothermal projects? Should this information be open to public?

Comments: 66 participants answered this question. The highest demand of the respondents is for up-to-date technical documentation on SGE. This includes standards, guidelines and publicly available general technical specification of SGE systems. Stakeholders often mentioned access to drill data and a statewide database or SGE register along with tools like shallow geothermal potential maps. Another important item is the improvement of current administrative regulations. To increase the acceptance of geothermal systems there is also a need for publicly available case studies of GSHP technology implementation with cost analysis and payback rate, which could be presented as an example to investors and end-users.

Generally, respondents answers point out, that all information should be open to public.

7. **Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?**
    a. Very helpful
    b. Less helpful
    c. No influence

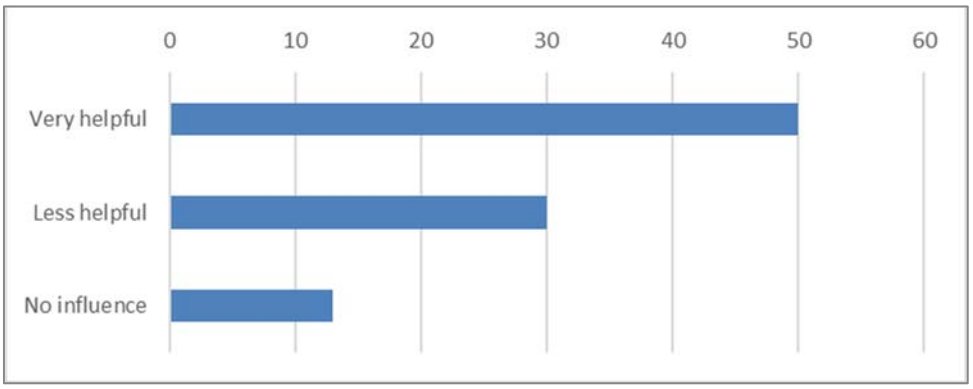

Figure 7: Analysis question 7: Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?

Comments: 93 respondents answered this question. More than half of them think that certification will be very helpful for quality improvements whereas 15% believe it will make no difference.

8. How many years are you active in the field of geothermal energy?

a. < 2
b. 3-5
c. 6-10
d. 11-20
e. > 20

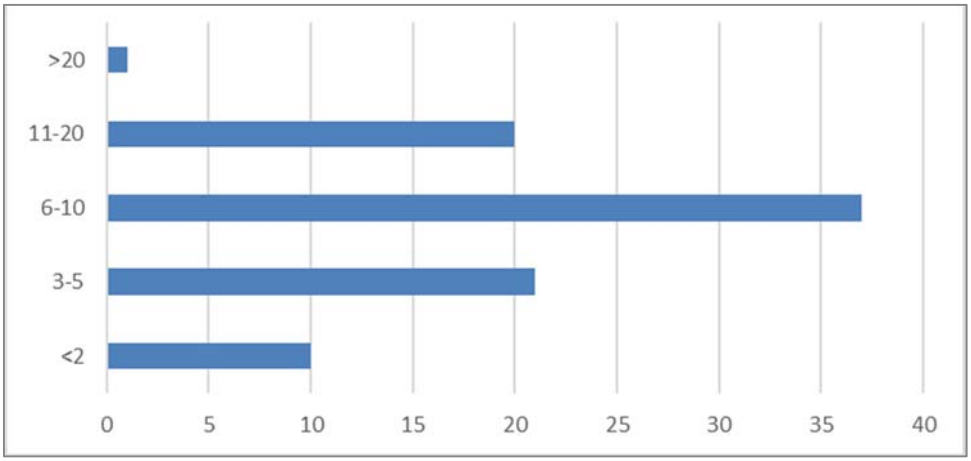

Figure 8: Analysis of question 8: How many years are you active in the field of geothermal energy?

Comments: Most of the respondents are active in the field of geothermal energy for 6-10 years (42%). 11% of respondents are starting their activities in SGE field – they are active less than 2 years. Only one respondent that had over 20 years of experience.

9. Place for your remarks, recommendations and ideas

Table 7: Remarks, recommendations and ideas

Answers	Keyword	Field of Activity
The new and important research topic in the field of SGE should be open loop systems and ATES (aquifer thermal energy storage). Such technology should be developed regarding the hydrogeological conditions and polish Water Law.	New areas for development in SGE in Poland	Research / NGO
One of the barriers for development of BHE technology in Poland is high VAT (23%) for BHE drilling. As this element (BHE) is a part of a building heating and cooling system it should have 8% VAT.	Legal / economical regulations	Drilling
Shallow Geothermal Energy and Ground Source Heat Pumps should be an important part of strategic documents at the government administration level.	Strategic / long-term actions	Planing/design
To improve quality of BHE design reports there should be a certification system for designers and drillers or an legal instrument to suspend professional certificate of BHE designer or driller.	Certification system	Licencing (authority)
To maintain dynamic growth of GSHP market in Poland the legal regulations of permitting of BHE drilling and GSHP installations should be not too strict. The more simplified the procedures will be - the more dynamic will be the growth of the Market.	Simplification of legal procedures	Drilling
Certification system in Poland for BHE drillers and designers might change the current situation.	Certification system	Licencing (authority)
There is a need to update the Geological Law. Guidelines and handbooks are a useful tool, but the main driver to oblige Investors to submit the BHE drilling reports to the geological authorities and to the National Geological Archive can be only a legal act such as a Geological Law. Actions to initiate such an update should be addressed to the Ministry of Environment.	Update of Geological Law	Licencing (authority)

Answers	Keyword	Field of Activity
Problems with BHE drilling reports submission after finalization of geological works. Geological authorities do not approve the BHE drilling reports in form of an official decision. Only their submission is notified and the documents are archived. The Investor submits the BHE design report, performs the BHE drilling and then is no feedback to the geological authorities in form of BHE drilling report. The current legal acts do not include any instruments to oblige investors to submit the BHE drilling reports to the local geological authorities.	Administrative regulation	Licencing (authority)
There is a need to organize a Training Course for geological authorities on the topic of Geothermal Heat Pumps and Borehole Heat Exchangers - design, execution and approval.	Qualification of personnel in general	Licencing (authority)
Guidelines or information without the support of the relevant law can be considered just a "wishful thinking". Only changes to the law and the enforcement of penalties can improve the situation.	Administrative regulation	Drilling
Changes in the law are needed.	Administrative regulation	Drilling
There is a very big role of PORT PC in normalisation of the heat pumps market in Poland.	Strategic / long-term actions	Other

Table 8: Keywords used to group remarks, recommendations and ideas

Keywords	Count
New areas for development in SGE in Poland	1
Legal / economical regulations	1
Strategic / long-term actions	2
Certification system	2
Simplification of legal procedures	1
Update of Geological Law	1
Administrative regulation	3
Qualification of personnel in general	1

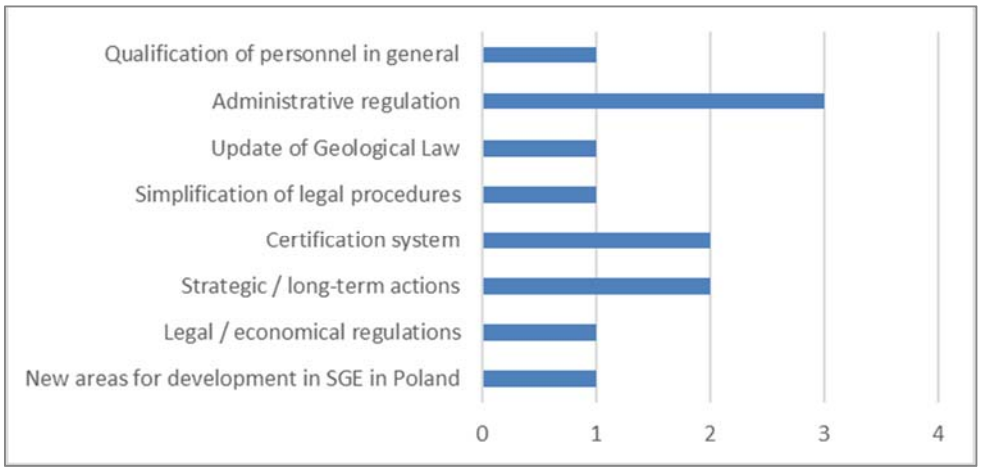

Figure 9: Analysis of question 9 of the online stakeholder survey in Poland reflecting the remarks, recommendations and ideas of the survey target group.

Comments: 18 participants used the opportunity to add remarks to the comments section of the questionnaire. Most of the comments were referring to updates and improvements in current legal regulations (including update of geological law and simplification of legal procedures).

One of the comments has proposed the legal / economic solution to decrease VAT tax for BHE drillings to stimulate the GSHP market.

Other comments included:

- The issue of a certification system for BHE drillers and designers.
- The need for strategic / long-term actions.
- New areas of development of SGE (Open-loop systems).
- Increase of qualification of personnel in general.

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ANNEX 5

STAKEHOLDER SURVEY ON QUALITY STANDARDS, CURRENT POLICIES AND REGULATIONS

RESULTS SLOVAKIA

Annex 5 - D.T2.4.2 09 2018

Geologische Bundesanstalt
LANDESAMT FÜR UMWELT, LANDWIRTSCHAFT UND GEOLOGIE
Freistaat SACHSEN
CZECH GEOLOGICAL SURVEY
GeoZS Geološki zavod Slovenije
AGH University of Science and Technology
geoENERGIE Konzept
GiGa infosystems
Bundesverband Geothermie
City of Ljubljana

1. **Which is/are your field/s of activity? (Multiple choices are possible)**
    a. Planning/Design
    b. Licencing (applicant)
    c. Licencing (authority)
    d. Installation
    e. Drilling
    f. Operation and Service
    g. Information systems and/or databases
    h. Research/NGO
    i. Other:

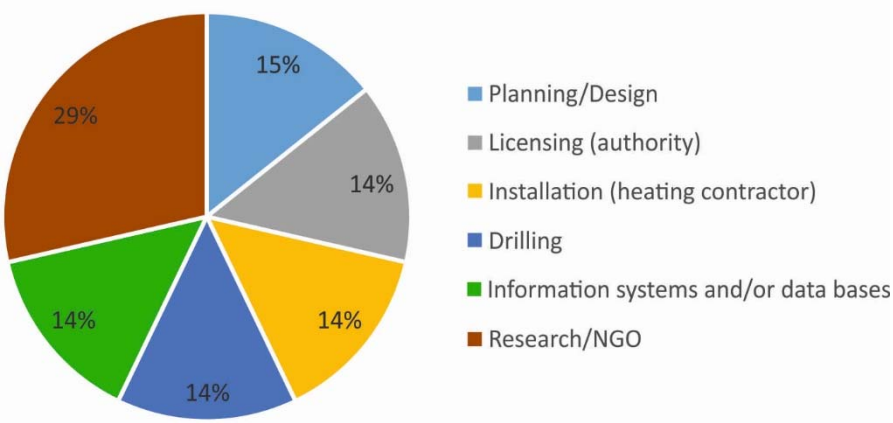

Figure 1: Participants of the online stakeholder survey in Slovakia

Comments: The biggest field of activity in which participants are active is the field of "Research/NGO". The fields "Planning/Design", "Licencing (authority)", "Installation (heating contractor)", "Drilling" and "Information systems and/or data bases" each represent a participant share of 14%.

2. **What is your opinion concerning the level of technical standardization for shallow geothermal systems in general?**

    a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

    b. I am not familiar with this topic

Figure 2: Analysis of question 2 of the online stakeholder survey in Slovakia reflecting the opinion towards the current technical standardization for shallow geothermal energy.

Comments: No participant rejected this question nor answered with "I am not familiar with this topic". More than the half of the participants think that the level of technical standardization is just right. The categories too low, far too low and too high got each one answer. The average opinion to the level of technical standardization is felt as just right in Slovakia.

3. **What is your opinion concerning the level of legal regulation for shallow geothermal systems in general?**

   a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

   b. I am not familiar with this topic

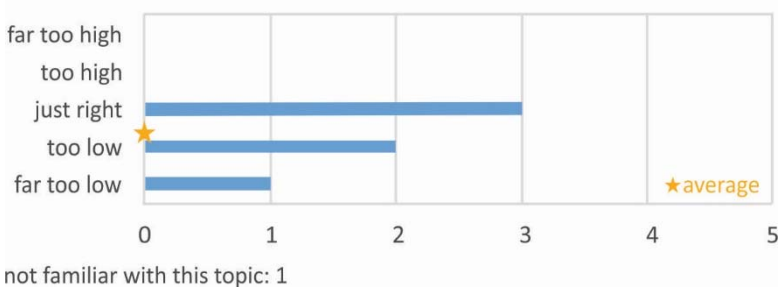

Figure 3: Analysis of question 3 of the online stakeholder survey in Slovakia reflecting the opinion towards the current legal regulation for shallow geothermal energy.

Comments: No participant rejected this question and one answered with "I am not familiar with this topic". Half of the participants think that the level of technical standardization is just right. The other half rates the standards too low or far too low (two and one answer, respectively). The general impression of the level of legal regulation in Slovakia is too low.

4. What kind of problems do you have in your field of activity concerning shallow geothermal projects?

Table 1: Problems concerning shallow geothermal energy projects in Slovakia. Answers are grouped to deduced keywords and the associated field of activity.

Answer	Summary	Keyword	Field of activity
Authorization of open loop systems by municipalities acting as building authorities, despite the fact that this type of heat pump (OLS) is subject to authorization by the state water management authorities of District Offices, Environmental Departments.	Permiting procedure responsibilities	Topics controlled by authorites only - Licensing	Licensing
Ignorance of the issue, emphasis on insignificance and lack of emphasis on importance.	General lack of information management and priority setting	Qualification of personnel in general	Planning/Design
Lack of information, the problem of pumping water and paying for it	Lack of information and revenues for pumped water	Technical Issues	Research/NGO
Ratio of gas and electricity prices. Gas is not charged fees for the development of RES	Ratio of the electricity and gas price, financial support	Technical Issues	Information systems and/or data bases
Nothing significant, usually the rather different "anomalies" we are dealing with are ongoing.	No mayor problems identified	Requirements in general	Installation
We are missing information on what rocks can provide how much heat load or cooling capacity	Lack of information in rock properties and Heat in place stored	Informations supply	Drilling
Almost nonexistent monitoring of utilization	Lack of monitoring	Monitoring	Research/NGO

Comments: Participants raised issues relating to unclear responsibilities within the licensing process, unfavourable policies and lack of information for the planning/design stage.

5. Which information or standards do you know that are helpful in your field of activity concerning shallow geothermal projects?

Table 2: Existing helpful information concerning shallow geothermal energy projects in Slovakia. Answers are grouped to deduced keywords.

Answers	Keywords	
In terms of authorization by state water authorities, evaluation of the hydrogeological conditions by experts are considered very important.	Professional assessment	Other
VDI 4640	Technical standards	Technical documents
Ratio electricity and gas	Financial aspect	other
All	Technical documents	
We have no information about any	Lack of information	Basic information

6. **Which information or standards <u>would be</u> helpful to you in your field of activity concerning shallow geothermal projects? Should this information be open to public?**

Table 3: Information that would be helpful for shallow geothermal energy projects in Slovakia. Answers are grouped to deduced keywords.

Answers	Summary	Keyword
The question is rather directed at designers and hydrogeologists, not the licensing authority. In our opinion, it is necessary to inform the public as much as possible.	Basic information	Basic information
Available YES	The respondent answered - YES to have accessible data	Basic information
Clearly available to the public	The respondent answered - YES to have accessible data	Basic information
Map of suitability and constrains	Map of suitable area for instalations	Tools
Any apps that support us. Yes, all important information should be available to the public as well.	All applications for the support of the HP industry	Tools
Based on this, we established the AVS (Association of Drilling Companies, z.o.), which is supposed to provide information in this area and to introduce trade norms that should form "Best Practices" and provide customers with the highest standards in this area.	Informations support, porposals for standards, best practices	Tools
All information should be available to the public	The respondent answered - YES to have accessible data	Basic information

Comments: Several participants indicated that they had all basic information available to them but a need for best practices and suitability maps was expressed.

7. **Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?**
    a. Very helpful
    b. Less helpful
    c. No influence

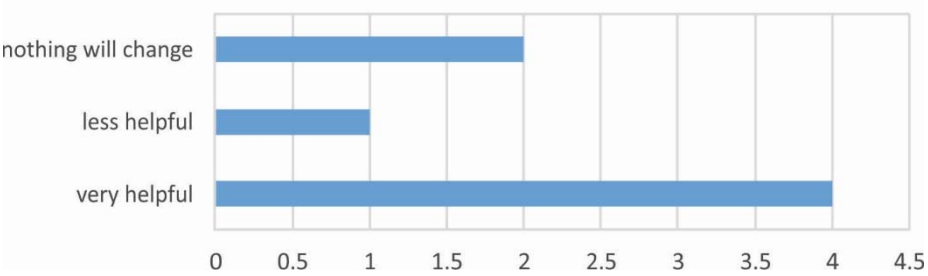

Figure 4: Results question 7: Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?

Comments: Four participants think that certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems. On the other hand, one participant thinks they are less helpful and two think that nothing will change.

8. How many years are you active in the field of geothermal energy?

a. < 2
b. 3-5
c. 6-10
d. 11-20
e. > 20

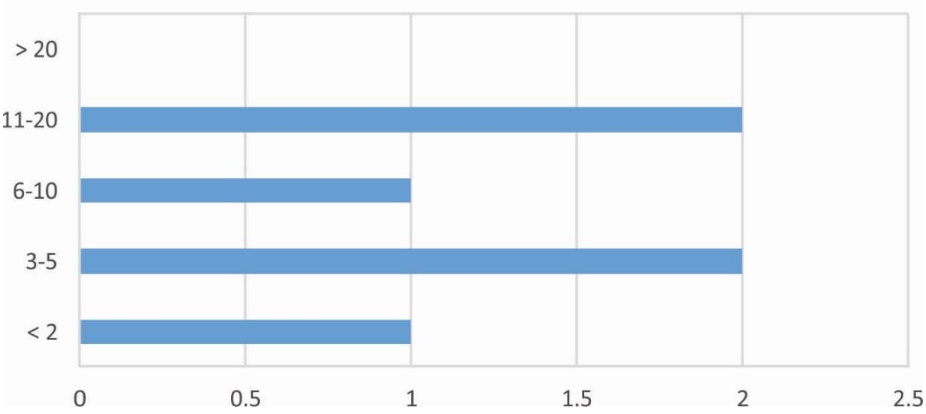

Figure 5: Results question 8: How many years are you active in the field of geothermal energy?

Comments: Half of the participants had 5 years or less experience with geothermal energy.

9. Place for your remarks, recommendations and ideas

Table 4: Additional comments to the stakeholder survey in Slovakia

Comments	Keyword
Under Act no. 364/2004 Coll. (Water Act) are wells for heat pumps of the waterworks and require the permission of the competent authority of the State Water Administration pursuant to Section 26 of the Water Act and the permit for the special use of water pursuant to Section 21 of the Water Act. At the same time, please note that according to § 3 par. (4) of the Water Act are groundwater intended primarily to supply the population with drinking water.	Legislation and permitting issues
We are interested in the information of conditions for all HPs. Change of the unconventional approach of the Ministry of Environment is desirable. On the one hand, creates complicated support programs and, on the other hand, makes it more difficult for water management and introduces water usage fees. From the mentioned we can exaggerate that the abrogation (cancellation) of the MoE would help the heat pump suppoprt.	Legislation and permitting issues
The certifications for installers should be more professional. I took part in examination and in my oppinion not competent persons were issued the certifications. This does not help the professional bussiness.	Legislation and permitting issues

Comments: Participants raised issues regarding the licensing process and the quality of certification for installers.

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ANNEX 6

STAKEHOLDER SURVEY ON QUALITY STANDARDS, CURRENT POLICIES AND REGULATIONS

RESULTS SLOVENIA

Annex 6 - D.T2.4.2 09 2018

Geologische Bundesanstalt
LANDESAMT FÜR UMWELT, LANDWIRTSCHAFT UND GEOLOGIE
Freistaat SACHSEN
CZECH GEOLOGICAL SURVEY
GeoZS Geološki zavod Slovenije
AGH University of Science and Technology
geoENERGIE Konzept
GiGa infosystems
Bundesverband Geothermie
City of Ljubljana

1. **Which is/are your field/s of activity? (Multiple choices are possible)**
    a. Planning/Design
    b. Licencing (applicant)
    c. Licencing (authority)
    d. Installation
    e. Drilling
    f. Operation and Service
    g. Information systems and/or databases
    h. Research/NGO
    i. Other:

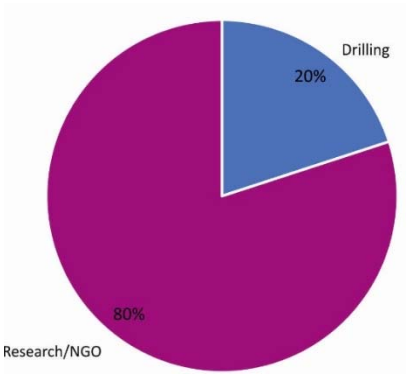

Figure 1: Participants of the online stakeholder survey in Slovenia

Comments: Four answers were received from the group of "Research/NGO" and one from "Drilling".

2. **What is your opinion concerning the level of technical standardization for shallow geothermal systems in general?**

    a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

    b. I am not familiar with this topic

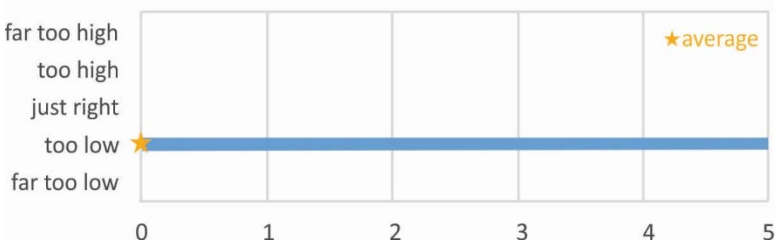

Figure 2: Analysis of question 2 of the online stakeholder survey in Slovenia reflecting the opinion towards the current technical standardization for shallow geothermal energy.

Comments: No participant rejected this question nor answered with "I am not familiar with this topic". All participants think that the level of technical standardization is too low.

3. **What is your opinion concerning the level of legal regulation for shallow geothermal systems in general?**

   a. Please evaluate your impression on a scale of 1 to 5 (1 = far too low, 5 = far too high).

1	2	3	4	5

   b. I am not familiar with this topic

Figure 3: Analysis of question 3 of the online stakeholder survey in Slovenia reflecting the opinion towards the current legal regulation for shallow geothermal energy.

Comments: No participant rejected this question nor answered with "I am not familiar with this topic". Two of the participants think that the level of technical standardization is just right. Three participants rated the standards as too low.

4. **What kind of problems do you have in your field of activity concerning shallow geothermal projects?**

Table 1: Problems concerning shallow geothermal energy projects in Slovenia.

Answers
Competition of companies which are not professionally qualified to perform works, but they have obtained grants to purchase the equipment
The standards on tenders do not have a realistic connection with the performance of works according to the principle of professionalism.
Disorder, dispersal of data
Absence of a product development strategy for a major expansion of this industry.
Absence of records of existing utilizations
Drilling without permits
Absence of monitoring of impact and estimation of status quo at areas with denser use of geothermal utilizations
Planning of installation is weak (lack of investigations)
Lack of knowledge about technological parameters of the system and its effect to the geothermal energy from the end-users, because the main characteristics, working and efficiency of the system were poorly or not at all explained by the manufacture
Poor data record (geological, technical,...)

Comments: Half of the participants drew attention to a lack of data. Another issue raised several times concerned the quality of planning and implementation.

5. **Which information or standards do you know that are helpful in your field of activity concerning shallow geothermal projects?**

Table 2: Existing helpful information concerning shallow geothermal energy projects in Slovenia.

Answers
Waters Act (ZV-1), Construction Act (ZGO-1), Mining Act (ZRud-1)
EN 15450:2007, NF X 10-970:2011-01, 2011, UNI 11468:2012, VDI 4640, SIA 546 384/6:2010, SIA D 0190:2005
Shallow underground geothermal parameters, Swiss standard (SIA), German standard (VDA)
Environmental restrictions (e.g. water protection areas)

6. **Which information or standards would be helpful to you in your field of activity concerning shallow geothermal projects? Should this information be open to public?**

Table 3: Information that would be helpful for shallow geothermal energy projects in Slovenia.

Answers
All contractors should have been certified for the scope of work for which they have been qualified and equipped (hardware) and have an appropriately educated full-time employees. The awarded certificate should be validated on a specified period (just like in mining or similar activities).
Information's regarding collection and preparation of geothermal data
Information or standards of the well constructions (materials), of closed and open loop systems testing (pumping test)
Information or standards for the abandonment of objects after the end of use.
Guidance for constructing the geothermal system at all phases of constructions with expected numbers of COP and SPF at natural geological-geothermal features of investigated location.
Standards on the methods of implementation geological, hydrogeological, geothermal investigations.
There are no special standards for drilling.
Guidelines for drilling in shallow geothermal (rarely because they have not yet been completed). In Slovenia, in principle, we do not have valid / required standards or they are not applied.

Comments: It is striking how the perceived lack of standards or guidelines covers all aspects of erecting a geothermal installation, from planning to drilling and abandonment.

7. **Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?**
    a. Very helpful
    b. Less helpful
    c. No influence

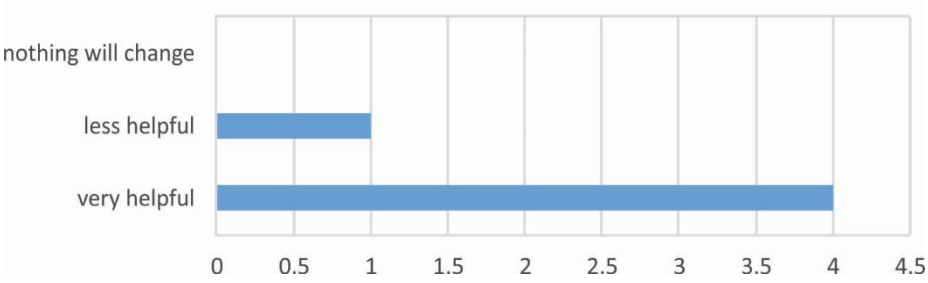

Figure 4: Results question 7: Do you think that obligatory certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems compared to the present situation?

Comments: Four participants think that certificates for planners, designers and installers would help to improve the quality of shallow geothermal energy systems. One participant thinks they are less helpful.

8. How many years are you active in the field of geothermal energy?

a. < 2
b. 3-5
c. 6-10
d. 11-20
e. > 20

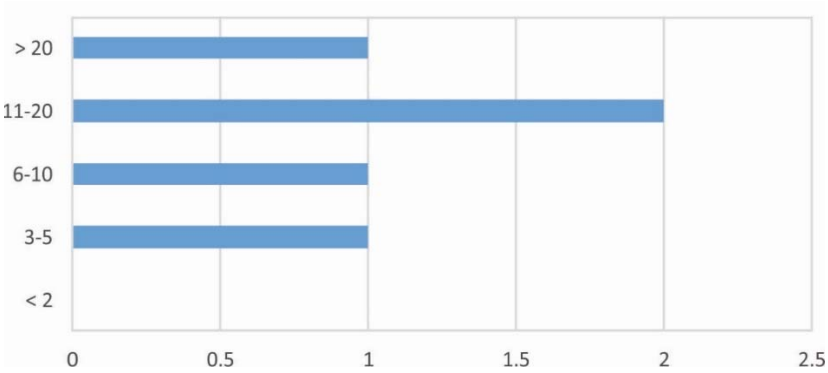

Figure 5: Results question 8: How many years are you active in the field of geothermal energy?

9. Place for your remarks, recommendations and ideas

Table 4: Remarks, recommendations and ideas from participants in Slovenia.

Comments
Joint actions, projects for better connection of all stakeholders in this area, e.g. through association.
I believe that the final guidelines for operators of heating and cooling systems on shallow geothermal energy, especially for drilling companies, will set up some sort of standard procedure for the implementation of systems; it is important that any installation of such a system, either open or closed loop system are recorded and kept in appropriate records on Ministry of the environment and spatial planning, Geological survey of Slovenia and Slovenian Environment Agency.

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CATALOGUE OF REVIEWED QUALITY STANDARDS, CURRENT POLICIES AND REGULATIONS

ANNEX 8

COMPARISION OF CURRENT QUALITY STANDARDS IN CENTRAL EUROPE

Deliverable: D.T2.4.2

Project partner: LP-GBA

09/2018

Geologische Bundesanstalt
LANDESAMT FÜR UMWELT, LANDWIRTSCHAFT UND GEOLOGIE
Freistaat SACHSEN
CZECH GEOLOGICAL SURVEY
GeoZS Geološki zavod Slovenije
AGH University of Science and Technology
geoENERGIE Konzept
GiGa infosystems
Bundesverband Geothermie
City of Ljubljana

Content

Frequently used abbreviations:

SGE(S) ..... Shallow geothermal energy (system)

OLS ..... Open loop systems (groundwater heat exchanger)

CLS ..... Closed loop systems (borehole heat exchanger)

1. Present regulation in GeoPLASMA-CE countries

Regulation element	GeoPLASMA-CE Partner country					
	Austria	Czech Republic	Saxony (Germany)	Poland	Slovakia	Slovenia
Drilling below groundwater table allowed						
Minimum distance to neighboring plot [m]						
Minimum distance to buildings [m]						
Minimum distance neighboring wells [m]						
Minimum distance to neighboring closed loop systems [m]						
Groundwater investigations necessary (Hydrochemistry)						
Certification for drilling companies needed						
Certification for planners or installers needed						
Numerical simulations required						
Minimum distance between pumping and reinjection site [m]						
Reinjection of used groundwater						
Temperature difference between extracted and reinjected water [°C, K]						
Absolute allowed temperature range of the reinjected water [°C]						
Allowed temperature change [°C]						
Accepted drawdown [cm]						
Pumping test obligatory						
Minimum distance to other heat exchangers of the same installation [m]						
Target value for the average inital and input temperature of the heat carrier fluid [°C]						
Regulations for heat carrier fluid type						
Regulations for refrigerant type						
Regulations for the backfilling of BHE						
Leakage test of ground loop and refrigerant tubing required						
Borehole drilling report required						
Taking core samples required						
Thermal response test required						
Calculation of drilling depth required						

In the previous deliverable D.T2.4.1 some technical parameters were evaluated with respect to their legal regulation (see overview Figure 1). GeoPLASMA-CE countries show a very heterogeneous picture regarding the kind of regulation of these parameters. Also the standards for these parameters are very diverse. The next chapter shows an analysis of the parameter handling defined by these regulations.

LEGEND	Explanation
	National/regional/local legally binding regulation
	Regulation by legally not binding instruments (like guidelines), but acknowledged as state of the art
	No written regulations

Figure 1: Summary from D.T2.4.1 showing the differences in the regulation of technical parameters in GeoPLASMA-CE countries.

2. Analysis of the actual state – Quality standards

For the analysis of quality standards of the selected parameters, the actual handling was investigated. The summary concentrates on the standard procedures. Exceptions are present but don´t reflect the general situation. Some interesting information in advance: The absence of written regulations in some countries does not mean that there is no established procedure. The chapter also includes general explanations of the technical parameters.

Figure 2: Description of possible regulations of quality standards.

2.1. General parameters affecting closed loop systems (CLS) and open loop systems (OLS)

Execution of planning/design

Planning means, amongst others such as evaluation of the location or plant design, also the preparation of the documents for licencing. To guarantee the sustainable and safe operation of a geothermal energy plant, appropriate planning is essential.

Actual state in GeoPLASMA-CE-countries

Standards for planners can be divided into three groups in the GeoPLASMA-CE countries. In **Austria, Saxony** and **Slovenia** there are no official requirements for planners**.** In **Slovakia,** the ministry must approve planners. In the **Czech Republic** and **Poland,** planners need certificates.

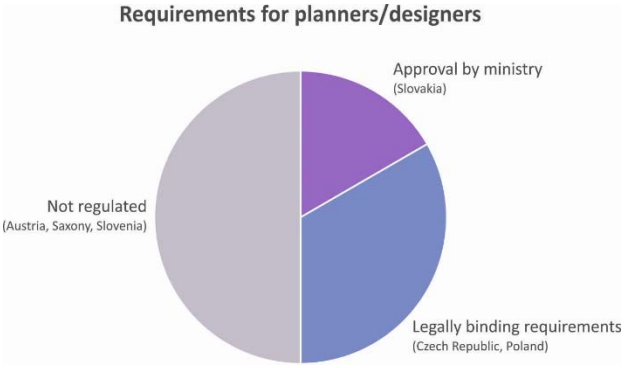

Figure 3: Summary of requirements for planners/designers in GeoPLASMA-CE.

Execution of drilling

As for planning and designing, appropriate drilling works are also essential for the installation of a geothermal energy plant.

Actual state in GeoPLASMA-CE-countries

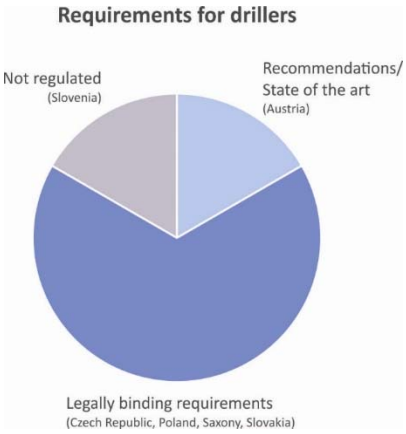

Figure 4: Summary of requirements for drillers in GeoPLASMA-CE.

Standards for planners can be divided into three groups in the GeoPLASMA-CE countries. **Austrian** guidelines recommend assigning only drilling companies fulfilling the qualification criteria of the Austrian association of drilling companies (VOEBU). Legally binding prerequisites for drillers are not present. In the **Czech Republic**, **Poland, Saxony** and **Slovakia** drillers need to fulfil legally stated needs. **Slovenia** is the only country in the GeoPLASMA-CE group without regulations concerning the executing drillers for SGE (for SGE < 300m).

Groundwater analysis

Knowledge about the groundwater chemistry can help to choose the proper equipment for open loop systems and therefore prevent damage. Especially increased iron or manganese contents can cause various deposits. For closed loop systems, groundwater analysis can also be relevant: Groundwater which is corrosive to cement can damage the grouting. This may short circuit different groundwater bodies.

Inappropriate operational management can be an additional consequence in all cases.

Actual state in GeoPLASMA-CE-countries

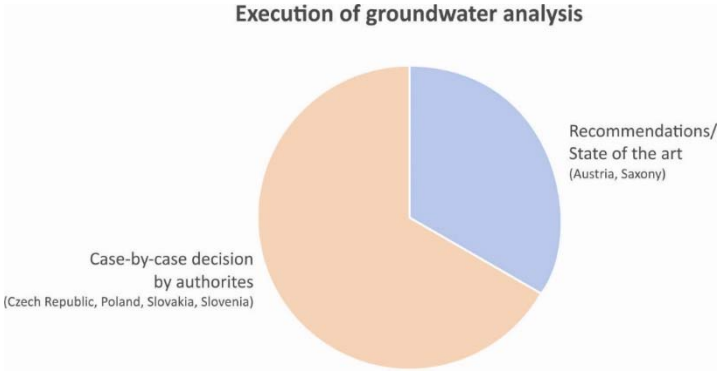

Figure 5: Summary: Execution of groundwater analysis in GeoPLASMA-CE.

Two different standards for handling groundwater analysis were identified within the GeoPLASMA-CE countries. In **Saxony** and **Austria,** the execution of groundwater analysis for OLS is strongly advised in guidelines. The decision for a groundwater investigation is up to the planner respectively the operator. Verbal information by various authorities confirm the practice that this is mostly up to the owner/operator and that analysis are not officially demanded. In **Slovenia**, **Poland**, **Slovakia** and the **Czech Republic** the handling of groundwater investigation is part of the licencing process. Interestingly, all of these standards focus on open loop systems while closed systems are mostly not even mentioned concerning this topic.

Numerical simulations

Numerical simulations help to state the interactions of the planned installation with its surroundings, especially neighbouring geothermal energy systems.

Actual state in GeoPLASMA-CE-countries

For the execution of numerical simulations for shallow geothermal energy installations, GeoPLASMA-CE countries show different procedures. In **Saxony,** the decision is part of the licencing process and decided by the authorities. In **Austria,** numerical simulations are recommended in guidelines for large-scale units or when complex hydrogeological conditions are present. In practice, authorities mostly make the decision during the licencing process. In the **Czech Republic**, **Poland**, **Slovenia** and **Slovakia** numerical simulations are not regulated or recommended in any document.

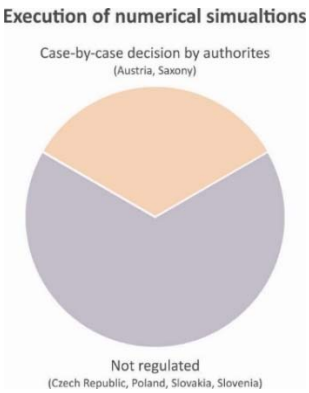

Figure 6: Summary: Execution of numerical simulations in GeoPLASMA-CE.

Pumping test

A pumping test ensures that the design of the open loop systems and the available groundwater are matching.

Actual state in GeoPLASMA-CE-countries

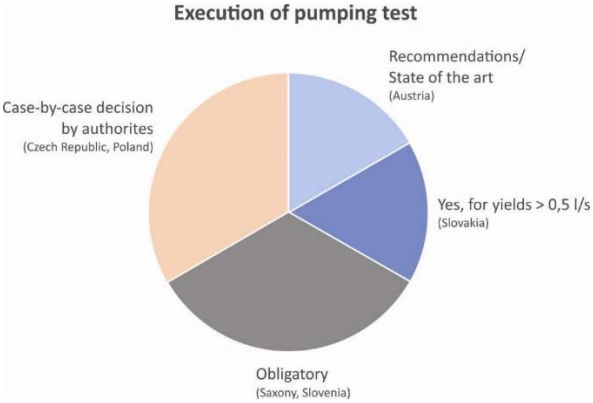

Figure 7: Summary: Execution of pumping tests in GeoPLASMA-CE.

Four different standards for the handling of pumping tests were identified within the GeoPLASMA-CE countries. In **Saxony** and **Slovenia,** the execution of pumping tests is obligatory. In **Austria,** the execution of pumping tests is good practice. The decision is up to the planner respectively the operator and rarely demanded during a licencing process. In **Poland** and the **Czech Republic,** the decision for a pumping test is part of the licencing process, respectively decided by the authority. In **Slovakia,** pumping tests are obligatory for yields > 0.5 l/s.

Environmental standards for technical components used in SGE

Environmental standards minimize the potential adverse impact onto the environment, such as ingress of contaminants (e.g. casing without softening agents, chromate-free grouting) into the ground water.

Actual state in GeoPLASMA-CE-countries

Definitions and specifications for environmental standards are present in Germany in legally binding documents. But specifications only concern materials hazardous to groundwater. In Austria recommendations for fluids and all other materials are given in legally not binding documents.

Minimum distance to neighbouring plot [m]

The use of shallow geothermal energy has an impact on the immediate subsurface environment. Installations which are placed close to a property border may cause conflicts. For example, soakaways can lead to soil wetness of neighbouring estates if too close to a property border. Thermal impacts in general as well as influences on the groundwater table get larger the closer the installation is to the neighbouring plot.

Actual state in GeoPLASMA-CE-countries

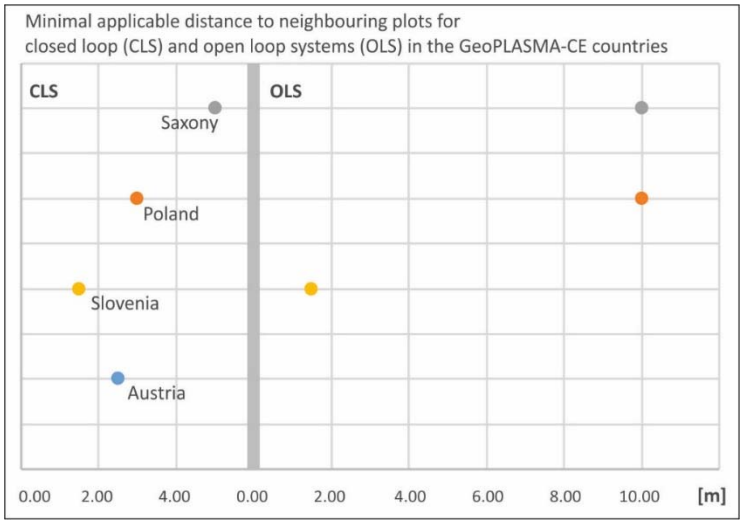

Figure 8: Summary of required minimum distances to neighbouring plots in GeoPLASMA-CE.

Research in the GeoPLASMA-CE shows diverse principles for minimum distances to neighbouring plots. Two countries (**Poland** and **Saxony**) define distances for both OLS and CLS in guidelines. In **Slovenia**, it is legally regulated by the Construction Act. In general, the range for CLS is from 1.5 to 5m. Distances for OLS are 1.5 or 10 m from neighbouring plots. In **Austria,** guidelines recommend 2.5 m only for the distance between CLS and the neighbouring plot. **Slovakia** and **the Czech Republic** have no written regulations.

Minimum distance to buildings [m]

Drilling activities may present hazards with regard to building integrity (deviation, vibration). This also applies to other installations such as supply lines.

Actual state in GeoPLASMA-CE-countries

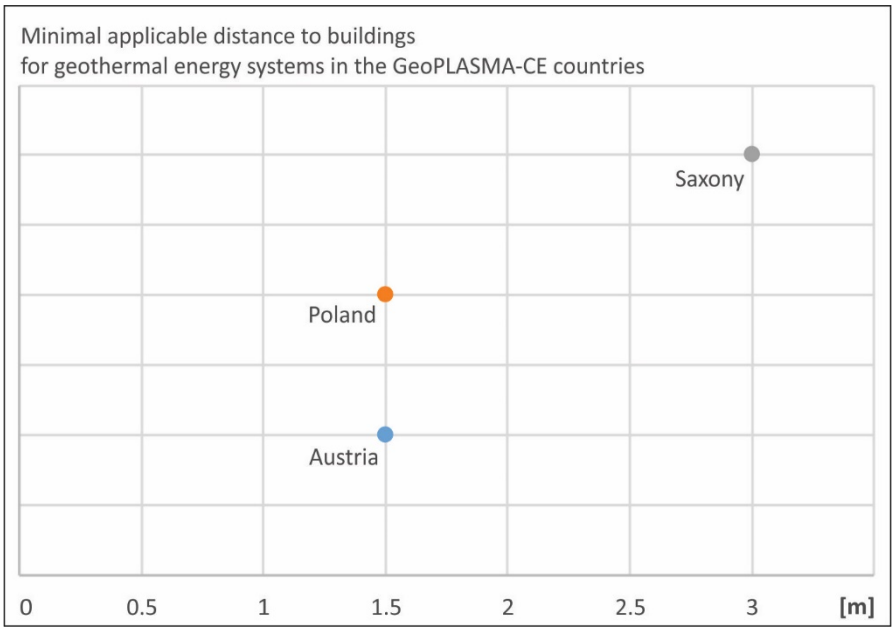

Figure 9: Summary of required minimum distances to buildings in GeoPLASMA-CE.

Three out of the six countries have written regulations. All of them are recommendations in guidelines. In **Austria** and **Poland,** distances are only given for CLS. In **Saxony**, distances are valid for CLS and OLS. Distances to buildings range from 1.5 to 3m. The **Czech Republic**, **Slovakia** and **Slovenia** have no written regulations.

Minimum distance to neighbouring wells [m]

Extraction and injection both influence groundwater levels and may affect extraction rates of neighbouring wells. This and thermal changes of the groundwater can also affect the system efficiency of other OLS if too close.

Actual state in GeoPLASMA-CE-countries

No country has defined minimum distances to any neighbouring wells. The general rule is that **pre-existing rights are not allowed to be affected**. Distances are individual and part of the licencing procedure.

2.2. Parameters concerning CLS

Standards for the design of closed loop systems (CLS)

An appropriate design of a closed loop system ensures a sustainable use of the temperature in the surround of the borehole heat exchanger. The design method must be adjusted to the size of the closed loop system.

Actual state in GeoPLASMA-CE-countries

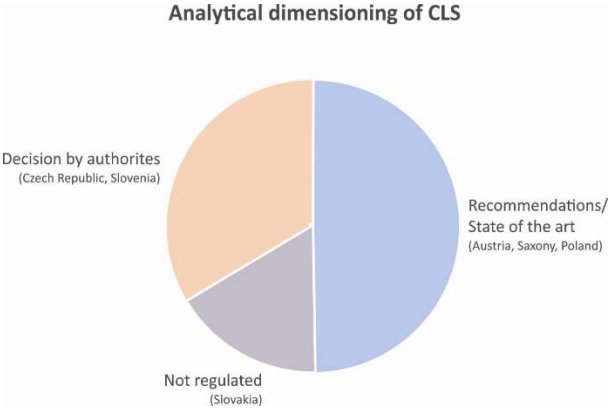

Figure 10: Summary of standards for the design of closed loop systems in GeoPLASMA-CE.

Four regulations of handling the design of CLS, respectively the calculation of drilling depths, are present in the GeoPLASMA-CE countries. In **Saxony, Poland** and **Austria,** the process of sizing CLS is recommended by methods mentioned in the state of the art. In **Austria**, it is emphasized that mentioned methods are only suitable for small-scale systems. For large-scale systems or if complex hydrogeological conditions are present, it is recommended to execute numerical simulations. In the **Czech Republic and Slovenia,** the method is part of the licencing process and decided by authorities. In **Slovakia,** this parameter is not regulated.

Current methods for the design of CLS are:

- In **Saxony** and **Austria,** the standard for a simple design is stated in the German guideline VDI 4640-2. Methods here are based on calculation with tables with empirical values (state of play 2001, see figure 13) or tables with calculated values from EED (state of play 2015).
- **Austria** also recommends to use curves and correction factors based on calculated values (according to SN 546384/6, 2010)
- In general, most standards in **Europe** use empirical or calculated values for length sizing for a simple design of CLS. A general summary of these standards is provided in figure 12. This summary also compares the results of those methods and shows the big difference between the use of empirical and calculated values (Sanner, 2018).

Underground	Specific heat extraction	
	for 1800 h	for 2400 h
General guideline values:		
Poor underground (dry sediment) (λ < 1.5 W/(m · K))	25 W/m	20 W/m
Normal rocky underground and water saturated sediment (λ < 1.5–3.0 W/(m · K))	60 W/m	50 W/m
Consolidated rock with high thermal conductivity (λ > 3.0 W/(m · K))	84 W/m	70 W/m
Individual rocks:		
Gravel, sand, dry	< 25 W/m	< 20 W/m
Gravel, sand, saturated water	65–80 W/m	55–65 W/m
For strong groundwater flow in gravel and sand, for individual systems	80–100 W/m	80–100 W/m
Clay, loam, damp	35–50 W/m	30–40 W/m
Limestone (massif)	55–70 W/m	45–60 W/m
Sandstone	65–80 W/m	55–65 W/m
Siliceous magmatite (e.g. granite)	65–85 W/m	55–70 W/m
Basic magmatite (e.g. basalt)	40–65 W/m	35–55 W/m
Gneiss	70–85 W/m	60–70 W/m
The values can vary significantly due to rock fabric such as crevices, foliation, weathering, etc.		

Figure 11: Table with empirical values from VDI-guideline 4640-2, Germany.

Standard and source	Number of BHE	Depth of BHE	Total BHE length	Deviation from EED result
VDI 4640-2 (2001), generic values (also in NF X10-970, 2011, and ÖWAV RB 207, 2009)	2	73.4 m	147 m	-33 %
VDI 4640-2 (2001), specific rock values (also in NF X10-970, 2011, and ÖWAV RB 207, 2009)	2	67.7 m	136 m	-38 %
VDI 4640-2 (draft 2015), after values for 2 and 3 BHE	2 3	102.1 m 72.2 m	204 m 216 m	-7 % -2 %
SN 546 384/6 (2010) (also in ÖWAV RB 207, 2009)	2	123 m	246 m	+12 %
MIS 3005 (2017) with MCS 022 (2011),	2	110 m	220 m	0 %
EED-calculation	2	110 m	220 m	0 %

Figure 12: Comparison of different methods for the sizing of BHE (VDI… German guideline, NF… French guideline, ÖWAV… Austrian guideline, SN… Swiss guideline, MIS and MCS… UK guideline).

Thermal response tests

Thermal response tests help to explore underground-properties and therefore enhance depth-calculations for closed loop systems.

Actual state in GeoPLASMA-CE-countries

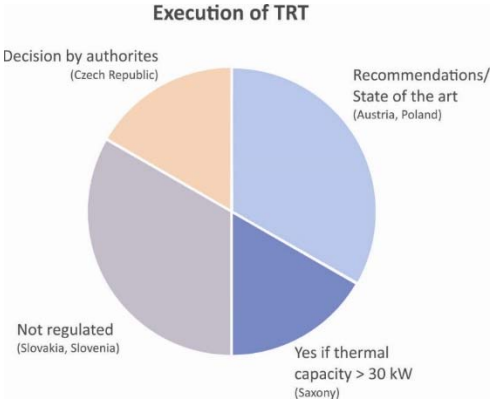

Figure 13: Summary of requirements for planners/designers in GeoPLASMA-CE.

Regarding the execution of thermal response tests (TRT), the GeoPLASMA-CE countries show five different procedures. Only in **Saxony** the execution of TRTs is obligatory for installations with thermal capacities > 30 kW. In **Austria** and **Poland** TRTs are recommended as a state of the art exploration tool. In Austria, they are strongly advised when complex geothermal loop systems are installed. In the **Czech Republic,** the decision for the execution of a TRT is part of the licencing process and decided by the authorities. In **Slovenia** and **Slovakia**, the execution of TRTs is not mentioned in any guideline or law.

Minimum distance to other heat exchangers of the same installation [m]

Heat exchangers influence their subsurface environment and thus potentially each other. The closer two heat exchangers are to each other, the lower the overall system efficiency. This must be considered while planning/designing.

Actual state in GeoPLASMA-CE-countries

Austria and **Poland** give recommendations for the minimum distance to other borehole heat exchangers (BHE) of the same installation. For **Austria**, they range between 8 and 10m and in Poland from 6 m to 8% of the total BHE-length. In **Poland,** the distance of 6m also matches with the recommended value for minimum distances between a BHE and the neighbouring plot. Later if doubled represents the minimum distance of two BHE of two different CLS. Applied to Austria the minimum recommended distance between neighbouring CLS is lower (2x 2.5m) than between BHE of the same installation (8-10m)! Since in **Austria** not all CLS must be notified or permitted, this can influence heat extraction rates without knowing.

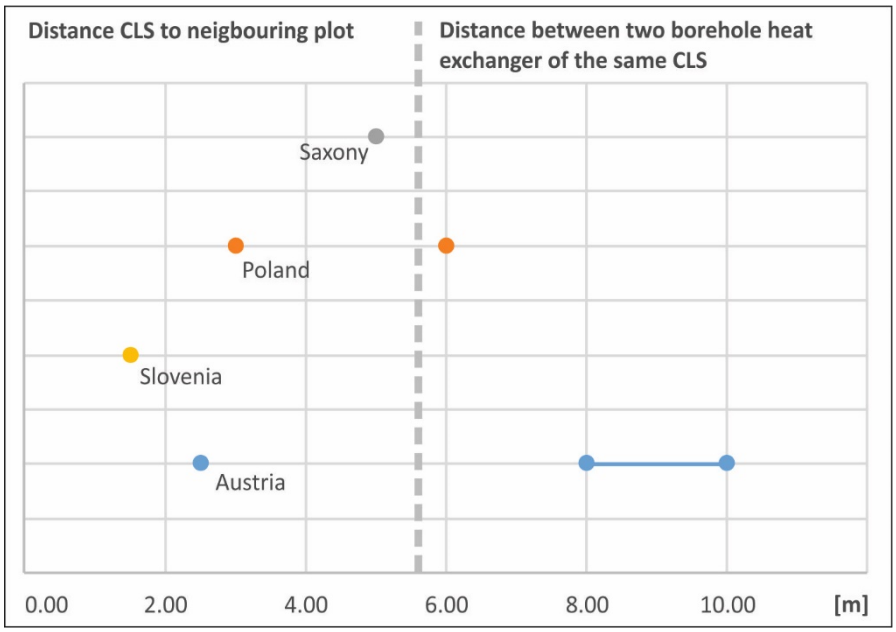

Figure 14: Summary of required minimum distances between to BHE of the same CLS in GeoPLASMA-CE.

Target value for the average temperature of the heat carrier fluid [°C]

The temperature of the heat carrier fluid shall be selected to obtain a sustainable and yet effective use. It has to be considered that too high heat extraction rates generate low soil temperatures, creating the risk of freezing, soil subsidence and low system efficiency.

Actual state in GeoPLASMA-CE-countries

Only **Saxony** and **Austria** include this parameter in guidelines. For heating purposes, both countries have the same recommendation:

- -1.5°C average of inlet and outlet temperature after 5-50 years. This can be realized with outlet temperatures of -3°C and inlet temperatures of 0°C.

For cooling purposes, **Austria** states that the temperature of the heat carrier fluid has to be < 30°C. In **Saxony** temperature shall be selected such that resulting groundwater temperatures are < 20°C.

Regulations for the grouting of borehole heat exchangers (BHE)

Grouting has to achieve hydraulic separation of the wellbore from the surrounding formations and surface precipitation in order to preserve the (hydro-) geological status quo. Hydraulic separation ensures separation of different groundwater stories and seals off problematic geological formations (e.g. soluble salts, swelling anhydrite) from ground water contact. Special resistant grouting material is required in the presence of cement corrosive waters. In case of a closed-loop system, the grouting material also plays an important role

regarding the thermal coupling of the wellbore to the surrounding formation. Grouting also provides mechanical support and protection to the casing.

Actual state in GeoPLASMA-CE-countries

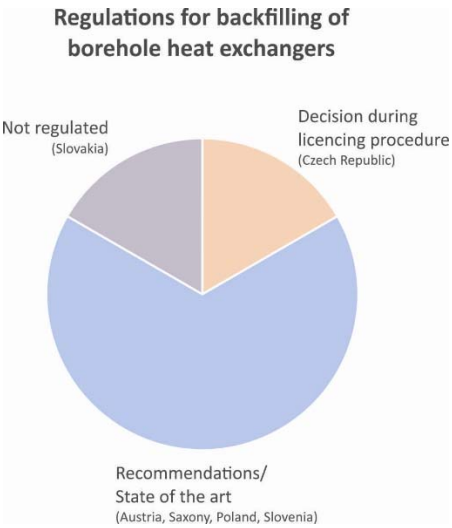

Figure 15: Summary of requirements for backfilling in GeoPLASMA-CE.

Backfilling is not regulated in **Slovakia**. **Austria**, **Saxony, Slovenia** and **Poland** provide recommendations. The decision about the execution is made during the licencing process in the **Czech Republic.**

Current recommendations for backfilling are:

- **Austria**: Backfilling of the borehole should be obligatory. The suspension should have density of at least 1.3 g/cm³. Recommended materials are cement-bentonite-suspensions (mix of 7.6:1) or finished products.
- **Poland**: Guidelines suggest bentonite or quartz sand filling of the well.
- **Saxony**: CLS have to be sealed off with non-hazardous materials not affected by sulfates or hydrogen carbonates and which is proven to be unaffected by repeated freeze-thaw cycles.

Leakage test of ground loop and refrigerant tubing

A leakage test highlights issues with the correct installation and functioning of equipment and can thus minimize adverse impact on the environment. As a quality control measure, it can prevent high follow-up costs and/or reduced efficiency of the system.

Actual state in GeoPLASMA-CE-countries

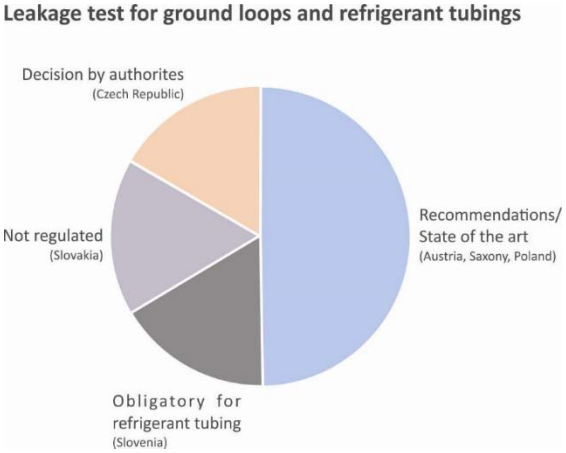

Figure 16: Summary of requirements for leakage tests in GeoPLASMA-CE.

In the **Czech Republic,** authorities decide about the execution of leakage tests during the licencing procedure. In **Slovakia**, this topic is not regulated. In **Slovenia,** the leakage test of the refrigerant tubing is obligatory by national law. **Austria**, **Poland** and **Saxony** have written recommendations in guidelines, which are experienced as good practice and executed by default.

Borehole drilling report and sampling

Lithological information, ground water levels, drilling method, borehole diameter, drilling fluid system and other information may be collected by authorities such as the geological survey, and is important for quality control (system design and efficiency) and environmental control. Cutting samples are also an instrument for quality control. They also serve as proof that the dimensioning based on thermal conductivities is appropriate. Therefore, they also help to determine the depth required for following wells. In some countries geological surveys or the local authorities may request cutting samples e.g. in regions of complex geology or if drilling depth is limited for geologic reasons (e.g. presence of anhydrite, aquiclude).

Actual state in GeoPLASMA-CE-countries

A borehole drilling report is obligatory and regulated by laws in **Poland**, **Saxony** and **Slovenia**. While in **Poland** sampling during drilling is not required, in **Saxony** and **Slovenia**, collecting cutting samples is obligatory. In **Austria**, a drilling report as well as the collection of samples is recommended by guidelines. In the **Czech Republic**, the decision is made during the licencing procedure. **Slovakia** has no regulations concerning drilling reports and sampling.

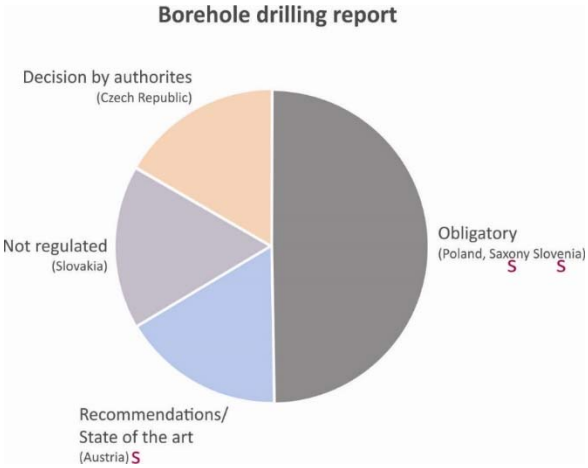

Figure 17: Summary of requirements for borehole drilling reports in GeoPLASMA-CE. The S stands for sampling required/recommended.

2.3. Parameters concerning OLS

Minimum distance between pumping and reinjection well [m]

Reinjecting too close to or upstream of the extraction well will reduce the temperature of extracted water and thus lower system efficiency (hydraulic short circuit).

Actual state in GeoPLASMA-CE-countries

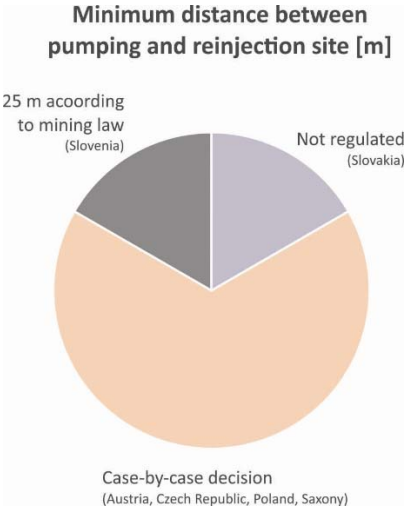

Figure 18: Summary of requirements minimum distances between pumping and reinjection site in GeoPLASMA-CE.

The distance between pumping and reinjection site is a case-by-case decision in **Austria**, the **Czech Republic, Poland and Saxony**. The decision is made based on hydrogeological conditions and neighbouring rights. **Slovakia** has no regulations. In **Slovenia**, the distance is given with 25 m according to mining Act.

Reinjection of used groundwater

Reinjection of groundwater prevents depletion of the aquifer but bears the risk of contamination. Reinjection prevents decreasing ground water levels and therefore possible negative impacts on the extraction rates of nearby wells. However, temperature changes will be observed in the ground water. This could lower the efficiency of geothermal wells located downstream if not considered. In turn given the right hydrogeological conditions, this could also allow using the aquifer as seasonal temperature storage (heating/cooling).

Actual state in GeoPLASMA-CE-countries

- Austria: State of the art. *"The reinjection of used groundwater to the same aquifer is standard and favoured."*

- Czech Republic: Not solved by a legal act, however it is part of the licencing process and a case-by-case decision of the authority.
- Poland: Water law: "*Injecting used groundwater is cancelling water usage fees if the only change in water properties is decrease of the temperature.*"
- Saxony: Water law: "*The general requirement is no adverse effects on groundwater.*"
- Slovakia: Not solved by a legal act
- Slovenia: No regulation present.

Type of demanded reinjection (soakaway or well)?

Surface soakaways are cheaper to realize but require a large suitable surface area with appropriate subsurface conditions (permeability). Compared to return-wells, a soakaway does not directly reinject the used water to the aquifer. This provides also more safety in case of pollution (principle of shallow reinjection).

Actual state in GeoPLASMA-CE-countries

No defined rules are given in any GeoPLASMA-CE country. In **Austria** the installation of a soakaway is preferred over direct injection.

Temperature difference between extracted and reinjected water [°C, K]

The higher the temperature difference between extracted and reinjected ground water, the higher the system efficiency. However, temperature differences can negatively affect bacteria and micro-fauna. Furthermore, higher temperature differences can reduce the system efficiency of downstream geothermal installations.

Actual state in GeoPLASMA-CE-countries

Recommended temperature differences between extracted and reinjected water range from 3 to 6 K. In **Austria** and **Saxony** written recommendations state a maximum delta-T of 6 K. In practice, 3-5 K are mostly used in **Austria**. This is also the recommended range in **Poland**. The **Czech Republic**, **Slovakia** and **Slovenia** have no written recommendations.

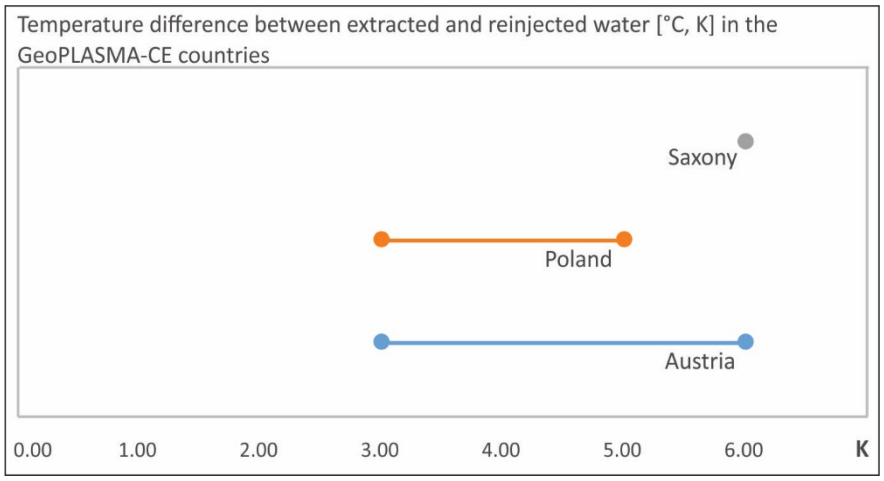

Figure 19: Summary of recommended temperature differences between extracted and reinjected water in GeoPLASMA-CE.

Absolute allowed temperature range of the reinjected water (min. and max. of the reinjected water) [°C]

A temperature change of the groundwater has influences on the viscosity, oxygen saturation and the solution behaviour of the water. Temperature changes may also affect the micro fauna of the groundwater. Those environmental effects are greater with increasing temperature differences. Excess cooling also may affect the heat pump systems due to icing.

Actual state in GeoPLASMA-CE-countries

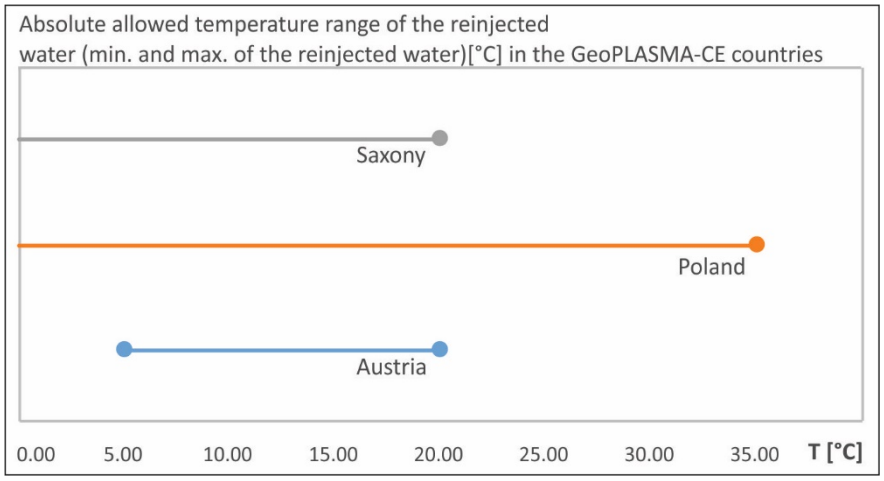

Figure 20: Summary of the recommended absolute temperature range of reinjected water in GeoPLASMA-CE.

Poland and **Saxony** recommend a maximum temperature of the reinjected water of 35°C respectively 20°C. The only country defining a minimum and maximum temperature for the reinjection is **Austria** with a range of 5-20°C. The **Czech Republic**, **Slovakia** and **Slovenia** have no written recommendations.

Accepted temperature change at neighbouring wells [°C]

Temperature changes depend on the individual conditions and can be quantified by simulations in combination with long-term monitoring.

Actual state in GeoPLASMA-CE-countries

No country has official limits concerning the accepted temperature at neighbouring wells. Experiences with authorities in **Austria** imply a limit of < 1 °C.

Drawdown [cm]

Drawdown impacts on all types of wells in the vicinity and reduces their maximum extraction rates. Excessive drawdown can also result in chemical damage (scaling) of the well in question.

Actual state in GeoPLASMA-CE-countries

No country has official limits concerning the accepted drawdown at neighbouring wells. Experiences with authorities in **Austria** imply a limit of < 10 cm.

3. Special geological and geographical conditions

Regulation element	GeoPLASMA-CE Partner country					
	Austria	Czech Republic	Saxony (Germany)	Poland	Slovakia	Slovenia
Artesian aquifers	* *	*	*		*	R
Very shallow water table where reinjection can be problematic		*		N	*	
Perched groundwater layers		*			*	
Two or multiple aquifer layers	*	*	*		*	
Mineral water resources	N	*	*	N	*	
Thermal water resources	N	*	*	N	*	
Gas occurences	*		*	N		N
Mining areas			*	N	*	N
Contaminated soil	*		*		*	
Evaporites (e.g. NaCl, gipsum)					*	
Swellable rocks (e.g anhydrite, clay)					*	
Karst area					*	
Water protection area	N N	*	N N	N	*	N N
Nature protected ecosystem area		*	*	N	*	N
Flood and erosion areas		*	*	N	*	N
Landslide areas					*	N
Costal zones						N

LEGEND
SGES allowed under special obligations or conditionally allowed
SGES not allowed
SGES not regulated
No topic in this country

Figure 21: Comparison of the regulation of special geological and geographical conditions, which can limit the installation of shallow geothermal energy systems.

N/R... Legally binding on a **N**ational/**R**egional level

*... Recommended by officially accepted guidelines

In the previous deliverable D.T2.4.1 installation in special geological and geographical conditions was evaluated with respect to the legal regulation (see overview Figure 22). GeoPLASMA-CE countries show a very heterogeneous picture for the kind of regulation under these conditions.