Guidelines and procedures for reducing licensing barriers

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Abbreviations

GHP	Geothermal Heat Pump
OLS	Open Loop System
CLS	Closed Loop System
RED II	Renewable Energy Directive II
EPA	Environmental Protection Agency
EIA	Environmental Impact Assessment
SPF	Seasonal Performance Factor
NECP	National Energy and Climate Plan
VDI	Verein Deutscher Ingenieure (Association of German Engineers)
ÖWAV	Österreichischer Wasser- und Abfallwirtschaftsverband (Austrian Water and Waste Management Association)
WHG	Wasserhaushaltsgesetz (German Water Resources Act)
RITE	Regulation on Thermal Installations in Buildings (Spain)
UNE	Spanish Standardization (e.g., UNE 100715-1, technical standard for closed-loop geothermal systems)
WKOTOOL	National tool in the Netherlands for permit management and monitoring of geothermal systems
CERRE	Centre on Regulation in Europe
EGEC	European Geothermal Energy Council
IRENA	International Renewable Energy Agency
IDAE	Institute for Energy Diversification and Saving (Spain)
Länsstyrelsen	Environmental Authority in Sweden
GeoDH	Geothermal District Heating (European project on geothermal heating funding by the Intelligent Energy Europe Programme of the European Union)
GeoElec	Develop Geotherml Eletricity in Europe (European project on geothermal co-financed by the EU)
GeoPLASMA-CE	Shallow Geothermal Energy Planning, Assessment and Mapping Strategies in Central Europe (European project on geothermal funding by Interreg Central Europe Programme)
GeoBOOST	Boosting geothermal heat pumps to mainstream cost-effective and efficient renewable heating and cooling in buildings (European project for the promotion of geothermal heat pumps funding by LIFE Programme, EU's funding)
MAGNA 50	Regional geological assessment tool
Omgevingsdienst	Environmental management authority in the Netherlands

1. Introduction

1.1 Objectives of this Guideline

The 'GeoBOOST' project aims to boost the adoption of geothermal heat pump (GHP) systems in the target countries by promoting the creation of clearer, more accessible and harmonised regulatory frameworks. WP3 focuses on i) analysing the current legal framework and procedures for the promotion of GHPs, ii) addressing energy planning tools and incentive policies iii) assessing the legal and policy framework to propose measures to create an enabling environment for GHPs.

This deliverable addresses the focal aspects of WP3 with the ambition to facilitate the licensing and management of the use of GHP for operators as well as for authorities in charge of applications and management of GHP systems. Considering these focus aspects, the present guideline is developed, which aims to provide a practical approach to overcome existing barriers, aligning with the project goals.

The main objectives of the deliverable are:

- Analyse the administrative, regulatory or licensing barriers or challenges in 'GeoBOOST' countries (Austria, Germany, Ireland, Poland, Spain, Sweden and the Netherlands).
- Identify best practices and successful strategies in 'GeoBOOST' countries.
- Propose actionable solutions to streamline licensing and administrative processes in the target countries.

The guideline aimed are authorities responsible for regulation and licensing, including local, regional and national bodies, as well as technical agencies in charge of monitoring compliance fostering a) clearer procedures, reducing administrative complexity and facilitating faster approvals and b) gain structured frameworks to ensure regulatory adherence and efficiency. It also aims to be a support tool for the private sector, fostering

- collaboration and understanding between the various actors involved in project planning,
- regulation and implementation, providing clarity on regulatory expectations, and
- facilitating investment decisions.

Whilst the primary focus is on 'GeoBOOST' participating countries, its recommendations are designed to have relevance in a wider European context. This includes the promotion of best practices, the harmonisation of procedures between Member States and the strengthening of cross-border cooperation. By addressing these aspects, the guide aims not only to facilitate the adoption of GHP in the target countries but also to lay the groundwork for the urgent development of more efficient and sustainable regulatory frameworks across Europe.

1.2 Motivation

1.2.1 Overview of Geothermal Heat Pumps in Europe

Geothermal heat pump (GHP) systems represent an efficient and sustainable technology that harnesses the thermal stability of the subsurface to provide heating, cooling and hot water. This approach stands out for its ability to reduce greenhouse gas emissions and operating costs compared to traditional fossil fuel-based systems (Self et al., 2013). There are different types of GHPs, such as closed-loop systems (CLS), with horizontal and vertical configurations and open-loop systems (OLS), which use groundwater or surface water as the heat exchange medium. These systems can be integrated into a wide variety of contexts, ranging from individual homes to industrial applications and district heating systems (Olabi et al., 2023).

In the European context, GHP systems are increasingly being recognised as a sustainable and energy-efficient technology for heating and cooling buildings across Europe. These technologies can significantly reduce energy consumption and CO_2 emissions, contributing to achieving the energy and climate targets set out in the European Green Pact and the Renewable Energy Directive (RED II) (European Commission, 2023; European Commission, 2018). However, despite their advantages, their adoption has been relatively slow, especially in some regions of Europe. This is due to several factors, including technical limitations, financial constraints and, most importantly, regulatory and licensing barriers that hinder the deployment of GHP systems. Understanding these barriers is key to accelerating the adoption of GHP across Europe (International Energy Agency, 2024).

1.2.2 Challenges in Regulatory, Administrative, and Licensing Processes

Permits and licences are required for GHP systems due to potential environmental impacts, such as drilling, groundwater interactions and subsurface emissions. While groundwater protection is often prioritised, restricting the use of GHP too cautiously may overlook its wider societal benefits. No technology is entirely risk-free, and demanding zero risk for GHP is unrealistic. A balanced regulatory approach should mitigate risks while enabling wider adoption of this sustainable energy solution. However, the process of obtaining permits and

authorisations can be lengthy, complex and costly. Different regulatory frameworks across European countries create inconsistencies in the installation process of GHP, complicating their deployment. The complexity and variability of regulatory frameworks across Europe result in delays and uncertainties in project implementation, making it difficult for stakeholders to navigate the approval process (Tsagarakis et al., 2020). Administrative processes often involve multiple levels of authorisation, technical inspections and bureaucratic procedures, which can increase costs and lead times (Centre on Regulation in Europe, 2024). Moreover, specific land use regulations, environmental impact assessments, and drilling restrictions can pose additional challenges for the installation of GHP systems, particularly in densely populated areas or regions with stringent environmental requirements. These barriers not only slow down the adoption of GHP but also deter potential investors and stakeholders from pursuing geothermal energy solutions (Roka et al., 2023).

1.2.3 The Need to Simplify Licensing Procedures

There is an urgent need to address regulatory, licensing and administrative challenges to unlock the full potential of GHP systems in Europe. To this end, simplifying licensing and regulatory procedures for GHP will encourage their adoption across the region (European Parliament, 2023). By reducing administrative burdens and streamlining approval processes, governments can encourage broader adoption and make GHP technologies more accessible to a wide range of users, including homeowners, businesses and local governments (GeoDH, 2014).

Simplified approval procedures can also reduce associated costs and make GHP systems more economically viable, especially for small and medium-sized enterprises or for residential applications (GeoDH, 2014). In addition, simplified processes can increase public acceptance of the technology by making it more accessible and understandable. Therefore, Simple administrative and licensing procedures, together with clear and harmonised regulations, have a fundamental role to play in ensuring that the benefits of geothermal energy are widely recognised and exploited (García- Gil et al., 2020).

2. Analysis of regulatory requirements and licensing procedures in GeoBOOST countries.

In this section, an analysis of the regulatory frameworks and licensing procedures in the countries targeted by the 'GeoBOOST' project is presented. The analysis uses a comparative approach based on the criteria established by the Renewable Energy Directive (2009/28/EC on the promotion of the use of energy from renewable sources) (Union, 2009; European commission, 2017; European Commission, 2018; European Commission, 2023). This regulatory framework aims to promote the use of renewable energy in Europe by simplifying and harmonising administrative procedures. The specific criteria designed to remove administrative barriers and simplify procedures include:

- Implementation of a **one-stop shop** centralising all procedures (Article [22.3.a]).
- Possibility of submitting **applications** through **online** platforms (Article [22.3.a]).
- Establishment of a **maximum time limit** for administrative procedures (Article [22.3.b]).
- **Automatic permission** of projects once the stipulated deadline has elapsed (Article [22.3.b]).
- Tailored procedures for **small-scale** projects (Article [13.1.f]).
- Identification of suitable **geographic sites for geothermal installations** (Article [22.3.c]).

In addition to the European legal criteria, the analysis incorporates findings and lessons learned from related European projects such as **GRETA** (Prestor et al., 2015), **GeoPLASMA-CE** (Rupprecht et al., 2017), **MUSE** (Klonowski et al, 2020), **GEO4CIVHIC** (GEO4CIVHIC, 2020), **Regeocities** (Jaudin, F., (2013). **GeoDH** (GeoDH, 2014; Angelino et al., 2016)), and **Cheap-GSHPS** (Cheap-GSHPs, 2018). These projects have provided valuable insights on the on planning, implementation and monitoring of geothermal systems. All the mentioned projects have already analysed and summarized the existing legal frameworks in their respective countries, forming a basis for the continued assessment within **'GeoBOOST'.**

This approach combines both a normative perspective and learnings from previous projects, providing a comprehensive overview of the challenges and opportunities related to legal and monitoring procedures. In particular, the analysis identifies key lessons, such as simplifying licensing, improving interinstitutional coordination, and enhancing thermal monitoring and system efficiency tracking, ensuring a more efficient and sustainable geothermal management.

Thus, this section not only assesses existing barriers, such as administrative complexity, lack of coordination between authorities and regional disparities, but also identifies ***best practices*** that can be replicated or adapted in 'GeoBOOST' target countries.

2.1 Current licensing procedures in GeoBOOST' countries

The current regulatory status and licensing requirements of 'GeoBOOST' participating countries are presented below (Table 2 and 3), according to the criteria presented in table 1. The criteria outlined in Table 1 are derived from the general principles set out in the Renewable Energy Directive (RED I, Section 2), which aims to streamline and simplify administrative procedures for renewable energy projects. While the RED establishes high-level policy requirements for Member States — including transparency, procedural simplification, and institutional coordination — Table 1 breaks these down into concrete, verifiable criteria for detailed analysis. For example, the RED's emphasis on streamlining licensing processes is reflected in the inclusion of criteria such as 'Initial contact points for submission' and 'Deadline for administrative processes`. Similarly, the RED's emphasis on institutional cooperation is reflected in the assessment of 'Inter-institutional cooperation and optimisation of licensing procedures. By structuring the analysis in this way, we ensure that the assessment of licensing frameworks in 'GeoBOOST' countries remains policy-relevant and practically applicable.

Table 1. Organised criteria

1. Legal and regulatory framework	- Laws and regulations
2. Licensing procedure	- Initial points of contact for submission - Application forms
3. Evaluation and approval	- Administrative entities involved - Type of licence - Documents required - Cooperation between institutions - Deadline for administrative processes - Automatic permit - Differentiated requirements between urban and rural areas - Specific restrictions and conditions - Duration of permit - Evaluation time
4. Monitoring and supervision procedures	- Mandatory monitoring - Mandatory abandonment
5. Decision support tools	- Assessment and planning tools - Online applications available

	- Inter-institutional cooperation and optimisation of licensing procedures - Assistance to applicants during the application process

These criteria follow a strategic and organised approach to address the analysis of regulatory requirements and licensing process in the 'GeoBOOST' project. They allow for a comprehensive and practical assessment of these procedures, highlighting areas for improvement and examples of best practices, which are key aspects for the following analyses.

Furthermore, the criteria consider the most relevant and practical aspects of the regulatory framework and its implementation, based on the guidelines of the Renewable Energy Directive (RED I, Section 2) and the findings of previous related projects. This ensures that the analysis is comprehensive, relevant, and aligned with both the objectives of the RED and the 'GeoBOOST' project.

Table 2. Current regulatory status and licensing requirements for OLS

Criteria	Austria	Germany	Ireland	Poland	Spain	Sweden	The Netherlands
1. Legal and regulatory framework	Water Act 1959, state of the art defined in ÖWAV Rule Sheet 207.	Federal Water Management Act (WHG)	Water Supplies Act 1942 Regulations 2018.	Based on water well regulations.	Water act. Regional governments regulate, no unified national framework.	Groundwater protection rules: environmental courts decide.	Regional regulations; national protocols for interference zones.
2. Licensing procedure							
- Initial points of contact for submission	Local water authorities (Bezirkshauptmannschaften) for < 300 l/min; federal authorities for > 300 l/min.	Local water management authorities.	EPA for significant abstractions (> 25m^3/day)	Local geological administration.	Local municipalities for building permits; water basin authorities for water use.	Länsstyrelsen	Provincial authorities; external offices ("Omgevingsdienst")
- Application forms	Forms provided by local authorities, region-specific.	Available in physical and digital formats.	Free registration online for water abstraction.	Forms available; content varies depending on Geological Works Project requirements.	Forms available, often region-specific.	Forms available online.	Web portal fields and free-form document upload.
- Assessment Time	Undefined; depends on complexity.	Typically, 3–12 months; some regions allow tacit approval if no decision within 6 months.	Undefined; governed by EPA for abstractions > 25m^3/day.	3-4 month.	9–12 months; administrative silence is considered rejection.	Undefined	2–6 weeks
3. Evaluation and approval							
- Administrative entities involved	Local, regional, and federal water authorities.	Water management, environmental protection, and urban planning authorities.	Local Authority, Environmental Protection Agency and National Authority responsible for	Regional water management administration.	Environmental authorities, water basin authorities, local municipalities	Länsstyrelsen and environmental courts.	External regional offices for permits; provincial authorities.

			water resources (Uisce Eireann)				
- Type of license	Groundwater abstraction and reinjection permits (Permitting Procedure).	Groundwater abstraction licence.	Abstraction licence for water use.	Water law permits.	Environmental impact assessment, water use permits, and building permits.	Environmental court approval.	Groundwater abstraction licence.
- Required documents	Property details, geological data, technical details, operational details.	Hydrogeological study, risk management plan, technical specifications, environmental impact assessment (if applicable).	Design specifications for abstraction > 25m³/day; environmental impact assessments for significant abstractions.	Geological Works Project, hydrogeological documentation, water law report.	Environmental impact assessments, geological surveys, technical designs.	Documentation based on court requirements.	Design studies, efficiency evaluations, negative impact assessments.
- Cooperation between institutions	Limited cooperation between local, regional, and federal bodies.	Integrated procedures in some regions to reduce redundancies.	Cooperation between institutions but requirements need to be fulfilled for each agency.	Minimal cooperation between geological and water management bodies.	Efforts to streamline processes through regional integrated permitting systems.	Collaboration between Länsstyrelsen and Environmental courts.	Limited harmonization in declared interference zones.
- Time limit for administrative processes	No defined time limit.	6 months in some regions, tacit approval possible under certain conditions.	8 weeks	Undefined	Maximum of 12 months; silence results in rejection	Undefined	2–6 weeks
- Automatic permit	No	Sometimes granted under tacit approval rules but not guaranteed.	No	No	No	No	Explicitly not allowed
- Different requirements in urban and rural areas	Same standards; additional restrictions in sensitive zones.	Stricter requirements in urban areas, especially in protected zones.	Limited differentiation based on groundwater use.	No differences noted.	Urban areas often have stricter requirements for infrastructure impact and safety.	Minimal differences; special rules for water protection zones.	No differences except in declared interference zones.
- Restrictions and specific conditions	Karst regions, water protection zones, sensitive areas.	Urban drinking water zones and protected areas have additional limitations.	Case-by-case considerations for	Restrictions near public water intakes.	Environmental restrictions based on region and	Restrictions near outer protection zones.	Interference zones may have specific conditions.

			environmental impacts.		sensitivity of water resources.		
- Permit duration	Case-by-case determination	Typically, 5–10 years; extensions require reassessment.	Undefined	Indefinite	5–30 years, depending on region and project type.	Undefined	Indefinite
4. Monitoring and supervision procedures							
- Regulations for monitoring	Case-by-case (no general legal requirement); authorities may require operational logs and temperature monitoring. This is the case mostly for big installations and/or OLS in close vicinity to other water rights.	Regular checks on water quality, abstraction rates, and system performance.	Proposed mandatory reporting for significant abstractions; periodic environmental checks.	Monitor the amount of abstraction and reinjection volumes.	Monitoring of environmental impacts and groundwater quality as part of operational permits.	Monitoring determined by environmental courts	Mandatory monitoring with specific parameters and frequent reporting.
- Decommissioning procedures and License Surrender	Procedures outlined by ÖWAV Guideline 207 (not legally binding but represents state of the art.	Decommissioning required; includes restoring ground conditions.	Mandatory steps set out in licensing conditions	Defined during geological project documentation.	Decommissioning plans must include site restoration.	Governed by environmental laws, but specific rules.	Defined by protocols; includes well backfilling and site cleanup.
5. Decision support tools							
- Assessment and planning tools	Traffic light maps for Vienna, not for all country.	Geotechnical data from regional agencies; tools for planning and evaluation.	Proposed tools in draft policies.	Limited tools available.	Hydrogeological maps and environmental assessment data provided regionally.	Basic decision tools through regional authorities.	WKOTOOL for planning and system registry.
- Online applications available	Partial documents may be emailed.	Available in some regions.	Yes, free registration for water abstraction.	No online submissions.	Varies by region; some offer full online processes.	Available through Länsstyrelsen	Partially online, web portal integration.
- Inter-institutional cooperation and optimisation of permit procedures	Limited cooperation.	Integrated permitting in some states.	Cooperation between institutions but requirements need to be	No major inter-agency optimization.	Regional initiatives for integrated permitting systems.	Coordination between Länsstyrelsen and environmental courts.	Harmonized processes in declared interference zones.

			fulfilled for each agency				

Table 3. Current regulatory status and licensing requirements for CLS

Criteria	Austria	Germany	Ireland	Poland	Spain	Sweden	The Netherlands
1. Legal and regulatory framework	Water Act. ÖWAV Rule Sheet 207. Regional differences according to outlines of confined groundwater bodies.	Local and federal standards. VDI Recommendation 4640.	No specific regulation for shallow systems. New regulations under development.	Mining and Geology Code.	Regional regulations; UNE 100715-1 as a non-binding guideline.	Local regulations per Kommun.	Local laws since 2024 with interference protocols.
2. Licensing procedure							
- Initial points of contact for submission	Local water authorities.	Water and mining authorities.	Geothermal Regulatory Authority (planned).	Local geological authorities.	Municipalities and regional energy and environment agencies.	Kommun' environmental departments.	Municipal and provincial authorities, outsourced to 'Omgevingsdienst'.
- Application forms	Local forms provided by the water authority.	State specific forms.	Not yet defined.	Not applicable.	Depends on the region.	Specific forms	WKOTOOL portal with required documents to upload.
- Assessment Time	2-6 months depending on the case.	8-10 weeks, max. 6 months.	Not defined.	1-3 months if including mining.	3-6 months depending on complexity of project.	No defined	2-6 weeks depending on region and requirements.
3. Evaluation and approval							
- Administrative entities involved	Local water and regulatory authorities.	Water, mining and nuclear safety for boreholes >100m, and Water authorities (Just in case to be necessary)	To be defined according to new regulations.	Local geological administration. depth more than 100m, mining administration	Multiple regional and local institutions depending on environmental and energy impact.	Local environmental departments, Länsstyrelsen and Environmental court.	Municipalities and provinces with outsourcing in services.

- Type of license	Notification in low impact areas or formal permission in sensitive areas. Permitting Procedure for installations near sensitive areas like water protection zones	Standard licence depending on depth.	Planned registration for shallow systems.	Drilling permit.	Customised regional licences depending on impact and depth.	Local licensing.	Compulsory licensing for systems, standardised requirements.
- Required documents	Geological maps, system design, technical standards such as ÖWAV 207.	Local forms and adherence to VDI 4640.	Under development.	Geological project, technical documentation.	Mapping, environmental assessment, compliance with RITE and local regulations.	Maps, technical certification of drillers.	System design, assessment of negative impact on neighbouring systems, SPF efficiency.
- Cooperation between institutions	Similar to open systems; varies by region.	Depends on state.	To be defined according to new regulations.	No coordination between entities.	Limited and regionalised.	Basic.	Basic communication in defined interference zones.
- Time limit for administrative processes	Varies by region and environmental sensitivity. Notification procedure: Authority has a time limit of 3 months requesting the advanced permitting procedure.	Max. 6 months.	No limit defined.	Up to 3 months with mining.	Depends on the region.	No specific limit set.	-
- Automatic permit	only for the notification procedure (if licensing authority does not react after 3	Limited to some regions.	Not defined.	Not applicable.	Not allowed in environmental procedures.	Not allowed.	Explicitly prohibited.

	months, the installation is automatically permitted.						
- Different requirements in urban and rural areas	Restrictions in urban or protected areas.	In urban areas is necessary to perform the hydrogeological simulations	Not defined.	Not applicable.	More rigidity in urban areas, specific environmental protections in natural areas.	Stricter in urban areas.	Specific requirements in interference areas.
- Restrictions and specific conditions	Water protection in sensitive areas.	Depending on state and urban/rural area.	Not defined.	Depending on local impact.	Environmental restrictions and underground infrastructure zones.	According to local sensitivities.	Based on interference maps and mandatory studies.
- Permit duration	25 years in notification processes.	20-25 years depending on state.	Planned undefined.	Indefinite.	Generally indefinite, with periodic renewals.	2 years, needs renewal.	Normally indefinite.
4. Monitoring and supervision procedures							
- Regulations for monitoring	Mandatory only in specific cases.	There are different rules for monitoring the system in different states, and it also depends on the size of the installation.	Expected to be included in future legislation.	Not required.	Environmental monitoring according to RITE and local regulations, but it is not mandatory.	Not unless stated in the permit but hut is very unusual	Mandatory except for small residential systems.
- Decommissioning procedures and License Surrender	Procedures outlined by ÖWAV Guideline 207 (not legally binding the best practice standard)	Depends on the reason to be abandonment	Expected to be included in future legislation.	Requires plan in initial documentation.	According to environmental assessment.	According to environmental laws.	Complete borehole sealing and fluid disposal.
5. Decision support tools							
- Assessment and planning tools	Not centralised; regionalised.	Local and regional geoportals	In development.	Not defined.	MAGNA 50 for regional geological assessments.	Basic decision tools through regional	WKOTOOL for assessment and planning.

	Traffic light maps for Vienna					authorities (Stockholm's stad)	
- Online applications available	Not fully available. Most of the licensing and notification procedures are handled through traditional methods such as email	Partial	In development.	Not available.	Depending on region; some offer portals for management.	Available in most cases.	Partially available through national portals.
- Inter-institutional cooperation and optimisation of permit procedures	Not centralised.	High variability between regions.	In development.	Non-existent.	Limited to regional/local levels.	Just normal bureaucratic ways	Basic communication in specific areas of interference.

2.2 Identification and Analysis of Best Practices

The transition from analysing current licensing procedures to identifying best practices requires a set of criteria (Table 4) that better captures the elements of an optimised regulatory framework. While the previous criteria focused on the description of existing procedures, this new structure is designed to highlight successful approaches that improve efficiency, transparency and scalability in different regulatory environments.

In this context, best practices consider the set of effective policies, processes and regulatory measures already implemented in some countries that contribute to a more efficient and accessible licensing system for geothermal heat pumps. These practices can either (1) remain successful examples within their respective countries or (2) serve as models for replication and adaptation in other European countries seeking to improve their regulatory frameworks.

Based on this knowledge, the criteria were reorganised, and new points were incorporated (Table 4).

Table 4. Criteria to identify best practices

Criteria	**Description**
1. Legal and regulatory framework	The overall legal structure governing GHPs, including national and regional laws.
3. Digitalisation	Measures that reduce administrative complexity, such as streamlined permitting pathways or automatic approvals.
2. Simplification of processes	The use of digital tolls for application submission, process tracking, and data management.
4. Administrative procedures	Specific steps involved in licensing, from initial application to final approval, and their efficiency.
5. Monitoring and supervision	Requirements for ongoing compliance, including reporting obligations and enforcement mechanisms.
6. Environmental regulation and zoning	Rules regarding environmental protection, land-use planning, and restrictions in sensitive areas.
7. Licensing requirements	Technical and procedural conditions applicants must fulfil to obtain a permit.
8. Registration of facilities	The process for officially recording geothermal installations and their specifications
9. Transparency and participation	Mechanisms for public engagement, stakeholder consultation, and data accessibility.
10. Awareness and assistance	Efforts to inform stakeholders about regulations and provide support during the application process.

These criteria reflect a broader and more strategic approach to identifying best practices in the target countries, as:

i) the new structure follows a logical sequence, starting with the regulatory framework (macro level) and concluding with operational and awareness-raising aspects (micro level);

ii) the inclusion of new criteria ensures the analysis addresses all relevant aspects required for the efficient implementation and replicability of best practices in different contexts; and

iii) the reorganization accounts for cultural and administrative differences between countries, facilitating the identification of adaptable and scalable practices within the framework of the 'GeoBOOST' project.

2.2.1 Best practices GeoBOOST' Countries

To identify the best practices, a review of national regulations and previous research results was carried out, based on the criteria outlined in the previous section. This analysis identifies specific best practices applied in 'GeoBOOST' countries (Table 5,6,7,8,9,10, and 11).

- **Austria**

Table 5. Best practices in Austria

Legal and Regulatory Framework	- All Open-loop systems must be permitted are regulated (by according to the 1959 Water Act). - Detailed permitting procedures include project documentation and environmental impact assessment. - Local and federal authorities intervene, depending on groundwater abstraction rates. - The license according to the permission (OLS and partly CLS) and the notification procedure (CLS) comes with a water right, protecting the installation from any negative impact of new water rights.
Environmental Regulation and Zoning	- Specific maps and tools, such as the **Geothermie-Atlas in Vienna,** are used to identify areas where systems are restricted or prohibited. This helps prevent conflicts and facilitates project planning.
Register of Installations	- Austria has a system of registration of open loop systems to ensure that authorities have visibility on the location and characteristics of installations. It allows for better resource management and interference prevention.
Transparency and Participation	- Local and regional authorities publish clear information on licensing procedures, necessary documents and technical requirements, promoting transparency and reducing uncertainty for developers. - Regulatory transparency exists, as clear rules and guidelines are accessible to applicants, reducing administrative uncertainty.
Awareness and Assistance	- Technical support from local authorities, as district offices offer personalised advice during the application process, helping developers to meet specific requirements. - Clear rules and guidelines are accessible to applicants, reducing administrative uncertainty.

- **Germany**

Table 6. Best practices in Germany

Digitalisation	- Some regions allow online applications and tracking of the status of the process, reducing administrative time and costs.
Administrative Procedures	- In some states, water, environment and planning authorities work together to avoid duplication of reviews.
Monitoring and Supervision	- Periodic water quality monitoring, system inspections and aquifer impact assessments.
Environmental Regulation and Zoning	- Digital maps and databases allow assessment of project feasibility before starting the formal process. - Local and regional authorities are available to answer any questions dealing with the licensing and submission procedure.
Licensing requirements	- Requirement of geothermal analyses prior to installation to reduce technical risks.

- **Ireland**

Table 7. Best practices in Ireland

Legal and Regulatory Framework	- EPA regulates water abstraction with compulsory licences for volumes greater than 25 m^3/day.
Environmental Regulation and Zoning	- Monitoring based on specific conditions to ensure environmental sustainability (temperature, volume, water quality). - Required for larger projects or in sensitive areas, ensuring sustainability of facilities. - Assessments adjusted to urban and rural areas, adapting to the characteristics of the environment.
Registration of Installations	- These registers are volunteer contributing to transparency and collection of useful data.

- **Poland**

Table 8. Best practices in Poland

Legal and Regulatory Framework	- Regulation for small, closed loop installations. - In the case of deeper installations of Closed loop systems there is regulation by the Geology and Mining Act, simplifying the process. - In the case of open loop systems there is regulated by water act.
Administrative Procedures	- Fast-track procedures and indefinitely valid permits for closed loops - Licensing is governed by national water and environmental legislation. - Simplified procedures for smaller scale projects.
Monitoring and Supervision	- Mandatory monitoring of abstracted and reintegrated water with meters. - Use of existing regulations (water wells) to ensure sustainability.
Licensing requirements	- Clear requirements for hydrogeological studies and technical specifications

- **Spain**

Table 9. Best practices in Spain

Simplification of Processes	- Some autonomous communities have implemented faster administrative processes, such as one-stop shops for permits.
Digitalisation	- Use of online platforms in regions such as Catalonia and Madrid to process permits and reduce time.
Administrative Procedures	- Collaboration between local and regional entities in Navarra and Valencia to simplify procedures. - Licensing managed by regional governments with special attention to Environmental Impact Assessments (EIA).
Monitoring and Supervision	- Periodic groundwater monitoring and sustainability assessments.
Environmental Regulation and Zoning	- Customised Environmental Assessments through Case-by-case analysis such as in Aragón and Castilla y León to mitigate specific impacts. - Responsible Water Management where the Hydrographic Confederations such implement strict measures to protect aquifers in open loop systems. - Protection of Sensitive Areas applied, special criteria in Natura 2000 areas to preserve biodiversity. - IGME maps: Use of geological and hydrogeological mapping (MAGNA 50) to assess subsoil potential.
Licensing requirements	- Technical Standards: application of UNE 100715-1 technical guide for quality assurance in closed loop systems.

- **Sweden**

Table 10. Best practices in Sweden

Simplification of Processes	- Simplified procedures for residential systems encourage the adoption of geothermal technologies.
Digitisation	- Some municipalities already allow electronic applications, improving efficiency. - Online applications available through Länsstyrelsen.
Administrative Procedures	- Cooperation between Länsstyrelsen and environmental courts helps to handle complex cases.
Monitoring and Supervision	- Widespread use of monitoring: Technological innovations to optimise the performance of installations.
Environmental Regulation and Zoning	- Special attention to water protection zones in urban areas.

- **The Netherlands**

Table 11. Best practices in the Netherland

Digitalisation	- There is a national portal 'WKOTool' for managing applications and registering geothermal systems, with interactive maps of restricted and interference zones.
Administrative Procedures	- Standardised protocols are in place. Clear technical requirements for design, impact and energy efficiency studies. - Licensing processes take 2-6 weeks, with licences generally indefinite.
Monitoring and Supervision	- Mandatory monitoring of temperature, flow and energy balance measurements at 15-minute intervals, with annual reports for large systems. Obligations include energy balance, SPF and injection temperatures. - Periodic reporting to authorities is mandatory.
Environmental Regulation and Zoning	- Protection of water resources with strict regulations in open systems, such as limiting injection temperature to 25 °C.

	- Specific rules for areas where open and closed systems coexist, avoiding thermal conflicts, interference zones. - Underground plans with strategic regulation of subsoil use to ensure sustainability and avoid conflicts.

2.2.2 Cross-country comparative best practices

This section compares the legal approaches adopted in different countries, highlighting the best practices that contribute to regulatory clarity, environmental protection and efficient licensing processes. By identifying effective regulatory models, this comparison aims to support the development of streamlined and harmonised frameworks across Europe.

1. Legal and Regulatory Framework

In terms of the legal framework, Germany stands out with its robust regulation under the Federal Water Act (WHG), which requires hydrogeological assessments and strict standards for open systems. Austria, on the other hand, sets technical standards through the ÖWAV RB 207 guideline. Ireland also has a detailed legal framework regulated under the Water Supplies Act 1942, which classifies requirements based on the volume of water extracted. In the Netherlands since 2013 new laws and regulations in registration of systems. permit requirements (some cases), certification required and obligation to assess and prevent thermal interactions between systems. Spain has a decentralized approach, where regional governments manage regulations, particularly those related to Environmental Impact Assessments (EIA). However, this fragmentation creates challenges in regulatory uniformity.

2. Process Simplification

Countries like Sweden, Ireland, and Poland have simplified procedures for closed-loop systems, reducing administrative burdens in non-sensitive areas. In Ireland, the absence of formal legislation for closed-loop systems has simplified procedures, but it also points to a gap in regulation that may affect long-term system quality and safety. Austria simplifies procedures for closed-loop systems in non-sensitive areas, requiring only a notification instead of a full license. The Netherlands has implemented "interference zones" to facilitate planning and avoid thermal conflicts between open and closed systems, optimizing administrative timelines. The Netherlands also has strict legal protocols for efficiency and energy balance. Germany has advanced by integrating procedures among different governmental entities, such as water, environmental, and urban planning authorities, reducing duplication and accelerating the approval process. These approaches serve as examples of simplification that could be adopted by other countries.

3. Digitalization

The Netherlands leads in digitalization with its WKOTOOL portal (https://wkotool.nl/), which centralizes applications and records and provides interactive maps to identify restricted areas. Sweden has also implemented an effective digital system, accessible via the Länsstyrelsen website (https://etjanster.stockholm.se/Varmepump/hur-har-grannarna-borrat), facilitating project submissions and tracking, especially in urban areas. In Spain, although some regions have developed digital portals, the lack of national uniformity limits the overall effectiveness of these tools. The Netherlands' comprehensive digital platform and Sweden's user-friendly online system provide examples of best practices that could be expanded or adapted in other regions to enhance transparency and efficiency in regulatory processes.

4. Administrative Procedures

Administrative management varies significantly between countries. The Netherlands excels with fast processing times ranging from 2 to 6 weeks, even for complex systems. In Germany, procedures have defined deadlines, usually between 8 and 10 weeks, with the possibility of tacit approvals in some states if the maximum deadline is not met. Conversely, in Spain, the process can extend up to 12 months, and negative "administrative silence" discourages applicants, highlighting an opportunity to improve time management and procedural clarity.

Integrated procedures vary between countries. Germany has formal cooperation between water, environmental, and urban planning authorities. The Netherlands has partial centralization in external regional offices. In contrast, Sweden has defined procedures but no integration between entities. Austria requires interaction with multiple entities with limited cooperation, while Spain presents significant regional variability, resulting in fragmented processes that can delay approvals.

5. Monitoring and Supervision

Monitoring is an area where the Netherlands excels. Continuous monitoring is required every 15 minutes for parameters such as energy balance, injection and extraction temperatures, and flow rates. Germany also prioritizes monitoring, especially in open systems, with regular water quality checks and periodic audits to ensure regulatory compliance. Austria, though less stringent, conducts case-by-case evaluations in sensitive areas, adapting monitoring requirements to the specific characteristics of each installation. Spain mandates monitoring for larger projects but lacks clear national standards. Sweden and Poland, on the other hand, have limited monitoring frameworks, with requirements only when explicitly stipulated in the license.

6. Environmental Regulation and Zoning

Spain and Sweden stand out for their focus on protecting sensitive areas. In Spain, Environmental Impact Assessments (EIA) are mandatory, and river basin authorities regulate installations in protected zones. Sweden applies strict restrictions in areas such as water recharge zones and nature reserves. Austria's environmental regulation includes detailed hydrogeological assessments to ensure aquifer sustainability. Germany has specific restrictions in urban areas and drinking water protection zones. The Netherlands, for its part, uses advanced zoning tools like "interference zones" to manage interactions between multiple systems and minimize environmental impacts, demonstrating an effective model for sustainable system planning.

7. Licensing Requirements

Licensing requirements in Germany include detailed hydrogeological assessments and specific technical certifications, particularly for OLS. The Netherlands complements these requirements with studies on energy efficiency (SPF) and negative impact analyses. In Ireland, required documentation includes technical specifications and environmental mitigation measures, which are particularly thorough for larger systems. Austria stands out by offering flexibility, allowing applicants to submit customized documentation if it meets minimum requirements.

8. Installation Registration

Installation registration is key to traceability and long-term management. Austria maintains a mandatory registry of OLS in the Water Book, ensuring that each installation is documented and its rights protected. The Netherlands has fully digitised this process through WKOTOOL, allowing public and transparent access to records. Sweden, while offering local tools for specific areas, lacks a centralized system, making nationwide tracking difficult.

9. Transparency and Participation

Austria leads in transparency and participation by offering preliminary consultations with local authorities, enabling applicants to understand the requirements before formalizing their proposal. In the Netherlands, access to open data through interactive maps significantly increases transparency, facilitating user planning. Germany provides informational sessions and technical assistance. In Spain, although some regions organise workshops and public consultations, these initiatives are not uniformly implemented, showing an area for improvement in citizen inclusion.

10. Awareness and Assistance

Assistance to applicants varies in scope. Austria offers detailed support through clear guidelines and technical assistance, ensuring that stakeholders can meet regulatory requirements. Sweden, through Länsstyrelsen, provides consultations with experts to assist in preparing applications and technical documentation. The Netherlands ensures that applicants are well-prepared and understand the necessary procedures through certification programs, strengthening technical and regulatory knowledge in the sector. Germany offers guidance and technical assistance through consultation offices.

3. Analysis of current barriers

3.1 Regulatory, Licensing, and Administrative Barriers in GeoBOOST' Countries

Regulatory, licensing and administrative barriers constitute a complex set of constraints that slow down and, in many cases, hinder the widespread adoption of GHP systems in Europe. Although different in nature, they are intrinsically connected, as they affect the process from initial project conception to final implementation. In this sub-section, three key types of barriers will be addressed in a differentiated manner: licensing, regulatory and administrative.

- **Licensing barriers**: These primarily involve the bureaucratic procedures necessary to obtain the permits required to install and operate a GHP system. Challenges stem from the lack of harmonization in licensing requirements across different countries and regions in Europe, creating an environment of uncertainty and delays (Dumas et al., 2013).

- **Regulatory barriers**: These include ambiguity, rigidity, or even the absence of specific regulations tailored to GHP systems. In some countries, regulations fail to adequately address critical technical aspects of GHPs, such as environmental impacts or potential thermal interference between nearby systems (Pasquali and O'Neill, 2015).

- **Administrative barriers**: These refer to internal procedures and processes within institutions responsible for licensing and regulation. Lengthy administrative processes, insufficiently trained staff, and extended waiting times are significant obstacles that increase both the costs and implementation times of GHP projects (GeoDH, 2014).

Categorising these barriers down into distinct categories provides a more comprehensive understanding of their impact on GHP adoption. Each barrier affects different aspects of the licensing process and thus requires a tailored approach to overcome.

The following sections (section 3.1.1 and 3.1.2) detail the country-specific regulatory, administrative and licensing barriers of the 'GeoBOOST' countries in open and closed loop systems. A series of tables (e.g. Table 12 for Austria) summarise these barriers, providing a structured comparison of significant challenges.

3.1.1 Barriers for OLS in GeoBOOST Countries

- **Austria**

Table 12. Barriers in Austria

Barriers	Description
Licensing	Validity of the permit: The duration of the permit is determined on a case-by-case basis, which can result in a lack of clarity for applicants.
	Extensive documentation: The need to include detailed information on water use, environmental impacts and geological studies can be a challenge for applicants.
	Non-mandatory forms: The existence of forms that are not mandatory can lead to confusion about what information is required for the application.
	Lack of online platform: Lack of a comprehensive online platform for the application and licensing process hinders efficiency.
	Delay in notification procedure: The applicant must wait 3 weeks until he/she can start with the installation, even if the authority declares earlier, that it will not object or require a permission procedure.
Administrative	Lack of a 'one-stop shop's model: The absence of a simplified or coordinated procedure creates confusion and delays the process.
	Indefinite time limits: The lack of a defined maximum time limit for the duration of administrative procedures in the permission licensing procedure, creates uncertainty and possible delays.
	Strict Documentary Requirements: The need to include technical information and hydrological studies can be challenging, especially for those unfamiliar with the requirements.
	Limited access to information: Although information resources are available, the lack of clear information on restrictions in sensitive areas can hinder the implementation of OLS.
Regulatory	Non-standardised monitoring: The lack of general requirements for operational monitoring can lead to variations in the oversight of systems, raising concerns about sustainability.
	Unclear reporting requirements: The absence of formal standards for the quality of operational reporting can result in inconsistent documentation, making it difficult to assess the effectiveness of systems.
	Non-Formalised Monitoring Requirements: The lack of a centralised system for monitoring data collection can hinder effective oversight and compliance with regulations.
	Non-Formalised Data collection and storage: In no Federal State do the authorities collect and store the monitoring data systematically and digitally. This data is therefore not easily available.
	Settlement and Post-Abandonment Procedures: The lack of clear procedures for the settlement of abandoned systems can raise management and compliance concerns

- **Germany**

Table 13. Barriers in Germany

Barriers	Description
Licensing	Lengthy processes and waiting times: The licensing process can take between 3 and 12 months, depending on the region and the complexity of the project. Although some regions have time limits (such as 6 months in Baden-Württemberg), 'tacit permission' does not necessarily guarantee full approval.
	Technical application requirements: Hydrogeological studies, technical system specifications, monitoring plans and safety certificates that comply with European standards are required, which adds a significant burden for applicants.
	Urban and protected area restrictions: In urban areas, open systems face additional barriers due to the density of underground infrastructure and proximity to drinking water protection zones. This can limit the viability of projects in these regions.
	Consultation and Requirements of Other Entities: Consultation with other authorities, such as urban planning and environmental offices, can lengthen approval time due to the coordination required.
	Lack of digitisation in some regions: Although some regions allow online applications, this is not a standard throughout the country. This may result in slower and less transparent administrative procedures in certain areas.
Administrative	Extensive and complex documentation: The preparation of hydrogeological studies, risk management plans, and environmental impact assessments in some cases can be a significant barrier in terms of time and effort.
	Multiple entities involved: The involvement of several authorities (water, environment, urban planning) can slow down the process and create administrative hurdles due to lack of coordination or non-integrated procedures.
	Permit Validation and Extension: The permit extension process can be complicated, as it requires demonstrating that the original operating conditions have not changed significantly.
	Variability in Processing Times: Processing times can vary significantly (3 to 12 months), which can create uncertainty for applicants.
Regulatory	Safety and Technical Regulations: Technical and safety standards set by the DVGW (German Gas and Water Association) must be met, which can be an additional challenge for system operators.
	Environmental Protection Plans: The need for an environmental risk management plan and consideration of underground planning to protect water resources can further complicate compliance.
	Monitoring and Supervision Challenges: The need for regular monitoring of water quality and quantity abstracted can present an operational challenge for open systems.
	Long-term groundwater planning: Planning of groundwater use is required to ensure that abstraction does not affect other users or cause environmental imbalances. This includes anticipating the long-term impact on groundwater levels and water quality.
	Decommissioning process: Regulations on decommissioning after use require restoring ground conditions and removing facilities, which adds additional cost and effort for operators at the end of the system's lifecycle
	Differentiated Requirements for Urban and Non-Urban Areas: Stricter regulations in urban areas can make permits more difficult to obtain compared to rural areas.

- **Ireland**

Table 14. Barriers in Ireland

Barriers	Description
Licensing	Water Abstraction Regulation: The need to obtain a permit for water abstraction under Water Environment (Abstractions and Associated Impoundments) Act 2022 and its associated Regulations (2024), especially if abstraction exceeds certain thresholds (25 m^3/day). The application includes design and specifications in the abstraction.
	Variations in Requirements: Different requirements for systems in urban and non-urban regions can further complicate the licensing process.
	Procedure Time and Validity of Licenses: Uncertainty about the time for the licensing procedure and lack of clarity about the validity of the concessions.
	Complex Application Procedure: The need to comply with various requirements for the submission of licences can be confusing, especially for those unfamiliar with the process.
Administrative	Cooperation Between Institutions: Lack of cooperation or workflow between administrative institutions, such as the EPA, can result in longer and more complex procedures.
	Limited access to clear guidance on the licensing process and available administrative support.
	Assistance to Applicants: If adequate assistance is not available during the application process, this can lead to errors and delays in applications.
Regulatory	Regulatory Gaps in System Discharge: While licensing requirements for water abstraction in open-loop systems are clearly defined (e.g., >25m^3/day requires a license), there is ambiguity regarding the use and potential discharge of these systems. This lack of clarity may pose challenges for planning and implementation.
	Lack of a Dedicated Licensing Framework: While Ireland has clear regulations on water abstraction—including for geothermal energy—there is no specific licensing procedure tailored to geothermal systems. This regulatory gap may create administrative hurdles for developers who must navigate broader water regulations rather than a geothermal-specific framework.
	Environmental Impact Assessment (EIA): While not required in all cases, the need for an EIA in specific situations—such as abstractions exceeding 2000m^3/day or projects in Special Areas of Conservation (SAC) and Natural Heritage Areas (NHA)—can introduce additional complexity and extend the licensing timeline.
	Underground Planning: Lack of adequate underground planning and related regulations can affect the long-term viability of open loop systems.
	Lack of Formal Regulations: While there are guidance documents for drilling and excavation related to open-loop systems, the absence of specific regulations may lead to inconsistencies in licensing processes and interpretation by authorities.
	Uncertain Monitoring Requirements: Although there are proposals to monitor systems annually, there are currently no clear regulations for monitoring, which can lead to varying interpretations.

- **Poland**

Table 15. Barriers in Poland

Barriers	Description
Licensing	Individual Case Handling: The absence of official requirements for installation and operation means that each case is treated differently, which can create uncertainty and variability in the process.
	Lack of Specific Information: Although general information is available, the lack of specific details about the process can be a barrier for applicants.
	Additional Permitting in Mining Territories: The need for additional permits if the well is in mining territory or is deeper than 100 m can complicate the regulatory process.
	Individual Well Permitting: Each well (soakaway or disposal well) is treated individually, which can complicate and lengthen the licensing process.
	Documentary Requirements: The need to submit Geological Work Project, Mining Plant Operation Plan (in mining areas or depth > 100m) and as-built hydrogeological documentation, and Environmental Impact Assessment can be complex and require additional time.
	No Clear Limits for Permit Extensions: Although permits are indefinite, there is no mention of whether there are restrictions on extensions in case of changes in system conditions.
	Lack of electronic procedures: There are no online applications for licensing, which makes the process slower and less accessible.
Administrative	Lengthy Processing Time: The 3-4 month waiting time for permits can be a significant obstacle for developers.
	Lack of Cooperation between Institutions: Lack of cooperation and the lack of a simplified procedure between administrative institutions hinder efficiency in the permitting process.
	Lack of assistance during the application process: Although general assistance is available, there is no detailed guidance or personalised support for applicants during the licensing process.
	Lack of Online Applications: There are no online application options, which can hinder access and efficiency of the application process.
Regulatory	No specific underground planning procedures: Long-term underground planning is not required, which could lead to future complications with the operation of the systems. Also, There are no regulatory differences between urban and rural areas, which may not adequately consider the specific conditions of each region.
	Restrictions in Areas Near Water Catchments: The prohibition on installing open loop systems near public water catchments can significantly limit the viable locations for these systems.
	Insufficient Regulated Monitoring: Although there are monitoring requirements, the lack of more detailed regulations on how to execute this monitoring can limit the effectiveness of the system.
	Lack of specific regulations for open loop systems: Open loop systems are regulated by generic water well regulations, which does not adequately address the needs of geothermal heat pumps.
	Lack of standardised criteria: There are no fixed criteria or standards for the installation and operation of systems. Lack of standardisation creates uncertainty in terms of licensing requirements.

- **Sweden**

Table 16. Barriers in Sweden

Barriers	Description
Licensing	Lack of Defined Timeframe for Approval: There is no specific timeframe set for the processing of licences, which creates uncertainty about the time needed to obtain approval or rejection of the application. This lack of a time limit also means that there is no guarantee of a response within a reasonable period, which may discourage investment in geothermal technologies.
	Licence Extension: In case a licence extension is needed, the court must be approached again, which generates an additional and lengthy process.
Administrative	Multiplicity of authorities: The process involves multiple entities, such as Länsstyrelsen and the environmental court, which can lead to delays and increase the administrative burden.
	Process Required for Approval: The licensing process involves the intervention of an environmental court (Miljödomstol), which makes the procedure longer and more complex than other types of licences. There is no automated approval process, which increases waiting times.
	Procedural Complexity Compared to Other Types of Systems: Administrative procedures for licensing open loop systems are more complex than for closed loop systems. This adds additional workload and time for both applicants and processing authorities.
	Lack of efficient cooperation: Although there is cooperation between Länsstyrelsen and the environmental court, it is described as normal bureaucratic procedures, without clear mechanisms to streamline processes
Regulatory	Lack of Clear Rules for Underground Planning: There are no detailed regulations on long-term underground planning, which could raise questions on how to properly manage the use of geothermal resources and interactions with other underground systems or infrastructure in the future.
	Lack of Specific Monitoring Regulations: Unless indicated by the environmental court as a licensing requirement, there is no general regulation on continuous monitoring of geothermal open loop systems. This can make it difficult to assess the long-term environmental impacts and effectiveness of the system.

- **Spain**

Table 17. Barriers in Sweden

Barriers	Description
Licensing	Regional Variability: The availability and procedure for licensing varies significantly between regions, which can create confusion and make the process difficult for applicants to navigate.
	Specific requirements: Some laws require natural restoration plans and specific protection measures, adding complexity to licence submissions.
	Multiple Authorisations: The need to obtain multiple authorisations and permits from different entities can complicate and lengthen the licensing process.

Administrative	Administrative Burden: The complexity of administrative procedures, coupled with the need to comply with multiple requirements, can result in a significant burden for applicants.
	Case-by-Case Approach: Case-by-case assessment by environmental authorities can result in inconsistent and subjective decisions.
	Lack of Unified Information: The lack of a national underground planning framework and variability in guidance on licensing procedures can make it difficult for applicants to fully understand what is required.
	Lack of Assistance: Although resources and supporting documentation exist, there may be a lack of direct and personalised assistance during the application process, making it difficult for applicants to fully understand the requirements and process.
	Slow Processing: Lengthy processing times and a lack of coordination between different authorities can cause delays in obtaining the necessary licenses
Regulatory	Fragmented Regulations: The absence of a unified national framework for underground planning and geothermal systems results in fragmented regulations that can be difficult to interpret and apply.
	Local Prohibitions: Although there are no specific prohibitions for open loop systems, in natural or protected areas general restrictions may apply that limit the installation of these systems, creating uncertainty for developers.
	Specific Conditions: Conditions imposed by environmental authorities based on local context and hydrogeological significance can be stringent and vary from location to location, complicating project planning and implementation.
	Environmental Assessment: In many regions, open loop systems are subject to environmental impact assessments (EIAs) that can be complex and lengthy, delaying licensing.
	Limited Advice on Non-Permitted Projects: The lack of clarity on when open loop systems can be prohibited can lead to uncertainty among applicants.

- **The Netherlands**

Table 18. Barriers in The Netherland

Barriers	Description
Licensing	Application Processing Time: Although the process usually takes 2-6 weeks, the lack of automatic permits after a certain period can be a challenge.
	Conditions for Validity of Licenses: Although the validity of licenses is indefinite, there may be restrictions on extensions that are not clearly spelled out.
	Complexity of the Licensing Process: The procedure requires a number of technical documents (system design, negative impact studies), which can complicate the submission.
	Impact Assessment on Existing Systems: The need to study the negative effects on adjacent systems can increase the time and costs of the licensing process.
Administrative	Dependence on External Authorities: License management involves several administrative entities (provincial, municipal and external), which can lead to confusion and lack of communication between them.
	Interaction with Multiple Entities: The involvement of different authorities can make the process difficult if communication between them is limited.
	Lack of Assistance during Application: There is no assistance available to applicants during the application process, which can be an obstacle for those who are not familiar with the requirements.
Regulatory	Strict Regulatory Requirements: There are stringent regulations on the installation and operation of systems, including energy efficiency compliance (SPF) and energy balancing. This can be an obstacle for new developers.
	Monitoring Obligations: Constant monitoring and reporting of specific parameters (injection temperatures, flow rates) is required, which can generate additional costs and staffing requirements.

	Interference Zones: The existence of declared interference zones can further complicate the process, as rules may differ in these areas and create uncertainty.

3.1.2 Barriers for CLS in GeoBOOST Countries

- **Austria**

Table 19. Barriers in Austria

Barriers	Description
Licensing	Lack of procedure in non-sensitive areas: no licensing procedure is necessary at all. This speeds up the process of putting the installation into operation, however no water right is assigned and therefore possible negative thermal interferences are neglected.
	Regional Variability: The lack of uniformity in how Austria's federal states define sensitive areas and licensing requirements can lead to confusion.
	Limited Access to Online Platforms: The absence of a centralised online application system may discourage some applicants, as the process is largely manual, which can be slower and cumbersome.
	Processing Time: Waiting times ranging from a few weeks to several months can be discouraging for applicants, especially for projects requiring full licensing.
Administrative	Required Documentation: The need to submit detailed documentation, such as system designs and environmental impact assessments in sensitive areas, can be a barrier for some applicants, especially those lacking technical expertise.
	Cooperation between Institutions: While cooperation between institutions is indicated to be like that of open loop systems, any lack of coordination between responsible entities can result in delays and frustrations in the licensing process.
	Missing harmonized database of CLS installations: Having no visible evidence of the numbers of existing CLS installations might be suggestive of CLS being a new, not-proven and therefore not-reliable technology. Without knowledge about the existing installations, giving reliable numbers about renewable heating and cooling systems is difficult
Regulatory	Lack of General Monitoring Regulations: The absence of general operational monitoring requirements under the Austrian Water Act may create uncertainty about the expectations and responsibilities of operators of closed loop systems.
	Additional Requirements in Sensitive Areas: The possibility of additional or different requirements in sensitive areas may be seen as a barrier, especially if it is not clearly defined what those requirements are.
	Perceived Environmental Risks: Strict regulations around sensitive areas, such as water protection areas, can be seen as a significant barrier, even if there are no real environmental risks associated with installing closed loop systems in those areas
	Lack of Monitoring Database: The lack of a centralised and digital monitoring data system makes it difficult to assess and track compliance with permit conditions, which could discourage developers from investing in projects.

- **Germany**

Table 20. Barriers in Germany

Barriers	Description
Licensing	Variability in Requirements: Each of the 16 federal states has its own specific application forms and requirements, which can create confusion and difficulty for applicants.
	Length of Process: The licensing process can take 8-10 weeks, with a maximum limit of half a year, which can be a considerable time for applicants.
	Validation and Restrictions: The need to start pilot drilling within a two-year timeframe and the timelines for project completion can be significant constraints for developers.
	Differentiated Requirements in Urban Areas: In urban areas, additional hydrogeological simulations are required, which can complicate and lengthen the licensing process.
	Availability of Information: Although information on the licensing procedure is available, the lack of clarity on when closed loop systems would not be allowed may create uncertainty for applicants.
Administrative	Multiple Authority Structure: The need to deal with multiple administrative entities, such as water authorities and mining authorities, can complicate the process and cause delays.
	Variable Cooperation between Institutions: Lack of cooperation or coordination between different state authorities can result in longer and more complex permit processes.
Regulatory	Varying Standards and Recommendations: Reliance on standards such as VDI 4640, which are recommended but not mandatory, can lead to uncertainty regarding compliance requirements.
	Lack of Clear Settlement Regulations: Regulation on post-exit settlement procedures may not be well defined, which can lead to liability and compliance concerns.
	Differing Monitoring Requirements: The existence of different monitoring standards in each state can be confusing and can result in a lack of a standardised approach to monitoring systems.

- **Ireland**

Table 21. Barriers in Ireland

Barriers	Description
Licensing	Lack of Specific Procedures: In Ireland, there are currently no specific licensing procedures for geothermal systems, which can create uncertainty and barriers for applicants.
	Registration Process: The need to register under a new regulatory regime may complicate market entry for closed loop systems, even if they are smaller in scale.
	Environmental Assessments: The need for a strategic environmental assessment and appropriate evaluation can lengthen the licensing process and complicate approval is specific NHA, SAC areas.

	Processing Time: If there is currently regulatory system and therefore no set time limit for processing applications. It would be important to provide a clear administrative timeframe for the regulatory process in new legislation so as to ensure this does not cause significant delays, discouraging investment in geothermal systems.
Administrative	Difficulties in Contact: If multiple administrative entities are involved, this can lead to confusion about who to contact for information or to submit applications.
	Assistance to Applicants: Lack of assistance during the application process can make applicants feel lost, which could lead to errors in submissions.
Regulatory	Lack of clear and specific regulations for closed and open loop systems can create legal uncertainty, which can discourage investment.
	Underground Planning Considerations: If underground planning is not considered in regulations, this could lead to problems in the long-term implementation of systems.
	Monitoring Regulations: If monitoring regulations exist, lack of clarity on how this monitoring should be executed can result in poor reporting of the geothermal heat pump sector and its contribution to sustainable development and decarbonisation of the heating and cooling sectors.

- **Poland**

Table 22. Barriers in Poland

Barriers	Description
Licensing	Extensive technical requirements: detailed technical documentation is required, such as the Draft Geological Works Project, Mining Plant Operation Plan (in case of mining areas or boreholes deeper than 100m) and post-drilling as-built hydrogeological documentation, which can be an additional burden for developers.
	Unclear completion process: The end of the licensing process is dependent on the submission of 'as-built' documentation, without clear regulations on other additional procedures. These administrative, regulatory and licensing barriers, if not optimised, can hinder the adoption of closed loop systems for geothermal heat pumps.
Administrative	Complexity of the licensing process: permits are required to be obtained from different entities: (local geological administration and mining administration) - when wells boreholes exceed 100 m or are in mining areas. There is no online procedure for the application, which can slow down the process.
	Processing time: The standard duration of the licensing process is 1 to 3 months, depending on the intervention of the mining administration. There do not appear to be automatic mechanisms for approval if the timeframe is exceeded.
	Lack of coordination between institutions: There is no effective cooperation or coordination between the institutions involved in the licensing process, which could further complicate permitting.
	Limited assistance during the application process: There is no institutional support or assistance for applicants during the application process, which can lead to confusion and delays.
Regulatory	Additional permit requirements for specific areas: If the closed loop system is located in a 'mining territory' or the depth of the borehole exceeds 100 metres, an additional permit is required from the mining administration, which adds complexity to the process.

	Lack of regulation for monitoring: There are no regulations for monitoring closed loop systems, which may result in insufficient control over the efficiency and environmental impact of these systems over time.
	Restrictions on drilling in special cases: Although permit denials are rare, they may occur in specific cases under the Polish Geological Law, such as when the project presents environmental risks or does not comply with legal requirements.
	Lack of long-term underground planning: There are no specific regulations on long-term underground planning for closed loop systems, which could limit the strategic development of these systems.

- **Spain**

Table 23. Barriers in Spain

Barriers	Description
Licensing	Complexity of the Licensing Process: In Spain, the licensing process for the installation of geothermal heat pump systems can be complex, as it involves multiple procedures that vary according to the autonomous community.
	Multiple Permit Requirements: Installers must obtain several permits from different administrations (local, autonomous and, in some cases, state), which can delay the licensing process.
	Lack of Unified Regulations: There is no uniform regulatory framework at national level, which generates confusion among applicants, as each autonomous community may have its own requirements.
Administrative	High Administrative Burden: The documentation required for licensing can be extensive, which results in a cumbersome administrative process and can be a disincentive to developers.
	Lack of coordination between administrations: Lack of coordination between different levels of government (local, regional and national) can lead to inefficiencies and delays in licensing.
	Limitations in Staff Training: Lack of specific training on geothermal technologies among civil servants can lead to misinterpretation of the requirements, affecting the processing of licenses.
Regulatory	Strict Regulatory Requirements: Environmental regulations can be strict, requiring environmental impact studies that increase cost and processing time.
	Legal Uncertainty: The absence of clear guidelines on the regulation of closed loop systems can create legal uncertainty, making project planning difficult.
	Changes in Legislation: Frequent changes in regulations, such as the Climate Change and Energy Transition Act and European directives, can create an uncertain regulatory environment for developers.
	Difficulties for Integration with Other Renewable Energies: Renewable energy regulations may not be aligned with the specificities of geothermal heat pumps, complicating their integration into broader renewable energy projects.

- **Sweden**

Table 24. Barriers in Sweden

Barriers	Description
Licensing	Lack of clear time limits: There is no set maximum time limit for permit approval, which can lead to uncertainty and delays.
	Technical Requirements and Full Documentation: The application for licensing of closed loop systems requires a detailed list of technical parameters, including the brand, size, type and quantity of heat exchangers, as well as details on drilling (depth and number of holes). Installers' licences must also be included.
	Unequal rigour of procedures: In urban areas, processes are more exhaustive, which may discourage urban owners due to additional requirements.
	Limited validity of permits: Permits are only valid for two years, which means that a renewal requires a new application, increasing the administrative burden for users.
Administrative	Fragmentation of responsibilities: Initial approval is given by the environmental departments of the Kommun (290 in Sweden). If the system is considered 'large' or potentially problematic, it is referred to Länsstyrelsen (regional agency), and in extreme cases, to the environmental court. This fragmented system can cause confusion and delays.
	Non-standardised processes: Although the Kommun have defined procedures, not all possible problems or requirements are anticipated in the available guidelines, leading to uncertainty in the process.
	Lack of optimised inter-institutional cooperation: Collaboration between institutions follows normal bureaucratic procedures, without specific measures to streamline permit processes.
Regulatory	Local Restrictions and Exceptions: In some areas, authorisation for drilling and installation work may depend on long-term risk assessment or exceptional local circumstances not specified in regulations.
	General environmental regulations: Although normal environmental laws apply, there are no specific procedures for the liquidation of abandoned systems, which may create long-term risks.
	Absence of specific monitoring regulations: Unless specified in the permit, closed loop systems are not subject to regular monitoring, which could affect sustainability and operational oversight.

- **The Netherlands**

Table 25. Barriers in The Netherlands

Barriers	Description
Licensing	Permitting Requirements: Open loop systems require a licensing permit, which can be complicated to obtain due to the need for environmental impact and efficiency studies. From January 2024, municipalities may define their own rules, which may lead to inconsistency and confusion in the licensing process.
	Lack of Clear Information: Although information on licensing procedures is available, the lack of clear explanations on when open loop systems are not allowed can make planning difficult.

Administrative	Slow Procedures: automatic permits can unnecessarily lengthen the process.
	Reliance on External Entities: Outsourcing the processing of applications to external offices can lead to delays and lack of communication between the entities involved.
	Lack of Assistance to Applicants: There is no direct assistance to applicants during the application process, which may result in errors or the submission of incomplete information.
Regulatory	Difficult Regulations: The existence of regulations requiring impact studies and compliance with specific protocols can be a significant barrier, especially for developers who are unfamiliar with these requirements.
	Differing Regulations by Region: While there are no different requirements for closed loop systems in urban and non-urban areas, interference zones may have different regulations, which can complicate planning.
	Strict Monitoring Requirements: The obligation to monitor and report data for all systems except those for single-family dwellings can be burdensome for developers, as it involves additional costs and resources.

3.2 Impact and consequences

Regulatory, licensing and administrative barriers not only hinder the implementation of GHPs but also generate significant impacts at multiple levels. These consequences directly affect the adoption of this technology by **end-users** and **developers** but also have important implications for the **authorities** in charge of regulating, monitoring and promoting sustainable energy solutions (Roka et al., 2023).

In this sub-section, the consequences will be analysed from three main perspectives:

- Adoption of GHP systems by **end-users** and **developers**, focusing on how barriers slow down or even paralyse project implementation.
- **Decision making** and **investment** in GHPs, analysing how these barriers increase perceived risk, discouraging project financing.
- The role of **authorities** as a target audience, highlighting their role in creating a more favourable regulatory and administrative environment.

3.2.1 End-users and developers

- Implementation delays

Regulatory barriers such as the need for multiple permits (e.g. hydrogeological assessment, environmental impact, water use) complicate and lengthen approval times. In countries such as Germany, open-loop systems require detailed assessments and consultations with multiple authorities, which can extend the approval process by up to 12 months. In Austria, similar

systems are subject to licences that require extensive water rights interference analysis and geological studies, especially in sensitive areas.

- Project stoppages

In urban or protected areas, specific restrictions must be considered during project planning. For example, in Spain, open-loop systems are not allowed in water protection zones, which limits the viable options for developers. Similarly, in Sweden, closed-loop systems can be rejected if they pose a risk to underground infrastructure, such as drinking water pipes or metro projects.

While these restrictions are reasonable from a safety and environmental perspective, they add layers of complexity to the planning and permitting process. Developers unfamiliar with these regulations may perceive these conditions as constraints and discourage investment in geothermal projects.

3.2.2 Decision-making and investment in GHPs

- Increased perceived risk

The need to comply with multiple technical, environmental and administrative standards increases the perception of risk among investors. This is exacerbated by the lack of harmonisation across regions. For example, In Spain, regulations vary considerably between autonomous communities, and some procedures, such as environmental impact assessments, are complex and slow. While in Germany, differences between federal states further complicate decisions for multinational projects.

Investors, faced with these uncertainties, prefer technologies with less administrative burden or clearer regulatory environments.

- High administrative costs

Regulatory compliance involves significant costs that are not always recoverable in the short term. Detailed documentation - such as hydrogeological studies, geotechnical maps and certifications - together with specific permits for open or closed systems, add to the upfront costs. While requirements such as specialised certifications (e.g. in the Netherlands) help to ensure the quality and safety of the system, they also add financial and procedural burdens, which can be challenging for small companies or those new to the market.

3.2.3 Authorities

As mentioned above, licensing, regulatory and administrative barriers not only impact developers and investors but also affect the performance and effectiveness of authorities in their key role of overseeing, regulating and encouraging the sustainable development of geothermal heat pump systems (GHPs). The main impacts on the role of authorities are detailed below:

- Fragmented responsibilities: In many countries, local, regional and national authorities share competencies over GHPs, leading to duplication of efforts and lack of clarity in procedures. For example, in Spain, project approval may require permits from multiple entities, such as hydrographic confederations, municipalities and regional environmental agencies, which slows down the process and overburdens institutions.

- Lack of digital tools: Administrative barriers without centralised platforms for managing applications, as is the case in Austria and Sweden, authorities must handle applications manually, increasing response times and the risk of administrative errors

- Insufficient resources for technical assessment: In regions with high demand or complex regulations, authorities may lack trained staff to review technically advanced projects. This is especially relevant in cases where detailed hydrogeological or environmental impact assessments are required, as in Germany.

- Inadequate monitoring supervision: Although in many countries, such as Austria and Germany, continuous monitoring of systems is required, authorities often do not have unified databases to store and analyse this data. This makes it difficult to assess performance and regulatory compliance over the long term.

- Increased administrative burden on authorities: Resistance to regulatory changes can lead to delays in the adoption of more modern and sustainable policies. For instance, the introduction of requirements to prevent thermal interference in densely urbanized areas, such as in Sweden and the Netherlands, is hindered by the absence of coherent underground planning systems, making enforcement more complex for authorities.

- Challenges in regulatory coordination: The lack of harmonized regulations across regions, as seen in Spain and Germany, complicates the work of authorities in establishing uniform standards. This fragmentation increases administrative workload and reduces the efficiency of regulatory enforcement.

- Demotivation to collaborate: The lack of clear communication channels and technical assistance can erode the willingness of private actors to work alongside authorities on sustainable geothermal energy projects.

- Increased pressure on authorities to meet climate targets: Administrative barriers and the absence of regulatory incentives slow down the adoption of GHPs, making it more challenging for authorities to ensure compliance with national and European climate and energy goals. This delay puts additional strain on regulatory bodies to align with NECP commitments and other climate strategies.

- Underutilization of Regulatory Tools: Without clear and effective regulatory frameworks, authorities miss the opportunity to use GHPs as a key tool for reducing emissions and promoting energy efficiency.

3.2.3.1 Role of Authorities in Creating a More Favourable Regulatory and Administrative Environment

- Creating a Favourable Regulatory Environment

Authorities can implement reforms to reduce regulatory barriers. This includes:

  - Introducing online platforms to streamline processes: Countries like the Netherlands and Austria already allow partially digital applications, but they still lack integrated systems to manage the entire process.

  - Simplifying inter-agency coordination: In Germany, although there is formal cooperation between water, environmental, and urban planning authorities, the process remains fragmented. "One-stop-shop" systems could reduce the time and administrative burden for applicants.

- Clearer Oversight and Monitoring

An efficient regulatory system should not only facilitate technology adoption but also ensure its sustainable management. For example, in Austria and Germany, authorities require periodic monitoring of system performance, tracking parameters such as extraction and reinjection temperatures and energy balance. However, the absence of national databases to unify this data complicates oversight efforts, making it more challenging for regulators to ensure long-term sustainability and compliance.

- Promoting Economic Incentives

Authorities can stimulate GHP systems adoption by offering subsidies or tax incentives to offset initial costs and perceived risks for investors. This approach has already been applied in some regions of Sweden, where local incentives have helped overcome administrative barriers. Details on various economic incentives applied in the **'GeoBOOST'** countries and general **recommendations** are outlined **in Deliverable 4.2** (Brancher & Steiner,2024).

4. Strategies for Simplification of Licensing Procedures for Geothermal Heat Pumps

The adoption of geothermal heat pump (GHP) systems faces significant challenges due to regulatory frameworks that in many cases, are not well adapted to emerging technologies like GHP systems (European Commission, 2016). As a result, developers and end-users must overcome significant barriers, such as extended administrative procedures, high costs and lack of clarity in requirements (Snape et al., 2015). To address these challenges, simplification strategies must be both effective and inclusive, balancing local needs with broader harmonisation efforts across Europe (EGEC, 2020).

This section presents strategies that combine general with specific approaches, considering the regulatory and administrative particularities of the countries targeted by the 'GeoBOOST' project. The goal is to streamline GHP project implementation while ensuring that procedures remain accessible and sustainable for both authorities and end-users.

4.1 Recommendations for Optimising Licensing Procedures

Current licensing procedures are often seen as barriers that deter investment and hinder the adoption of innovative technologies. This sub-section presents a set of proposals aimed at turning these procedures into facilitating tools.

Implementing these proposals is expected to not only streamline permit issuance but also strengthen trust in the regulatory system, encouraging key stakeholders to embrace geothermal heat pump systems as a sustainable and efficient solution.

4.1.1 General recommendations for OLS

The following general recommendations for OLS are outlined below. A description is provided in Table 26.

Table 26. Solutions for OLS

Licensing simplification	Develop specific procedures for licensing OLS systems at the national level, ensuring that they are clear and uniform
	Establish a nationally unified licensing framework that allows for minimal regional adaptations to simplify the process for applicants.
	Define standardised criteria for EIAs to streamline their execution, particularly for low-impact systems.
	Create a tiered assessment system that tailors licensing procedures to the level of risk and environmental impact of the project.

	Integrate related permits (e.g., environmental, construction, and water use permits) into a single, coordinated process
	Digitise and simplify documentary requirements through pre-defined electronic forms and clear guidelines.
	Implement maximum deadlines for processing licences, with automatic approval mechanisms if deadlines are not met, including the possibility to start as soon as the licensing authority allows it.
	Implement nationwide online application systems to ensure accessibility and transparency in the licensing process.
Administrative simplification	Create a centralised online platform ('one-stop-shop') for the submission and follow-up of applications, which coordinates the different requirements of the entities involved
	Appoint a single national or regional authority to act as a liaison between developers and regulatory institutions.
	Establish inter-institutional agreements to coordinate and streamline administrative procedures, ensuring cooperation between entities such as urban planning and environmental agencies.
	Provide technical support and step-by-step guides during the application process, including a personalised advisory service.
	Reduce administrative burden by automating processes, simplifying technical reports, and allowing the reuse of documents across projects.
	Develop nationally standardised forms and requirements for hydrogeological studies, technical system specifications (flow, temperatures, efficiency), and environmental impact assessments.
Regulatory Streamlining	Develop a specific regulatory framework for open loop systems, ensuring that it is clear and consistent at the national level.
	Establish national guidelines for operational monitoring of systems, with clear requirements proportionate to the scale of the project.
	Establish clear and streamlined protocols for the decommissioning and environmental restoration of obsolete systems, minimising additional costs and burdens for operators.
	Develop a unified national framework for underground planning and geothermal systems to prevent regulatory fragmentation.
	Clarify re-injection requirements and specific conditions at the local level, ensuring that operators have clear and uniform guidelines
	Develop a digital registry for all shallow geothermal systems (open loop systems) to facilitate better planning, monitoring, and integration into energy strategies.
Additional Consideration	Offer regular training to local and regional authorities to ensure consistency in regulatory implementation.
	Launch public awareness campaigns to enhance social acceptance and mitigate opposition to OLS projects.

4.1.2 General recommendations for CLS

For CLS, the general recommendations are presented below in Table 27.

Table 27. Solutions for CLS

Licensing simplification	Create clear and unified licensing procedures at national level, reducing variability between regions.
	Appoint a single national or regional authority to facilitate communication between developers and regulatory bodies, streamlining the licensing process.
	Create a direct support system for applicants, including technical assistance in submitting documentation and an interactive guide on requirements.
	Establish formal agreements between responsible authorities to ensure smooth and efficient cooperation, avoiding delays caused by lack of coordination between entities
	Reduce documentation burdens for small-scale projects or low-risk areas.
	Train officials in geothermal technologies and licensing procedures to minimize misinterpretation of requirements

	Create nationally standardised forms to ensure uniformity in CLS applications.
	Create a tiered assessment system that tailors licensing procedures to the level of risk and environmental impact of the project.
Administrative simplification	Create a centralised online platform ('one-stop-shop') for the submission and follow-up of applications, coordinating the different requirements of the entities involved.
	Develop specific guidelines for geothermal systems in sensitive areas, ensuring that additional requirements are clear and proportionate to the environmental risk.
	Integrate environmental, construction, and water use permits into a single streamlined approval process.
	Digitise and simplify documentary requirements through pre-defined electronic forms and clear guidelines.
	Implement maximum deadlines for processing licences, with automatic approval mechanisms if deadlines are not met, including the possibility to start as soon as the licensing authority allows it.
Regulatory Streamlining	Create a specific regulatory framework for closed loop systems that applies across all regions of a country.
	Clearly define monitoring procedures for geothermal systems, specifying the parameters to be evaluated and reporting frequencies.
	Review regulations in protected areas to ensure that requirements are based on risk analysis and do not impose unnecessary restrictions. This would include a risk-based approach to actual contamination or environmental impact.
	Establish a national monitoring system to track system performance.
	Clarify reinjection requirements and specific conditions at the local level, ensuring that operators have clear and uniform guidelines.
	Develop guidelines that allow for rapid adaptation of geothermal projects to changes in national or European regulations, ensuring that developers can implement compliance measures without significant delays.
	Develop a digital registry for all shallow geothermal systems (closed loop systems) to facilitate better planning, monitoring, and integration into energy strategies.
	Create a public and centralised database with all relevant information on licensing procedures and technical requirements for geothermal systems, accessible to all applicants.
Additional Consideration	Launch public information campaigns and training for developers, owners, and installers, explaining the benefits of geothermal heat pumps and how to comply with regulations efficiently.
	Provide regular training to local and regional authorities to reduce discrepancies in the application of regulations.

4.2 Recommendations for Local Contexts: 'GeoBOOST' countries

Given the diversity of regulatory frameworks, administrative capacities and political priorities in the target countries of the 'GeoBOOST' project, this sub-section provides a detailed analysis of the tailored solutions developed for each country. Based on the identified barriers, customised strategies have been designed to address regulatory and administrative challenges effectively.

This approach ensures that the proposed solutions are realistic, feasible, and adaptable to local conditions. These strategies will not only facilitate the adoption of GHP systems but also contribute to the more efficient and sustainable management of geothermal resources in each participating country of the 'GeoBOOST' project.

4.2.1 Recommendations for OLS in 'GeoBOOST' countries

- **Austria**

Table 28. Solution for Austria

Licensing simplification	Establish clear deadlines for processing: Implement specific deadlines for each stage of the licensing process. This would provide greater predictability and help applicants better plan their projects.
	Standardised Guidelines and Templates: Provide clear guidelines and standardised templates for the submission of documents, which would make it easier for applicants to collect and submit the required information.
	Facilitating Interagency Cooperation: Establish mechanisms for better collaboration and communication between the different entities involved in the licensing process, perhaps through interagency working groups.
Administrative simplification	Create online platforms where applicants can submit all documents, track their applications and receive notifications on the status of their permits. This could streamline the process and reduce the administrative burden.
	Simplifying Abstraction Permit Requirements: Evaluate and simplify the process for obtaining water abstraction permits, perhaps by creating a low threshold where a simplified process is required for small abstractions.
	Standardised Settlement Procedures: Create clear and easy-to-follow procedures for the settlement and closure of abandoned systems, ensuring that environmental and regulatory concerns are addressed.
	Establish clear deadlines for administrative procedures: Defined maximum time limit for the duration of administrative procedures
Regulatory Streamlining	Implement Uniform Standards: Develop uniform standards and regulations for the installation and operation of open loop systems, ensuring that they are clear and applicable in all regions.
	Establish Clear and Centralised Monitoring Requirements: Develop a centralised system for the collection and analysis of monitoring data, which could facilitate compliance with regulations and allow for more effective oversight
	Develop a Standardised Monitoring Framework: Create a monitoring framework that establishes clear requirements for operational oversight, including data collection and storage, which would allow for more efficient and consistent management.

- **Germany**

Table 29. Solution for Germany

Licensing simplification	Fast-track procedures for small projects: Implement a simplified procedure for small-scale systems, especially in areas with low environmental impact. This could include faster reviews and reduced requirements for projects that do not significantly affect water resources.

	Application of interim permits: If a full licence cannot be issued within the stipulated timeframe, interim permits could be issued to allow operation of the system under monitoring while the process is being completed. This would avoid unnecessary delays in projects that comply with the main regulations.
Administrative simplification	Centralisation and integration of procedures: Create a one-stop shop where applicants can manage all licensing-related procedures, integrating all relevant authorities (water, environment, urban planning). This would reduce duplication of reviews and lack of coordination between entities.
	Expansion of digital platforms: Ensure that all regions offer the possibility to apply online, making it easier to submit documents, track the status of applications and communicate with authorities. A centralised platform at national level could improve accessibility and efficiency.
	Improved technical assistance: Expand technical assistance services during the application process, providing clear guides and educational workshops to help applicants comply with more complex requirements. Telephone and online assistance can resolve doubts and facilitate the preparation of documentation.
	Improve access to geotechnical data: Develop and maintain regional and national geological and water resources databases accessible to developers. These databases should include interactive maps indicating areas favourable for open loop system installation, as well as restricted or sensitive areas, which would facilitate planning and reduce rejections due to incompatibilities.
	Automated and digitised monitoring: Implement real-time digital monitoring systems that allow operators and authorities to verify compliance with abstraction limits and water quality. Automated monitoring would reduce the administrative burden for authorities and provide greater transparency and efficiency in environmental control.
Regulatory Streamlining	Periodic review of regulations: Promote regular reviews of regulations to ensure that they adapt to new technologies and mitigation techniques. This could include updating environmental protection standards to reflect advances in geothermal and pumping technologies.
	Proactive groundwater planning: Encourage the implementation of long-term groundwater management plans at regional or national level. These plans should provide for the shared use of water resources, avoiding overexploitation and conflicts between users, with the collaboration of affected communities and developers.
	Flexibility in urban areas: Review restrictions in urban areas and establish clear rules that allow for more flexibility in terms of the installation of open loop systems, as long as technologies are used that minimise interference with other underground infrastructures.
	National Standardisation: A uniform regulatory framework at national level, which can be adapted at regional and local level, would simplify procedures, reduce costs and encourage the adoption of SGES.
	Standardisation of technical requirements: Unify the technical requirements for open loop geothermal systems at national or European level to reduce differences between regions. This would provide greater clarity and predictability for developers.
Additional Consideration	Cooperation between public and private entities: Encourage greater cooperation between regulators, technology providers and local communities to improve transparency and understanding of the benefits of geothermal heat pumps. Collaborative platforms could speed up dispute resolution and improve the efficiency of licensing processes.

	Incentives and financial support: Offer financial incentives and subsidies for the adoption of open loop systems, especially in regions with higher barriers. These incentives could help reduce the upfront costs of regulatory compliance and facilitate access to state-of-the-art monitoring and security technologies.
	Education and Training: Promote information programms to increase awareness of regulatory requirements among developers and local authorities.

- **Ireland**

Table 30. Solution for Ireland

Licensing simplification	Simplified Environmental Assessments: Establish a simplified environmental assessment process for smaller scale or reduced impact projects, which would speed up the licensing process.
	Simplified Licensing for Small Projects: Create simplified or automatic procedures for small-scale systems (e.g. for domestic use), which have fewer administrative requirements and do not require the same rigorous licensing as industrial or large-scale projects.
	Inter-institutional Coordination: Encourage coordination between different authorities and levels of government to ensure that regulations are consistent and uniformly applied, reducing uncertainty for developers.
	Exceptions in Non-Critical Areas: Establish exceptions or less stringent requirements in areas that do not have high environmental or hydrogeological sensitivity. In this way, projects in these areas could avoid extensive assessments that would not be necessary.
	Clear and Accessible Guidelines: Create detailed and accessible guidelines that explain licensing requirements in plain language, so that applicants easily understand the process and the necessary requirements.
Administrative simplification	Digitisation and Single Application Platform: Create a national online platform that centralises all licence application processes, reducing the number of physical documents and simplifying the submission process and tracking the status of licences. This platform could integrate information on specific regional requirements, allowing applicants to obtain clear guidance based on their location.
	Clear and Standardised Guidelines: Develop unified and detailed national-level guidelines that explain the application process step-by-step. These guides should be accessible online and available in local offices, including case study examples and clarification on required documentation.
	Technical Assistance and Training: Provide technical assistance through regional centres or accredited consultants that can guide applicants. The implementation of regular workshops and briefings would help users to better understand the process and comply with the requirements.
	Personalised Assistance: Provide personalised assistance to applicants through public consultancies or helplines, where experts can answer questions and guide applicants through the process.
Regulatory Streamlining	Develop Clear Regulations: Create clear and concise regulations that specify the conditions under which open loop systems can be installed, especially in protected or highly sensitive areas.

	Unified National Framework: This framework should include common criteria for groundwater and environmental protection, facilitating project planning and design.
	Define clear thresholds and requirements: In relation to OLS for geothermal heat pumps where re-injection is achieved to the production aquifer that address the likely installed capacity ranges achievable
Additional Consideration	Financial Incentives: Provide financial incentives or subsidies for geothermal energy projects, which may motivate developers to comply with regulations and facilitate the licensing process.

- **Poland**

Table 31. Solution for Poland

Licensing simplification	Simplification of required documentation: reduce the amount of documentation required or merge certain reports into a single comprehensive document that includes all necessary information. This could include integrating the Geological Works Project (and in case of mining areas or depth > 100m – Mining Plant Operation Plan) and the Environmental Impact Assessment.
	Digitisation of processes: Implement online application systems to streamline the licensing process. This would reduce waiting times, facilitate access to information and improve communication between applicants and regulators. Implementation of digital process in the submission and verification of all licensing reports
Administrative simplification	Creation of a one-stop-shop system: Establish a single point of contact for the management of permit applications, where applicants can submit all required documentation and where the different entities (geological, water, mining) cooperate to avoid duplication of procedures and optimise the flow of information.
	Reducing granting times: Establish shorter deadlines and set clear limits for the authorities' response time. An 'automatic permit after expiry of deadlines' mechanism could help ensure that times are not unnecessarily lengthened.
	Online collection of applications and reports: Create an online database of existing OLS installations to avoid interference between them.
	Standardisation of the evaluation process: Standardise project evaluation requirements and criteria so that projects are not treated on an individual basis. This could include the creation of unified documentation formats and clear guidelines to reduce subjectivity in the review of each case.
Regulatory Streamlining	Development of specific regulations for open loop systems: establish regulations tailored to open loop systems, with clear requirements and technical standards that consider both water and geothermal aspects, avoiding the application of regulations designed for conventional water wells.
	Improve environmental and thermal monitoring: Introduce more robust requirements for environmental and thermal monitoring, not only for the amount of water abstracted and re-injected, but also to ensure that there are no thermal interferences or negative impacts on the subsurface. Advanced sensor technologies and automatic systems could be used to facilitate continuous monitoring.

	Differentiate regulations according to geographical context: Adapt regulations to distinguish between urban and rural areas, as conditions and risks can vary significantly. In urban areas, for example, stricter control of land use and underground infrastructure may be necessary.
	Removing barriers near public water sources through technical approaches: Explore technical solutions that allow the installation of open loop systems in areas near public water catchments, using technologies that ensure protection of water quality and security of supply.
Additional Consideration	Information and training campaigns: Conduct training and awareness campaigns targeting both operators and regulatory authorities to improve understanding of open loop geothermal systems and their benefits.
	Economic and financial incentives: Offer financial incentives such as subsidies or tax credits to promote the adoption of these systems and help cover the costs of administrative and licensing procedures.

- **Spain**

Table 32. Solution for Spain

Licensing simplification	Unification of Procedures: Develop a unified national framework that standardises licensing procedures and requirements for the installation of open loop systems, reducing regional variability.
	Clear and Accessible Guidelines: Create detailed and accessible guidelines that explain licensing requirements in plain language, so that applicants easily understand the process and the necessary requirements.
	Use of Digital Technology: Develop digital platforms for submitting applications and tracking the status of licences, which would improve transparency and efficiency in the process.
	Inter-institutional Coordination: Encourage coordination between different authorities and levels of government to ensure that regulations are consistent and uniformly applied, reducing uncertainty for developers.
Administrative simplification	Simplified Environmental Assessments: Establish a simplified environmental assessment process for smaller scale or reduced impact projects, which would speed up the licensing process.
	Single Processing Windows: Implement one-stop shops in local authorities to handle all licence applications centrally, which would facilitate the process and reduce the administrative burden.
Regulatory Streamlining	Develop Clear Regulations: Create clear and concise regulations that specify the conditions under which open loop systems can be installed, especially in protected or highly sensitive areas.
	Risk-Based Assessments: Implement environmental impact assessments based on a risk-based approach, where projects are assessed according to their actual impact potential, allowing for greater flexibility in meeting regulatory requirements.
Additional Consideration	Financial Incentives: Provide financial incentives or subsidies for geothermal energy projects, which can motivate developers to comply with regulations and facilitate the licensing process.
	Training and Capacity Building: Offer workshops and training sessions for applicants on the licensing process, which would help them to better understand the requirements and prepare their applications more effectively.

	Personalised Assistance: Provide personalised assistance to applicants through public consultancies or helplines, where experts can answer questions and guide applicants through the process.

- **Sweden**

Table 33. Solution for Sweden

Licensing simplification	Digitisation of the process: Introduce online permit application systems, integrated with water resources databases for more efficient review.
	Category assessment: Differentiate projects by scale and impact (residential vs. industrial) to define proportionate requirements.
	Simplify forms: Unify and simplify required permit forms, reducing redundant information.
	Simplify requirements for extensions: Reduce requirements for permit extensions if the original project conditions have not changed.
	Institutional cooperation: Formalise collaboration agreements between the entities involved (Länsstyrelsen and environmental courts) to streamline procedures.
	Time reduction: Establish maximum time limits for application review, with automatic approval if the deadline is not met.
Administrative simplification	Centralisation of processes: Implement a one-stop shop to coordinate all permits related to water abstraction and reinjection. Establish online platforms that allow users to track the progress of their application.
	Capacity Building for Local Authorities Train local authorities on technical issues related to groundwater and its interaction with open systems, to avoid delays due to lack of knowledge.
	Environmental impact-specific permits: Create permit categories based on the level of extraction and impact on groundwater, reducing requirements for small or low-risk projects.
Regulatory Streamlining	Clear standards: Define national standards for permitting requirements, reducing variations between regions. Establish specific rules for small residential systems that have minimal impacts.
	Differentiate regulations according to geographical context: Adapt regulations to distinguish between urban and rural areas, as conditions and risks can vary significantly. In urban areas, for example, stricter control of land use and underground infrastructure may be necessary.

- **The Netherlands**

Table 34. Solution for The Netherland

Licensing simplification	Fully Online Application Portal: Enhance the existing web portal to allow for a fully digital application, facilitating application submission, status tracking, and direct communication with authorities.
	Reduction of Necessary Documentation: Simplify documentation requirements, eliminating any redundancy or unnecessary paperwork, especially for areas without geothermal interference.

	Standardised Templates and Protocols: Introduce standardised templates for required documents, such as design study and impact assessment, to ensure consistency in submissions and reduce the number of rejections due to formal errors.
	Exemptions for Small Systems: For smaller scale installations that do not pose a high risk, simplified permits or exemptions could be offered, speeding up the process for small-scale developers.
	Applicant Assistance: Establish a helpdesk to guide applicants through the licensing process. This assistance can be through specialised staff or an automated online system that answers frequently asked questions and provides guidance on specific requirements.
Administrative simplification	One-stop-shop for Permit Management: Implement a one-stop-shop system where all applications related to the open loop system (both licences and additional permits) are handled in one place, centralising communication between institutions.
	Better Coordination between Institutions: Establish more effective cooperation mechanisms between provincial authorities, municipalities and external services ('omgevingsdienst') to ensure that communication and processes are aligned and avoid duplication of efforts.
	Automatic Approvals after Time Limit: Implement a system where, if authorities do not respond within the set timeframe (2-6 weeks), the permit is automatically approved, incentivising timely review by the responsible entities.
Regulatory Streamlining	Review of Regulations for Small Systems: Establish differentiated regulations for smaller systems, where technical and regulatory requirements are less stringent, such as reduced monitoring and maintenance obligations, and simplified requirements for installations in non-critical areas.
	Harmonisation of Standards for Interference Zones: Create a clear regulatory framework that integrates open and closed loop systems in interference areas, to avoid contradictions or conflicting regulations between these two types of systems.
	Automated Monitoring Protocols: Introduce automated monitoring tools that directly report operational data to authorities (flow rates, temperatures, energy balances), reducing the need for manual reporting by operators. This could improve the efficiency of regulatory compliance.
	Flexible Decommissioning Protocol: Simplify regulatory requirements for decommissioning systems, allowing for less costly sealing methods in cases where no significant environmental impacts are expected, reducing the burden on owners when systems become obsolete.

4.2.2 Recommendations for CLS in 'GeoBOOST' countries

- **Austria**

Table 35. Solution for Austria

Licensing simplification	Create online platforms for the submission of applications, with digital forms, application status tracking and user support tools. This would speed up the process and reduce the administrative burden for both applicants and local authorities.

	Reduce the number of documents required for licensing in non-sensitive areas, e.g. by eliminating the need for full geological studies or environmental impact assessments when certain conditions are met.
	Accelerate Permit Renewal: Simplify the permit renewal process, especially if the installation has operated within the parameters of the original permit. This could include automatic permit renewal, if there are no significant changes in operation or environmental impact.
	Exemptions or Accelerated Procedures for Small Installations: Introduce 'fast-track licensing' procedures or full exemptions for small systems or in non-sensitive areas, where environmental risks are minimal. This would reduce the waiting time for low impact projects.
Administrative simplification	Establish a formal mechanism for cooperation between the different institutions involved (water authorities, urban planning, environment) to avoid duplication of work and streamline the process. This could be achieved through a 'one-stop shop' that manages all aspects of licensing.
	Promote Greater Public Communication: Encourage an open dialogue between authorities, developers and the public to increase understanding of the environmental benefits of geothermal systems and reduce the perception of risk. This could contribute to greater acceptance and less resistance to projects.
	Provide free technical assistance or training seminars to help applicants understand and comply with licensing requirements. This assistance could be available through the online platform or through local offices.
	Create a centralized online platform to enter new CLS systems with the intention to fill in gaps for Federal States, who do not collect that information already.
Regulatory Streamlining	Review of Sensitive Area Standards: Conduct a review and update of sensitive areas, removing areas that no longer need special protection, or creating a process to regularly update these designations based on current scientific data.
	Harmonise procedural rules: Promote harmonisation of licensing procedures at the federal level to avoid differences between states, which would make it easier to understand the requirements in any region. A standardised regulatory framework would reduce confusion and provide more legal certainty.
	Clear and Transparent Guidelines: Develop clear and accessible guidelines for applicants that explain in detail when a permit is required and what steps need to be followed. These guidelines should be available online and tailored to different levels of project complexity.
	Incorporate Smart Monitoring Requirements: Rather than implementing mandatory monitoring at all facilities, automated monitoring systems could be used only at projects where specific risks are identified. Monitoring can also be simplified by using low-cost sensor technology that automatically provides data to authorities.

- **Germany**

Table 36. Solution for Germany

Licensing simplification	Complete Digitisation of the Process: Create a fully digital application system that allows online submission and tracking across all states. It speeds up the process, reduces wait times and facilitates access to information and paperwork efficiently and remotely.

	Accelerated Procedures with Clear Deadlines: Establish clear and guaranteed deadlines for processing licences (e.g. no more than 8 weeks), with automatic approval if deadlines are not met. This would avoid excessive delays and give certainty to developers.
	Flexible Permit Extension: Allow automatic extension of permits when the project faces justified delays (technical, climatic or financial problems). It would prevent projects from losing permits due to causes beyond their control, facilitating planning.
Administrative simplification	Unification and Inter-institutional Cooperation: Establish formal cooperation mechanisms between the authorities involved (water, mining, etc.), with a 'one-stop shop' that centralises the management of the process. It would reduce duplication of procedures, simplify communication and reduce waiting times.
Regulatory Streamlining	Simplification of Procedures in Urban Areas: In urban areas, use standardised simulation tools to avoid multiple hydrogeological studies and simplify requirements. It would streamline the licensing process in densely populated areas, where these studies can be more complex and costly.
	Clarity in Monitoring Requirements: Establish clear and standardised rules for monitoring geothermal systems across the country, depending on the size of the project. It would create consistency in monitoring requirements, facilitating implementation and compliance.
	Unified National Application Standard: Implement a unified, standard application form for all federal states. It would reduce confusion and administrative burden by creating a more consistent and predictable process across the country.
Additional Consideration	Assistance and Training in the Application Process: Offer advisory services and training to applicants through water authorities or online portals. It would improve understanding of requirements and procedures, reducing errors in application submission and avoiding delays.
	Technical Assistance for Small Projects: Provide assistance and training, with tailored technical support for small developers or households. It would facilitate the adoption of small-scale geothermal technologies, democratising their access.
	Information availability: Ensure online access to comprehensive, up-to-date information on geothermal permitting rules and restrictions to facilitate project planning

- **Ireland**

Table 37. Solution for Ireland

Licensing simplification	Clear and Proportional Licensing Limits: Define an appropriate threshold of depth requiring formal licensing (such as the 500 m in review) and ensure that shallower systems only need simple registration rather than a full licensing process. Smaller or lower impact projects could be implemented more quickly with fewer bureaucratic requirements.
	Use of Digital Procedures: Implement fully online applications and processes for registration and licensing, including electronic forms and digital tracking of applications, which would significantly reduce processing times and bureaucracy, making it easier to submit applications.

	Establishing Maximum Time Limits and Automatic Permits: Establish a legal maximum time limit for the review of applications and, if this time limit is exceeded, automatically grant provisional approval. It would assure applicants that they will not face unnecessary delays, incentivising investment in geothermal energy.
	Increased Coordination between Institutions: Establish formal cooperation mechanisms between the different entities involved in the licensing process, with standardised procedures and a single inter-institutional review. It would avoid duplication of procedures and applications, speeding up approval times.
Administrative simplification	Simplification of Application Requirements: Reduce the number of documents required in the initial application, requesting only essential data, and allow other documents to be submitted once the project moves to later phases. Less administrative burden at the beginning of the process, making it easier and faster for developers to obtain initial permits.
	Centralisation of Information and Procedure: Create a one-stop shop or centralised portal where applicants can access all information, submit applications and receive assistance during the process. Applicants would have a clear point of contact, reducing confusion about who to contact, eliminating duplication of procedures.
Regulatory Streamlining	Establish specific and detailed regulations for closed loop systems, at different depths, with clear guidelines for all types of geothermal projects. This would provide legal certainty and clear guidance to applicants on requirements, reducing uncertainty.
	Differentiated Regulations according to Project Size and Location: Create regulations proportional to the size of the project and its impact, with more flexible requirements for smaller installations or in rural areas, while maintaining stricter regulations for projects in urban or sensitive areas. It would allow for more flexible and efficient development in less problematic areas, encouraging the use of geothermal systems in rural areas.
	Flexibility in Underground Planning: Include long-term underground planning in the regulations but allow exceptions or flexibilities for temporary or small-scale installations. Developers would have a clear framework to work within, but with enough flexibility not to stop low-impact projects.
	Clear Standards for Monitoring: Create clear and standardised guidelines on how monitoring should be conducted, what data is needed and how often it should be reported, along with the use of modern technologies (such as remote monitoring sensors). It would facilitate compliance without imposing an undue burden on operators.
	Risk-based monitoring: Implement a project risk-based monitoring system, where only projects above certain environmental impact thresholds need intensive monitoring. Lower impact systems would have fewer monitoring requirements, reducing costs and operational complexity.

- **Poland**

Table 38. Solution for Poland

Licensing simplification	Introduction of online applications: Develop an online application system for drilling and licensing permits, allowing applicants to submit documents, track the status of the process and receive notifications. This would significantly reduce waiting times, improve transparency and facilitate access to information for applicants.

	Set automatic deadlines with tacit approvals: Implement an automatic approval mechanism if the authorities do not respond within a certain timeframe (e.g. 1 month). This would avoid unnecessary bureaucratic delays and speed up the process for developers.
Administrative simplification	Reduce the amount of documentation: Simplify the list of required documents by combining certain technical reports and allowing the submission of digital documents that include all information in a single package. It would reduce the workload for developers and allow authorities to analyse the information more efficiently.
	Assistance and support during the application process: Provide technical assistance and guidance to applicants during the application process, through support offices or digital platforms that offer guidance and answer frequently asked questions. It would improve the user experience, avoid application errors and facilitate understanding of the process.
	Establish clear design and implementation standards: Define national or European standards that developers can follow to ensure that projects comply with requirements from the outset, facilitating the approval of licenses. It would avoid the need for extensive reviews by authorities and streamline the permitting process.
	Shorter deadlines and simplified procedures for small projects: Create simplified procedures for small, closed loop system projects, with shorter deadlines and reduced documentation requirements. It would incentivise more small developers to adopt these systems, facilitating wider implementation in urban and rural areas.
	Creation of a 'one-stop shop': Establish a one-stop shop system where developers can make all necessary applications through a single point of contact. This system could integrate the entities involved (geological administration, mining administration, etc.). It would increase the efficiency of the process, reducing processing times and eliminating the need to interact with multiple institutions.
	Institutional cooperation: Encourage cooperation between the entities involved (geological, mining and other administrations) through the creation of cooperation agreements or coordination mechanisms. It speeds up permit processing and avoids duplication of processes.
Regulatory Streamlining	Unify permitting requirements: Simplify requirements for projects involving multiple jurisdictions (such as mining areas or depths greater than 100m) by unifying regulations or creating a single licence covering all aspects. It would reduce the administrative burden and speed up project approvals.
	Review and standardise legal requirements: Update regulations to reduce the amount of technical documentation required, keeping only essential requirements that do not create redundancy. It would reduce costs and time for developers, while maintaining safety and environmental compliance.
	Monitoring regulation: Implement clear regulations for monitoring of closed loop systems, including automated monitoring systems and periodic reporting requirements. Consideration could also be given to incorporating fiscal or financial incentives for those who implement voluntary monitoring systems. It would improve the performance and environmental impact management of geothermal systems, ensuring efficient and safe long-term operation.
Additional Consideration	Awareness and education campaigns: implement programmes to educate both applicants and local authorities on the importance and process of installing closed loop systems. It increases transparency and facilitates better decision making by all stakeholders.

- **Spain**

Table 39. Solution for Spain

Licensing simplification	Digitisation of Licensing Processes: Implement electronic licensing platforms to facilitate the submission of documents and accelerate the review process by administrative bodies. This would also allow for greater transparency and real-time tracking of application statuses.
Administrative simplification	Create a one-stop-shop system for license processing at the regional or national level, where applicants can manage all necessary permits through a single platform. This would reduce complexity and improve coordination between administrative bodies.
	Simplification of Documentation: Reduce administrative burdens by eliminating redundancy in the required documents. A simplified submission process with fewer steps and forms would make the system more efficient.
	Improved Inter-administrative Coordination: Establish mechanisms for cooperation and coordination between different levels of government (local, regional, and national) to streamline the permitting process and avoid delays due to miscommunication.
	Training of Public Officials: Provide specialized training in geothermal energy to officials responsible for reviewing applications, improving their technical and regulatory knowledge, which would help avoid misunderstandings and errors in the licensing process.
Regulatory Streamlining	Unification of Requirements at the National Level: Develop a common regulatory framework for all autonomous communities to harmonize licensing procedures and technical requirements. This would reduce regional differences and make the permitting process easier for developers and installers.
	Clarification and Updating of Regulations: Update existing regulations to include clear and specific guidelines for closed-loop geothermal heat pump systems, reducing uncertainty and providing detailed instructions for installation and operation.
	Adapting Regulations to Promote Renewable Energy: Review legislation to ensure renewable energy regulations are more inclusive and supportive of geothermal systems. This could include regulatory incentives such as tax breaks or exemptions to encourage the installation of geothermal heat pumps.
	Regulatory Stability and Predictability: Provide a more stable and predictable regulatory framework for geothermal technology in the long term, fostering developer confidence and attracting investment. This would involve avoiding abrupt regulatory changes that could disincentivize new projects.
Additional Consideration	Public Information and Awareness Programs: Develop public awareness campaigns and training for developers and citizens on the benefits of geothermal energy and the pathways to simplify its adoption, creating a more favourable environment for its implementation.

- **Sweden**

Table 40. Solution for Sweden

Licensing simplification	Standardised licensing for small systems: Create a simplified licensing procedure for lower impact systems, reducing time and administrative requirements.
	Automatic permit renewal: Allow permits for closed systems to be automatically renewed if no technical or environmental problems are reported during operation.
	Preliminary online assessments: Create digital tools for users to verify project feasibility before starting the formal process.
Administrative simplification	Validation of certified technicians: Require installers and drillers to be certified, simplifying the technical assessment of projects.
	Creation of a 'one-stop shop': Establish a one-stop shop system where developers can make all necessary applications through a single point of contact. This system could integrate the entities involved (geological administration, mining administration, etc.). It would increase the efficiency of the process, reducing processing times and eliminating the need to interact with multiple institutions.
	Set automatic deadlines with tacit approvals: Implement an automatic approval mechanism if the authorities do not respond within a certain timeframe (e.g. 1 month). This would avoid unnecessary bureaucratic delays and speed up the process for developers.
	Institutional cooperation: Encourage cooperation between the entities involved (geological, mining and other administrations) through the creation of cooperation agreements or coordination mechanisms. It speeds up permit processing and avoids duplication of processes.
	Assistance and support during the application process: Provide technical assistance and guidance to applicants during the application process, through support offices or digital platforms that offer guidance and answer frequently asked questions. It would improve the user experience, avoid application errors and facilitate understanding of the process.
Regulatory Streamlining	Unify permitting requirements: Simplify requirements for projects involving multiple jurisdictions by unifying regulations or creating a single license covering all aspects. It would reduce the administrative burden and speed up project approvals.
	Review and standardise legal requirements: Update regulations to reduce the amount of technical documentation required, keeping only essential requirements that do not create redundancy. It would reduce costs and time for developers, while maintaining safety and environmental compliance.
	Monitoring regulation: Implement clear regulations for monitoring of closed loop systems, including automated monitoring systems and periodic reporting requirements. Consideration could also be given to incorporating fiscal or financial incentives for those who implement voluntary monitoring systems. It would improve the performance and environmental impact management of geothermal systems, ensuring efficient and safe long-term operation.
	Awareness and education campaigns: implement programmes to educate both applicants and local authorities on the importance and process of installing closed loop systems. It increases transparency and facilitates better decision making by all stakeholders.

- **The Netherland**

Table 41. Solution for The Netherland

Licensing simplification	Implement Fully Digitised Procedures: Complete the digitisation of the licensing process by creating efficient online platforms where all stages of the application, from submission to issuance, can be processed. This would speed up processing and minimise errors.
	Establish Uniform Procedures at National Level: Currently, municipalities can define their own rules, which leads to inconsistency. A more uniform approach at the national level, with clear and homogenous procedures and criteria, could reduce confusion and facilitate licensing.
Administrative simplification	Allow Automatic Permitting in Simple Cases: Introduce automatic or simplified permitting for small or low environmental impact projects, reducing the administrative burden and speeding up the licensing process in cases where risk is minimal.
	Provide Technical Assistance to Applicants: Establish a helpdesk to guide applicants through the licensing process, especially for those who are unfamiliar with the technical and regulatory requirements. This could include help lines, tutorials or dedicated staff to answer queries.
	Improve Transparency of the Licensing Process: Provide clear and accessible guidance on specific licensing requirements, including when and why an open loop system might not be approved. This would help applicants anticipate potential problems and adapt their designs
Regulatory Streamlining	Simplify Monitoring Requirements for Small Projects: Tailor monitoring requirements for smaller systems (below certain capacity thresholds), reducing the obligation for detailed reporting and long data storage periods, which would decrease the economic and administrative burden for small developers.
	Establish Clear Interference Zone Standards: Define clear and homogenous criteria for thermal interference zones, avoiding arbitrary differences between regions. This would help developers anticipate restrictions and design compliant systems without generating unexpected delays
	Relax Environmental Impact Standards: Introduce a simplified environmental impact assessment for projects of lower risk or located outside sensitive areas, allowing for a quicker and less costly review procedure.
Additional Consideration	Clear and Transparent Guidelines: Develop clear and accessible guidelines for applicants that explain in detail when a permit is required and what steps need to be followed. These guidelines should be available online and tailored to different levels of project complexity.
	Promote Greater Public Communication: Encourage an open dialogue between authorities, developers and the public to increase understanding of the environmental benefits of geothermal systems and reduce the perception of risk. This could contribute to greater acceptance and less resistance to projects.

5. Implementation and Continuous Monitoring

5.1 Implementation strategies of Licensing Solutions

For the competent authorities, the implementation of solutions to simplify the licensing procedures for GHP systems must be based on robust strategic planning and coordinated implementation. This implies not only the implementation of the solutions in the target countries, but also an approach that ensures the sustainability and adaptability of the measures over time. The key steps for successful implementation are described below.

5.1.1 Strategic Planning

Before the implementation of the proposed solutions, the authorities should establish a clear planning, including:

- Define specific objectives: Clearly establish what the implementation aims to achieve (e.g., reducing time, costs, and administrative barriers), ensuring the objectives are measurable and aligned with regulatory frameworks (GeoElec, 2009).
- Select pilot areas: Identify regions or municipalities where the solutions will be initially applied to assess their effectiveness prior to full-scale implementation (Goetzl et al., 2020).
- Coordinate stakeholders: Assign responsibilities to government agencies, technical experts, and community representatives to ensure an efficient workflow.
- Establish a detailed timeline: Define deadlines for each phase of implementation, including testing, adjustments, and scalability stages (IWG, 2023).
- Assess potential risks: Identify possible barriers and develop mitigation strategies to address them proactively.

5.1.1.1 Assignment of roles and responsibilities (GeoENVI, 2020; VNF, 2017)

- Identification of key actors:
    - Governments and regulatory authorities: Government agencies responsible for energy, environment and infrastructure should be identified, as they provide regulation, oversight and permitting for the installation of GHPs. This includes both national and local levels, as in many countries licensing and permitting competencies may vary by administrative level.

- Implementation and monitoring agencies: Depending on the country, there may be specific agencies that regulate renewable energy installations or heating and cooling systems. These should be aligned with the licensing simplification objectives and be responsible for coordinating with other stakeholders and ensuring transparency in the process.

- Private actors: Project developers and technology companies installing GHPs should be actively involved in the process, as they have direct contact with end consumers. Their involvement will ensure that licensing solutions are practical and operationally efficient.

- Non-governmental organisations and industry associations: Energy associations, environmental advocacy groups and other public interest entities have a role in promoting the adoption of GHP and raising awareness of the need for a streamlined licensing process.

- Academia and research institutes: Academic institutions can support in the collection and analysis of technical data to assess the implementation of the new procedures. They can develop impact studies on the adoption of geothermal heat pumps and their effectiveness in different contexts. Their involvement in the creation of predictive models and assessment tools will help to optimise planning.

- Clarification of responsibilities (Speer et al., 2014; Levine & Martinez, 2023):

  - Task assignment: It is important to assign specific and clear tasks to each actor involved. For example, local authorities could be responsible for the initial permitting process, while national authorities would be responsible for ensuring that consistent regulations are maintained at a broader level.

  - Coordination mechanisms: Coordination between actors should be structured in a formal way, such as the creation of inter-institutional committees or working groups for real-time monitoring and problem solving.

5.1.1.2 Assessment of Available Resources

The authorities should assess:

- Institutional capacities (USAID, 2011; IRENA, 2021; IRENA, 2016):
    - Staff training: Authorities responsible for licensing procedures should be trained on the new simplified procedures, on the technologies involved in GHP and on the best practices of leading countries in the adoption of these technologies. This reduces resistance to change and improves the efficiency of the process.
    - Infrastructures: Once the key actors have been identified, an assessment of existing infrastructures should be carried out to facilitate digitisation and the use of technological tools in the licensing process.
- Funding and budget (IDAE, 2011; Solar Power Europe, 2019):
    - Identify funding sources: the availability of funds at both local and national level should be assessed, as well as exploring international sources of funding (such as EU funds) to support the implementation of changes to the licensing process. The budget should cover staff training as well as the implementation of digital platforms and promotion of the new regulations.
    - Determinate Long-term cost: It is important to project the associated long-term costs, not only those of implementation, but also those related to maintaining digitised licensing systems and ongoing monitoring of results. D 4.1 (Thelin & Malmberg, 2024) provides a tool to analyse levelized cost of energy (LCOE) to compare GHP systems with other various heating and cooling technologies.
- Available technologies (Prestor et al., 2015; Rupprecht et al., 2017; Klonowski et al, 2020; GEO4CIVHIC, 2020; Pasquali and O'Neill, 2015; GeoDH, 2014; Cheap-GSHPs, 2018):
    - Existing platforms: By examining the digital licensing tools and platforms already available, it is possible to assess their degree of effectiveness, their accessibility and the ease with which they can be adapted to implement the GHP licensing system. In many cases, new platforms may need to be developed, or existing ones enhanced to integrate GHP-specific modules.

- Automation and digitisation: In terms of technology, automation of repetitive tasks, such as validating legal requirements, tracking applications and issuing permits, should be prioritised, which can save time and resources, and minimise human error. Also, digitisation of files and simplified forms is an important component to improve efficiency and transparency.

5.1.1.3 Prioritisation of Actions

To ensure effective implementation, a gradual approach is recommended.

- Prioritisation criteria (Danilova, 2024; Zaheb et al., 2024; Aggarwal & Usapein, 2023):
  - Feasibility analysis: allows to analyse which solutions are most feasible according to the political, economic and social conditions of each country. Some countries may already have relatively simplified licensing procedures, while others may have more significant barriers. Solutions should be adaptive to the administrative maturity of each context.
  - Expected impact: Measures that promise the highest impact in terms of reducing licensing processing time and costs should be prioritised. For example, the creation of digital platforms or simplification of forms can have an immediate and visible impact, while legislative or regulatory changes might require more time.
- Short-, medium- and long-term planning (Levy et a., 2021; Esposito et al., 2024; Oduro et al., 2024):
  - Short-term actions: The first actions should focus on training key staff and improving the existing technological infrastructure. This includes the creation of educational resources, simplified procedural guides, and the introduction of e-licensing platforms.
  - Medium-term actions: Implementation of new rules or modification of existing ones, together with continuous improvement of digital licensing platforms, should be underway. Simplification of administrative procedures and implementation of a more robust monitoring infrastructure to assess the effectiveness of new solutions.
  - Long-term actions: Long-term objectives include full integration of licensing and monitoring systems at all levels of government, consolidation of best

practices and creation of financial incentives that promote large-scale adoption of GHPs.

5.1.2 Coordinated Implementation

5.1.2.1 Development of cooperative frameworks (Gephart & Tesniere, 2015; Rountree & Baldwin, 2018)

- Establishment of inter-institutional working groups: These teams should include experts in energy, technology, environment and public administration to ensure that procedures are technically sound and can be efficiently implemented at local, regional and national levels.

- Regional and local cooperation protocols: Where licensing procedures are delegated to local authorities, there should be clear protocols for cooperation between these levels and central government to ensure consistency and efficiency.

5.1.2.2 Implementation of digital tools (Ivic et al., 2023; Muthu et al., 2016):

- Development and implementation of e-licensing platforms: Licensing platforms should be user-friendly and adapted to local needs, allowing for the uploading of documents, real-time validation of requirements and streamlining of administrative processes.

- Digital training: Public officials should be trained in the use of these platforms, with the objective of ensuring that they are used effectively to reduce processing times and increase transparency.

5.1.2.3 Change management strategies (Worley et al., 2018; Ross & Day, 2022):

- Effective communication: Dissemination campaigns should be conducted to inform about the benefits of the new procedures, as well as public consultation spaces to resolve doubts and receive suggestions.

- Incentives and motivation: Reduced administrative fees should be proposed for early adopters of the new procedure. In addition, there should be recognition of good practices among local authorities.

- Monitoring of public perception: Authorities should conduct surveys to assess the acceptance of the new procedures and future adjustments to the implementation strategy based on the feedback received.

5.2 Monitoring and Evaluating the Efficiency of Measures adopted

Once the solutions for the simplification of licensing procedures have been implemented, it is necessary to establish a robust framework for monitoring and evaluating the effectiveness of the measures adopted (IRENA, 2022). This will ensure that the objectives of the 'GeoBOOST' project are met in a sustainable and efficient manner. Regulatory authorities should implement monitoring systems that allow for a continuous assessment of the performance of the simplified procedures and rely on data to allow for real-time adjustments and optimisation of processes. The key steps for monitoring and evaluation are detailed below.

5.2.1 Defining Success Indicators

Before starting monitoring, it is recommended that the authorities define clear indicators to measure the impact of the measures implemented. Indicators can be divided into quantitative and qualitative and should be aligned with the project objectives (Boie et al., 2015; PO 2014; Whited et al., 2015).

5.2.1.1 Quantitative Indicators:

- Reduction in licence processing time: Measure how much the time required to issue licences has decreased compared to previous procedures.
- Reduction in administrative costs: To assess whether the costs associated with processing licences have been reduced, both for regulatory authorities and project developers.
- Number of licences issued: Monitor the number of licences issued for GHP installations over time, as an indicator of technology adoption.
- Level of digitisation of processes: Measure the proportion of licence applications processed through electronic platforms compared to previous manual processes.
- Environmental and energy impact: Track compliance with environmental standards in approved projects. In addition to measuring energy savings from the adoption of GHP and the reduction of carbon emissions compared to traditional methods.

5.2.1.2 Qualitative Indicators:

- User satisfaction: Conduct surveys or interviews with stakeholders (regulatory authorities, project developers, and end-users) to assess their level of satisfaction with the new procedures.
- Perception of simplification: Assess how key stakeholders perceive the simplification of processes and whether they consider that procedures have become clearer and more efficient.
- Operational efficiency: Assess the authorities' ability to manage and monitor license applications more efficiently thanks to the new tools and procedures.

5.2.2 Continuous Monitoring of Processes

To ensure that the measures taken remain effective and adapt to changes in the legal, economic and technological environment, it is recommended that authorities implement a continuous monitoring system. This implies the use of tools that allow for real-time data collection and continuous evaluation of the processes.

5.2.2.1 Monitoring Tools (Zhou et al., 2020; Ugwuanyi, et al., 2017, Vine & Sathaye, 2000):

- E-licensing platforms: Digital platforms used for licence processing should have integrated monitoring capabilities. This allows tracking the progress of each application, identifying bottlenecks and detailed tracking of processing times.
- Dashboards: Dashboards (Power BI, Tableau, or customised dashboards) provide a real-time view of pre-defined key performance indicators (KPIs). These can include the number of requests, average processing time, and percentage of approved requests.
- Real-time monitoring of administrative burden: It is necessary to have tools that measure administrative burden in real time, allowing the identification of areas where the process can be further simplified or improved.
- Perception surveys and roundtables (face-to-face or online): It is important to involve key stakeholders, such as local authorities, developers and end-users, in the review of procedures to obtain qualitative feedback.

- Benchmarking: Comparison of the results obtained with the best national or international practices or with other regions implementing similar initiatives.

5.2.2.2 Review and Update of Processes (OECD, 2024)

- Periodic review of procedures: Periodic reviews of simplified procedures ensure that there are no new barriers or inefficiencies. This may include annual evaluation of the licensing processes and their comparison with the established objectives.

- Fast feedback mechanisms: Mechanisms should be put in place to allow authorities and private actors to report problems or suggestions for improvement in real time. These comments should be evaluated quickly, and corrective measures should be implemented efficiently.

5.2.3 Impact Assessment

Impact assessment refers to measuring the direct and indirect effects of the measures taken on the adoption of GHPs and their successful implementation. This assessment should be conducted at various stages of the project to get a clear picture of how solutions affect outcomes over time.

5.2.3.1 Short-term evaluation:

- Impact on technology adoption: In the first months or years, it is recommended to measure the adoption rate of GHPs in the target countries. This includes the number of ongoing GHP projects, and the number of permits issued (Rao et al., 2024; Liu et al., 2022).

- Impact on stakeholder perceptions: In the short term, surveys should be conducted with key stakeholders (project developers, local authorities, etc.) to assess their perception of the effectiveness of the new measures. This will help to identify possible areas for improvement quickly (Scheller et al., 2024; Schulte et al., 2022).

5.2.3.2 Long-term evaluation(OECD, 2024; Scheller et al., 2024; Schulte et al., 2022):

- Sustainability of simplification: In the long term, it should be evaluated whether the implemented measures continue to be effective and sustainable. This includes measuring operational efficiency over the long term and the persistence of reductions in processing times and costs.

- Impact on mass adoption of GHPs: As more projects are implemented, it should be assessed how the simplification measures have facilitated the widespread adoption of GHPs in the target countries and in other regional contexts.

5.2.4 Adjustments and Continuous Improvement

One of the most important aspects of monitoring and evaluation is the ability to make quick and efficient adjustments based on the results obtained.

- Feedback cycles: The data and feedback collected (e.g. KPIs or indicators) (Li et al., 2023) should be used to adjust licensing policies and procedures on an ongoing basis. This includes revising regulations if necessary or updating digital platforms to improve their functionality (Carreño, 2024).

- Continuous improvement plans: It is recommended to implement a continuous improvement cycle, based for example on the PDCA (Plan-Do-Check-Act) methodology (Nguyen et al., 2020), ensuring that processes are constantly adjusted and improved to maintain efficiency and effectiveness (OECD, 2024).

5.2.5 Reporting and Transparency

The results of monitoring and assessment should be presented in a clear and transparent manner to stakeholders, including authorities, project developers and the public.

- Periodic reporting: Evaluation reports should be conducted on a regular basis (e.g. semi-annually or annually) and should include both quantitative and qualitative results, challenges identified during implementation, recommendations for process improvements, success stories and lessons learned (Boie et al., 2015; Saxena & Muhammad, 2018).

- Public access to results: To ensure transparency, monitoring results and implemented improvements should be shared with stakeholders, building trust in the process and showing progress towards project objectives (Grimmelikhuijsen & Meijer, 2014).

6. Conclusion and recommendations

This document highlights the importance of developing a solid legal and administrative framework for the management of geothermal heat pumps (GHP) in Europe, representing a significant advancement in the integration of renewable energy and the achievement of carbon neutrality in the European Union. The analysis results underscore the need to address regulatory, administrative, and technical barriers that hinder the deployment of these systems, especially in countries with federal or highly decentralized structures, where harmonizing standards is complex.

The report identifies the main challenges in licensing, monitoring, and inter-institutional coordination, demonstrating the need for strategies adapted to each national context. It highlights the importance of establishing defined administrative deadlines without resorting to automatic approval, optimizing procedures without consolidating them into a single entity, and strengthening monitoring mechanisms without overburdening operators. Additionally, differences in regulatory frameworks and best practices across various countries have been analysed, allowing for the identification of significant gaps and opportunities for improvement in geothermal resource management.

Based on this analysis, recommendations have been formulated for both authorities, operator and industry stakeholders:

1. Harmonisation and Standardisation of Regulations

A clear and homogeneous regulatory framework would facilitate the planning and development of GHP projects.

- Develop national regulations aligned with European legislation, ensuring compliance with the Renewable Energy Directive (RED II) and EU climate goals.
- Create best practice guidelines at the European level, including simplified licensing procedures and standardized criteria for environmental assessment and monitoring.
- Foster cooperation between countries to share experiences and best practices, promoting the adoption of uniform regulations across the EU.
- In countries with federal or highly centralized structures, it is recommended to:
    - Define minimum national standards as a reference for local regulations, ensuring consistency in technical and environmental requirements without imposing a single framework.

- Develop reference guidelines instead of mandatory regulations, allowing each region to adapt recommendations to its regulatory context.
- Promote interregional cooperation through the creation of forums or working groups among local authorities.

2. Digitalisation and Simplification of Administrative Procedures

The implementation of digital tools and the reduction of administrative burdens can improve licensing efficiency.

- Establish digital one-stop shops for license management, reducing bureaucracy and speeding up approval times.
- Integrate permits into a single coordinated procedure, especially for small-scale projects, avoiding duplication of processes across entities.
- Develop standardised forms and requirements proportional to the project's environmental impact.
- Implement maximum timeframes for license approval with intermediate review mechanisms, rather than resorting to automatic approval.
- Improve inter-institutional coordination through cooperation agreements between agencies.
- Implement digital tracking platforms where applicants can monitor the status of their applications.
- Standardise documentary requirements among different agencies to avoid redundancies.

3. Strengthening Monitoring and Supervision

Proper monitoring would ensure the sustainability and safety of GHP systems.

- Establish mandatory monitoring systems, differentiating between small installations and large projects.
- Create national registers of geothermal installations accessible to local administrations and regulatory bodies (Deliverable 2.2 provides a systematic approach to data collection and monitoring, Brancher, M., & Steiner, C. 2024)
- Develop digital tools for data collection and analysis, allowing for the evaluation of system performance and environmental impact.

4. Greater Stakeholder Engagement and Capacity Building

Collaboration between the public and private sectors is key to accelerating geothermal adoption.

- Promote the training of public officials and technicians in regulations and licensing processes.
- Develop technical assistance programs for developers and users.
- Conduct awareness campaigns on the benefits of geothermal energy.

5. Incentives and Financial Support Mechanisms

Reducing economic barriers would facilitate the expansion of GHP systems (Deliverable 4.2 provides details on economic incentives in 'GeoBOOST' countries and general recommendations).

Key approaches include:

- Establish grants and financing programs for geothermal installations, particularly in residential and commercial sectors.
- Implement tax incentives and reductions in administrative fees for developers and investors.
- Explore public-private financing schemes to encourage investment in large-scale geothermal infrastructure.

These recommendations aim to ensure the strategic deployment of new GHP installations, maximising energy efficiency and ensuring long-term sustainability.

Finally, strategies for process simplification in different national contexts have been identified, highlighting the importance of harmonized regulatory frameworks, optimized administrative procedures, and digital tools that facilitate licensing. Moreover, the report underscores the impact of current barriers on GHP adoption, noting how regulatory uncertainty and administrative costs influence the decision-making process of developers and investors.

The analysis and recommendations presented in this document reaffirm the need for a robust regulatory framework and a coordinated European-level approach, enabling improvements in energy efficiency, carbon emission reductions, and progress toward a more sustainable and resilient energy system, consolidating geothermal energy as a key resource in the energy transition.

7. Relevance for Policymakers and Local Administrations

The municipalities, both large and small, are increasingly facing energy challenge. Therefore, they must find solutions that provide affordable and reliable energy services, which can contribute the energy independence and low carbon emissions. In this contexts, geothermal energy offers municipalities strategic, economic, social, and operative advantages.

Geothermal Heat pump offers a long-term, stable and efficient solution. This technology has clear advantages: such as significant reduction in heating and cooling costs, predictable operating costs, less exposure to energy price volatility, constant energy supply, guaranteed quiet and visually discreet operation, increased comfort in public and/or private facilities, and substantial reductions in emissions. Several studies and experiences in Europe have shown that geothermal heat pumps achieve seasonal performance factors (SCOP) that typically range between 3.0 and 5.0 under European conditions (IEA, 2022; EHPA, 2023). In addition, well heat exchangers also have a very long service life, typically ranging from 25 to 50 years (Koohi-Fayegh, 2025; Violante, 2022). These advantages make geothermal energy an attractive option for municipalities seeking resilient and future-proof infrastructure.

Despite its maturity, the deployment of geothermal energy is being slowed down by non-technical factors, such as:

- administrative complexity;
- fragmented regulatory procedures; and
- limited access to subsurface data or uncertainty about planning.

WP3 addresses these challenges by developing tools and guidelines to support local and regional authorities. These tools are created in response to a broader need: to enable local and regional authorities to take informed, practical, and economically sound decisions about heating and cooling in public buildings and urban areas.

Deliverable 3.3 focuses on practical recommendations to simplify licensing procedures for shallow geothermal systems; its relevance extends beyond administrative efficiency. Streamlined, transparent and predictable procedures are essential for enabling municipalities and regional authorities to make effective use of geothermal energy as part of their long-term heating and cooling strategies.

In this sense, the recommendations in D3.3 not only streamline administrative processes but also support broader strategic objectives: accelerating decarbonisation,

improving public infrastructure, reducing long-term costs and fostering a more resilient and sustainable energy future for municipalities and regions. For policymakers, this deliverable provides a clear pathway to translate regulatory ambition into practical, effective action on the ground.

For all these reasons, the results presented in this deliverable not only advance academic and regulatory understanding but also provide a solid foundation for municipalities and regional administrations seeking to integrate geothermal energy as part of their long-term planning and sustainability strategies.

By providing harmonized, practical, and adaptable approaches, WP3 enables municipalities, planners, and regulators to incorporate geothermal energy with confidence and efficiency. This ensures that decisions remain sound, future-oriented, and aligned with the economic, social, and environmental goals of each community.

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