Science to policy report on recommended measures towards a supportive regulatory and policy framework

October 2024

Author:

Giulia Cittadini (EGEC), Philippe Dumas (EGEC), Emil Martini (EGEC)

Deliverable: D5.3. Science to policy report on recommended measures towards a supportive regulatory and policy framework

Version: 4 **/ Status:** Final version

Verified by: SAPHEA's partners **/ Approved by:** SAPHEA's partners **/ Publicity level:** PU-public

Contact: Giulia Cittadini, g.cittadini@egec.org

www.saphea.eu

This article/publication is based upon work from the project SAPHEA, funded by the European Union's HORIZON EUROPE research and innovation programme under the Grant Agreement number 101075510

Funded by the European Union

HISTORY OF CHANGES		
VERSION	PUBLICATION DATE	CHANGE
1	19/09/2024	First draft version
2	27/09/2024	First review by partners
3	27/09/2024	Graphs in Saphea style. Add references. Proof-reading and editing. Updated draft Proof-reading and editing. Review by WP leader
4	30/09/2024	Final draft
5	30/09/2024	Final version
6	04/10/2024	Submission

Disclaimer:

This article/publication is based upon work from the project SAPHEA, funded by the European Union work programme HORIZON EUROPE under the Grant Agreement number 101075510. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Table of Contents

List of tables

List of figures

1. Executive summary

This report provides a comprehensive set of recommendations with the objective of promoting the development of geothermal heating and cooling (geoHC) networks in Europe. By considering the regulatory, financial and social barriers of geoHC systems, the study calls for several actions that should be implemented to overcome the challenges identified. One of the most serious challenges regards the state of the art of the permitting procedure which usually entails long administrative processes and the involvement of several national and local authorities. The fact that many countries lack clear regulatory frameworks specifically addressing the specific characteristics of geothermal energy further enhances these issues. Harmonising the regulatory framework across EU member states is therefore crucial, as well as adopting streamlined and consistent procedures expediting project development. In order to minimise the constraints placed on investors, it is important to speed up the processes and provide specific procedures that will encourage investments in this area. Since financial constraints are a key factor hindering the growth of geoHC technology uptake, this report calls for adopting adequate and effective financial measures to enhance the competing power of geothermal projects against other energy sources. The introduction of risk mitigation tools can indeed significantly reduce financial uncertainties associated with geothermal projects by lowering the cost of capital and making geothermal investments more attractive to private investors. Aside from regulatory and financial constraints, the report underscores the need for greater public awareness and social acceptance of geothermal energy through the promotion of educational campaigns and public engagement initiatives for increasing awareness of the environmental and economic benefits related to geothermal energy. Studies demonstrate indeed that showcasing the reliability, sustainability and efficiency of geoHC systems can help alleviate public concerns and build support for local projects.

2. Introduction

This report aims to provide a comprehensive set of recommendations for the development of a supportive regulatory and policy framework that facilitates the deployment of geothermal heating and cooling (geoHC) networks across Europe. In the transition towards a decarbonised Europe, geoHC networks can play a critical role in achieving climate goals, enhancing energy security, and ensuring sustainability in the heating and cooling sector.

Taking on the findings of the report on the status quo on regulatory and policy framework in the context of geoHC networks in Europe (Deliverable 5.1), Chapter 3 presents the market drivers and barriers impacting geoHC systems. Drawing from the current regulatory landscape, technological advancements, and market conditions, this chapter identifies key challenges and opportunities for geHC development, considering EU and national strategies as well as taxation and financing opportunities coming from the EU. By leveraging insights from industry stakeholders, policymakers, and technical experts, this report offers actionable recommendations that can guide European and national authorities in creating a favourable environment for geoHC networks. Chapter 4 provides recommendations on regulatory aspects, such as developing consistent national policies, simplifying administrative procedures for permitting, and implementing supportive legislation on a financing framework. The recommendations collected in Chapter 5 address instead participative and social perception aspects on the basis of the analysis carried out in the Status report on the socio-environmental conditions for the implementation of geoHC networks in Europe (Deliverable 5.2). The findings of this report are also used to develop the recommendations on sustainability aspects of Chapter 6.

3. Better regulatory and policy framework for geoHC in Europe

3.1. Market drivers and barriers

Deliverable 5.1. already examined the status quo of regulatory and policy frameworks in the context of geoHC networks in Europe. Taking on the key finding of Deliverable 5.1, this paragraph briefly summarises and updates the market drivers and barriers affecting the environment where geoHC networks operate, considering the factors that address both the policy and regulatory framework and the economic conditions influencing the market [1].

3.1.1. Hindering factors impacting geoHC networks in Europe

Complex and lengthy permitting processes should equally be ranked among the risk factors regarding geoHC networks. Bureaucratic and administrative hurdles make it more challenging to secure the required approvals and permits for geoHC initiatives resulting in rising costs and time consumption. Furthermore, these procedures tend to be long in nature and include the need to obtain approval on a range of different procedures from different authorities, each having its own requirements and standards. This kind of complexity causes uncertainty in the time and costs involved which in turn deters potential investors and developers. Lastly, the absence of streamlined procedures is in itself counterproductive, leading to a longer duration of the projects as well as increased cost of additional work.

[1] SAPHEA (2023), Status quo report on regulatory and policy framework in the context of geoHC networks in Europe, D5.1 Regulatory-and-policy-framework.pdf (egec.org).

Hindering factors	Impact
Permitting: multiple steps and approval from various authorities	Uncertainties regarding the time and resources needed.
Standardisation: lack of streamlined procedures	Prolonged project timelines and higher operational costs.
Regulatory: absence of targeted legislation for geothermal energy	Regulatory uncertainty, and lack of clear guidelines for the development of geoHC projects.
Governance: lack of a coordinated approach (overlapping jurisdictions and fragmented responsibilities among different government levels)	Duplicated efforts and inefficiencies.
Financing: absence of adequate financial incentives	GeoHC projects become less competitive compared to other energy sources.

Table 1: Hindering factors impacting geoHC networks in Europe (2024)

The **absence of targeted legislation** for geothermal energy leads as well to regulatory uncertainty. Many regions in Europe do not have specific legislation for geothermal energy, with the consequence of increasing the ambiguity that the developers and investors shall encounter while duplicating efforts needed and inefficiencies inducing such critical impact.

At the same time, **Inadequate financial incentives** and **risk mitigation schemes** contribute to hindering geoHC network development. Financial mechanisms such as subsidies or grants exert a positive impact towards the economics of geoHC projects especially in their early phases. But unfortunately in many parts of Europe, these incentives are either weak or poorly designed, reducing the attractiveness of these systems and keeping the investment bent towards this sector.

Below are reported the key elements playing a significant role in determining the economic viability of geoHC systems:

1. Energy prices directly impact the cost savings that can be achieved by switching to geoHC systems. When conventional energy prices (e.g., natural gas or electricity) are high, geoHC systems become more economically attractive due to their potential for lower operating costs.
2. Advances in technology and economies of scale can support the reduction of the installation of geothermal infrastructures.
3. The efficiency of geoHC systems in converting geothermal energy into heating and cooling directly affects their operating costs.
4. The availability of funding and attractive financial mechanisms can encourage investments in geoHC projects by reducing upfront costs and making geothermal installations more accessible to residential and commercial users.
5. Market demand for sustainable and renewable energy solutions significantly drives geoHC adoption.
6. Fluctuations in fossil fuel prices impact the economic attractiveness of geoHC systems, making them more economically viable when fossil fuel prices rise and the relative cost of geoHC systems decreases.

3.1.2. Supportive factors for geoHC networks in Europe

The development of geoHC networks in Europe is significantly supported by the current **EU legislative framework on climate and energy**. By setting an ambitious agenda to make the EU's economy sustainable, the European Green Deal aims at achieving net-zero greenhouse gas emissions by 2050 [2], and the Fit for 55 package, similarly, aims to reduce

[2] European Commission (2019), The European Green Deal, resource.html (europa.eu).

them by at least 55% by 2030, compared to 1990 levels. Together, these policies create a favourable environment for the growth of geoHC by setting long-term goals, providing funding opportunities, and fostering innovation in the renewable energy sector [3].

The **establishment of binding targets** for renewable energy use in heating and cooling significantly incentivises the development and deployment of geoHC systems, as they ensure a stable and predictable market for renewable energy, encouraging investments and facilitating long-term planning for developers and policymakers.

Legislation promoting district heating and cooling often includes measures that support the integration of geoHC networks into the existing ones, and therefore create a conducive environment for the adoption of them, making it easier and more cost-effective to implement these systems on a large scale.

Public awareness campaigns and educational initiatives can also play a crucial role in enhancing the perception of geothermal energy. by highlighting its environmental benefits and therefore building public support for geoHC projects. Demonstrating the reliability and efficiency of geothermal energy can indeed reduce concerns about its impact on the environment while informing about its overall feasibility and performance.

Supportive factors	Impact
EU climate and energy policies	Promoting significant investments in renewable energy technologies like geoHC.
Binding targets for renewable energy use in heating and cooling	Ensuring a stable and predictable market for renewable energy, encouraging investments and facilitating long-term planning.

[3] European Parliament (2024), Fit for 55 Package, EPRS_BRI(2022)733513_EN.pdf (europa.eu).

Legislation promoting district heating and cooling	Making easier and more cost-effective to implement district heating and cooling systems on a large scale.
Increased awareness and acceptance of geothermal energy	Alleviating concerns regarding geoHC systems feasibility and performance, leading to greater acceptance among consumers, businesses, and policymakers.

Table 2: Supportive factors for geoHC networks in Europe (2023).

3.2. EU and national strategies

In the last decades, the European Union and national governments have established various strategies and policies to promote the use of renewable energy sources, including geothermal energy, as part of their broader efforts to address climate change and enhance energy security. As already mentioned, the European Green Deal involves reviewing existing legislation [4] and introducing new initiatives to foster a circular economy in Europe. Additional measures focusing on saving energy, producing clean energy, and diversifying energy supplies will be further integrated into the ongoing revisions of existing legislation by the REPowerEU plan in May 2022.

The revised Renewable Energy Directive (RED III) places substantial attention on the heating and cooling provision of renewable energy sources, and promotes DHC networks in the support of those. Article 23 of RED III targets to induce an obligatory growth of renewable energy share for heating and cooling sector of 0.8% annually until 2026 and then 1.1% for the period of 2026 to 2030. This directive also stresses territorial planning, risk mitigation policies and measures, and heat and/or cold purchase agreements.

[4] Renewable Energy Directive (RED), the Energy Efficiency Directive (EED), and the Energy Performance of Buildings Directive (EPBD), collectively known as the "Fit for 55" package.

According to the Regulation of the European Union governance and planning climate action, the EU member states shall create National Energy and Climate Plan (NECP). These plans describe how each country will address the five dimensions of the Energy Union: decarbonisation, energy efficiency, energy security, internal energy market, research, innovation and competitiveness. The NECPs are essential for the achievement of the EU-level objectives through the national channels and for the appropriate and effective measures in support of renewable energy technologies, and particularly geoHC networks.

Within the supportive EU framework, however, great obstacles still exist at the national level. These comprise long and cumbersome administrative processes, regulatory voids such as the absence of a dedicated licensing regime for deep geothermal projects, and poor monetary rewards.

3.3. Regulations for better market conditions

Regulations for better market conditions for geoHC networks involve several key aspects that can be optimised to facilitate the growth of geoHC technologies. It is imperative to make licensing and permitting processes in the EU more efficient, as well as guaranteeing accessibility to geological data. Project development can be expedited by cutting down the number of licences and regulatory authorities who shall be involved in the processes.

The fact that there is no directed legislation concerning geothermal energy results in regulatory ambiguity. Such frameworks have to be developed on the level of the member states as well as the level of the EU, by putting in place a separate licensing regime for deep geothermal projects and ensuring that the right to exploit geothermal energy is governed in a clear and efficient manner. Effective policies for geothermal projects should therefore encompass subsidies, grants, low-interest loans, and tax incentives specifically for geothermal projects. Implementing risk mitigation schemes and heat purchase agreements can also attract more investments by reducing financial risks.

It is also necessary to develop a fair market which does not limit itself to traditional players and can accommodate newcomers from different sources of energy. By revising the current market regulations to limit long-term gas contracts it would be possible to create a more level playing field for the sector.

The new EU legislative framework on climate and energy policies provides a supportive environment for renewable energy. Ensuring its implementation among Member States is functional for a broader adoption of geoHC technologies.

Finally, developing technical standards and building capacity within the industry, including training qualified professionals at national, regional, and local levels, is crucial to ensure key players are able to handle the complexities of geothermal projects and harmonise terminology and standards across the EU.

3.4. Licensing and acceleration areas

Licensing for geoHC systems is a critical aspect of the regulatory framework that can significantly impact the speed and efficiency of project deployment. As already mentioned (see 3.1.1), by reducing the number of regulatory agencies concerned, streamlining administrative processes and providing permit time limits would increase the efficiency of licensing procedure and therefore reduce delays and lower costs.

One way is to create special laws concerning the development of geothermal energy and mineral resources that define the rights and duties during the exploration and exploitation of geothermal resources. Such measures would be very important in enhancing their assurance to investors. The identification of acceleration areas would be beneficial for ensuring more efficient targeting of resources and efforts.

Key strategies for identifying and leveraging acceleration areas	
Priority zones for development	Designating specific geographical areas as priority zones for geothermal development can streamline regulatory processes and concentrate resources. These zones can be selected based on factors such as geothermal potential, existing infrastructure, and market demand.
Simplified procedures in acceleration areas	For these designated acceleration areas, regulatory procedures should be further simplified to encourage rapid development (e.g., expedited permitting processes, reduced fees, and enhanced support for project developers).
Pilot projects and demonstration sites	Establishing pilot projects and demonstration sites within acceleration areas can showcase the viability and benefits of geoHC technologies.
Integration with urban planning	Integrating geoHC development with urban planning initiatives can enhance the effectiveness of acceleration areas. This integrated approach can facilitate the deployment of geoHC technologies in both new developments and retrofitting existing structures.
Incentive programs and financial support	Providing targeted financial incentives and support programs (e.g., grants, subsidies, low-interest loans, and tax incentives) in acceleration areas can further stimulate geoHC adoption.

Table 3: Key strategies for identifying and leveraging acceleration areas (2024)

3.5. Taxation

Taxation policies play a crucial role in shaping the market conditions and economic viability of geoHC systems. The Status quo report on regulatory and policy framework in the context of geoHC (Deliverable 5.1) already addressed the role and the impact of different tax instruments in the development of geoHC networks. The table below summarises and updates the key findings extracted from the previous analysis, differentiating between tax incentives and credits, VAT reductions, property tax incentives, and carbon tax and emissions trading.

Tool	Impact
Tax incentives and credits (e.g., investment tax credits (ITCs), production tax credits (PTCs), and accelerated depreciation.	Tax incentives and credits are essential tools used by governments to encourage investment in renewable energy projects, including geoHC. Investment tax credits allow investors to deduct a certain percentage of their investment in geoHC systems from their tax liability, reducing the upfront cost and financial risk associated with such projects, and making them more appealing to potential investors. Production tax credits provide financial benefits based on the amount of renewable energy produced and supplied to the grid. By rewarding actual production, these credits incentivise the efficient operation and maintenance of geoHC systems. Accelerated depreciation permits faster write-offs of capital investments in geoHC technologies, improving cash flow and reducing taxable income in the early years of a project. This can be particularly advantageous for businesses with high initial capital expenditure.
VAT reductions and exemptions	Value-added tax (VAT) reductions and exemptions on geoHC equipment and services can lower the overall cost

	of installation and maintenance by reducing the tax burden on these systems.
Property tax incentives	Local governments may offer property tax exemptions or reductions for properties that install and use renewable energy systems. These incentives lower the ongoing operational costs for property owners, providing long-term financial benefits and promoting the integration of geoHC in residential and commercial buildings.
Carbon tax and emissions trading	Implementing a carbon tax or participating in emissions trading schemes can indirectly benefit geoHC systems by making fossil fuel-based heating and cooling more expensive, thereby increasing their cost and encouraging the shift to cleaner energy sources like geoHC.

Table 4: **Taxation tools and their impact on geoHC networks (2024).**

Many of the EU Member States have already gone ahead to introduce tax policies for geoHC and other sustainable energy technologies. For example, in Germany, the Renewable Energy Sources Act (EEG) provides tax incentives and subsidies for renewable energy projects, including geothermal energy. In France, specific tax credits (e.g., Crédit d'impôt transition énergétique – CITE) are available for renewable energy installations under the Energy Transition for Green Growth Act [5]. In the Netherlands, the Energy Investment Allowance (EIA) offers tax deductions for investments in energy-efficient technologies, including geoHC systems [6], enabling businesses to offset a significant

[5] Ministry of Environment, energy and the sea (2016), Energy transition for green growth act, Energy Transition for Green Growth Act in action - Regions, citizens, business (32 pages - juillet 2016 - Versions anglaise).pdf (ecologie.gouv.fr).

[6] Netherlands Enterprise Agency, RVO, Energy Investment Allowance (EIA), Energy Investment Allowance (EIA) | Business.gov.nl.

portion of their investment from their taxable profits, and hence reducing the overall tax burden.

3.6. Financing opportunities from the EU

In general, in the European Union, grants do not cover the entirety of the funding needs of a project and other sources of capital would often be needed for 50% of the total investment costs. However, grants are usually designed to decrease the cost of capital – which increases with the risk. This is intrinsically the case when part of the project is funded for “free”. The fact that grants can come in at the early stages of the project to provide funding for project development (ELENA, EHIA., etc.) or for high-risk stages of the project (such as drilling an exploratory well for a geothermal project) can provide benefits in terms of cost of capital that far outweigh the actual size of the grant.

The EU, in the name of more efficient use of public funding, is increasingly developing financial instruments that use grants as a risk mitigation tool, developing repayable or convertible grants, or funding crucial parts of projects. The structure of the Innovation Fund, which replaces the NER300 in directing ETS funds to innovative renewable energy projects, reflects this trend, with the possibility to have part of the support validated (i.e. the grant does not have to be repaid) through milestones and not only in terms of performance of the project [7].

[7] European Commission (2004): Financial instruments and models for heating and cooling, Financial instruments and models for energy production - Publications Office of the EU (europa.eu).

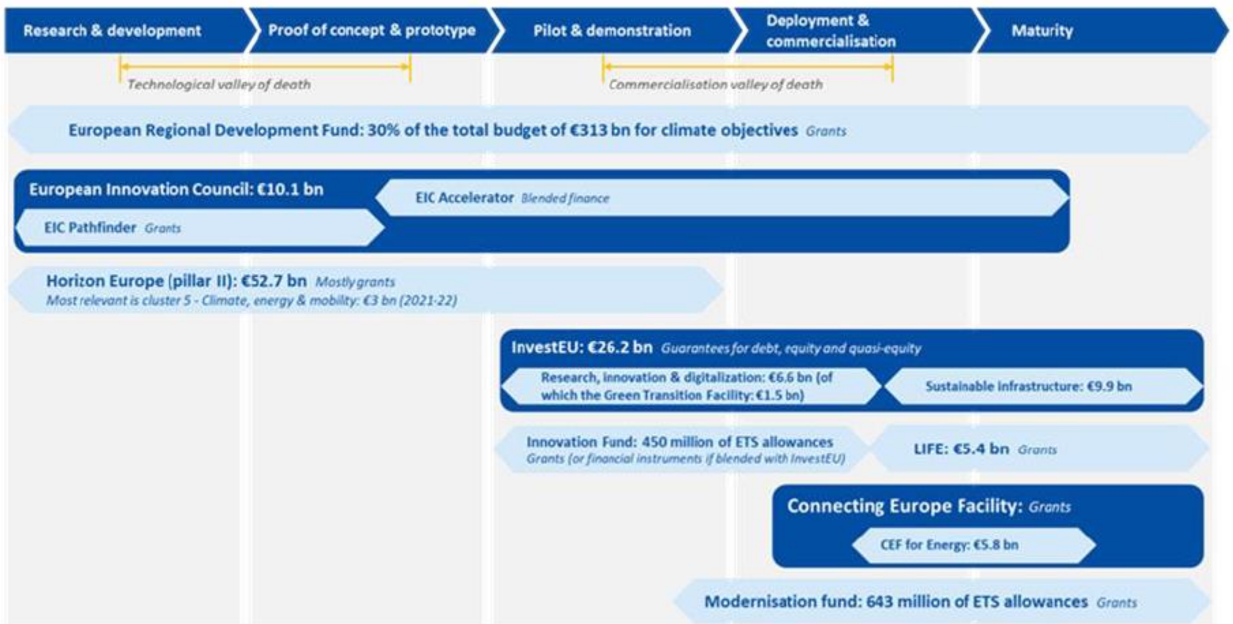

Figure 1: overview of EU financing programmes according to their targeted TRL levels (2004). Source: European Commission

3.6.1. The European Investment Bank's (EIB) main funding opportunities

The European Investment Bank (EIB) is the European Union's bank [8]. Operating as the biggest multilateral financial institution in the world and one of the largest providers of climate finance, the EIB can intervene to support projects through different channels such as:

- **Loans:** recipients range from large corporations to municipalities and small and medium-sized enterprises;
- **Technical assistance:** which is provided by a team of experts (economists, engineers and sectoral specialists) to complement its financing facilities;
- **Guarantees:** covering risks of a single or several projects. These unlock additional financing for small- and medium-sized enterprises or mid-caps by covering a

[8] European Investment Bank, Energy, https://www.eib.org/en/projects/topics/energy-natural-resources/energy/index.

portion of possible losses from a portfolio of loans. In some cases, the Bank also guarantees possible losses from a project to unlock additional investments;

- **Equity:** primarily investing or co-investing along with funds focused on infrastructure, the environment, or small- and medium-sized enterprises and mid-size corporations. In some cases, the Bank also provides direct quasi-equity financing to support innovative companies in seek of financing to grow.

In line with the EU's energy policy, the EIB financed energy infrastructure with some €60 billion between 2016 and 2020. This included over €53 billion for renewable energy, energy efficiency and electricity grid projects in Europe and around the world.

In November 2019, the EIB adopted a new ambitious energy lending policy. Importantly, the Bank has decided to phase out the financing of traditional fossil fuel energy projects, including natural gas, since the end of 2021.

Geothermal energy is among the energy sources targeted by the Bank for its renewable energy investments, notably for the heating and cooling sector. In the framework of this new policy, it is possible to finance:

1. Deep-seated geothermal energy contributing to the EU policy objectives.
2. Smaller projects served through project aggregation through an intermediary. A distinction is made between (i) Mature and (ii) Research, Development and Innovation projects.

Currently, the EIB does not fund projects in the early stages, but only projects that have proven their economic viability (i.e., exploitation phase).

EIB financing: the Dutch example

HVC Groep, a sustainable energy and waste company in The Netherlands, has signed a 15-year €50 million loan agreement with the European Investment Bank. The EIB financing is supported under the European Fund for Strategic Investments (EFSI) of the Investment Plan for Europe. HVC will use the loan for its investment plans in the period 2020-2024, which will cover both the expansion of its existing district heating networks in Alkmaar and Dordrecht and investments in geothermal sources for the heating of greenhouses in the Westland area.

Lending represents 90% of the financial commitment of the Bank, which uses several channels to provide financing:

- **Project loans:** these are the main vehicle for EIB financing. It is a direct lending to an entity (company, public authority, etc.) for large single projects. The Bank typically provides loans for a minimum of €25 million, which usually covers no more than 50% of the total investment cost of the project. They are generally awarded in sectors of key importance with impacts on the economy, notably infrastructure investments (transports, energy, water etc.);
- **Intermediate loans:** this type of loan is made through a local bank to which the EIB issues a loan to finance smaller-scale projects on which the local financial institution can more easily gather information and propose adapted vehicles. They notably allow the EIB to reach SMEs, midcaps or local authorities.
- **Venture capital**: through the European Investment Fund, the EIB intervenes in the venture capital market to provide financing to start-ups, high-tech businesses and other innovative SMEs.
- **Equity:** the Bank also intervenes through equity, notably taking part in funds promoting EU policy priorities – on infrastructure & environment or on carbon, for instance.

The Bank allocates funding in line with its Corporate Operational Plan, which assesses projects on the basis of "Soundness" (its economic and environmental quality), "Relevance" (contribution to EU policy priorities) and "EIB Contribution" (what is needed of the EIB). This means that: "The Bank's borrowers must be capable of repaying the loan and must provide adequate financial security" and "Projects must comply with the Bank's other policies, particularly on procurement, Environmental and Social Principles and Standards and anti-fraud". The Greenhouse gas impact of the projects is also accounted for. Where needed, environmental impact assessments may be required by the EIB.

Following the adoption of the Sustainable Finance Taxonomy, the EIB Energy Lending policy will likely be amended to reflect these requirements, which may lead to additional reporting requirements for geothermal projects depending on implementation.

3.6.2. Towards different uses of grant-based financing

Grant-based financing is a stable form of public support for renewable energy projects, notably when it comes to the support of innovative technologies, demonstration projects or high-risk ones. The grant, usually a fixed amount of money awarded by a public authority to a project, may cover a large share of the total costs or be a marginal part of the financing scheme. Different types of grant financing usually serve different purposes:

- **Non-repayable grants** happens when a grant is provided to a project in order to finance it. The money awarded is given to the project operator without financial conditionality (such as equity or reimbursement), but some conditions may be set to ensure the money is properly used. It is a form of financing particularly suited for very innovative projects (typically Horizon Europe in the EU), or for projects carried by public authorities themselves (e.g., ESIF). Examples of projects that benefited from ERDF grants include the United Downs project in Cornwall in the UK – first geothermal electricity project in the country, and the city of Schwerin in Germany. The Heat Fund in France is a major and successful example of a large-scale facility providing grants to geothermal energy projects (usually at a larger scale) in order to correct the market imbalances due to the dominant position of gas or nuclear energy in the heat market.

- **Repayable grant**: a repayable grant is typically a grant that has to be repaid if certain conditions are met. In some cases, the grant may have to be repaid if the project is not successful, which is notably the case for grant financing awarded as part of the NER300. In others, the grant would only be repaid if the project is successful, which is quite a suitable scheme to reduce investment risk and helps in the early stage of marketability.
- **Convertible grants** are a more innovative type of financial instrument that is designed to ease the market development of innovative technologies. The funding, awarded as a grant, can be converted into another type of financing (equity, debt, etc.) once the project attains a certain degree of success (this may be the successful completion of the drilling phase for a geothermal project, for instance).

4. Recommendations on regulatory aspects

4.1. Simplifying administrative procedures for permitting

Within the current framework, at least 606 GW of geothermal heat pumps, heat networks and district heating systems are required to meet the EU's -55% greenhouse gas emission reduction target. This equates to about 4-8 thousand direct geothermal district heating and cooling systems or heat networks. While Article 16 of the Renewable Energy Directive requires Member States to permit new renewable energy installations within three years, the Governance Regulation requires Member States to outline concrete measures they will take to ease permitting. Currently, Portugal, France, Denmark and Spain are the only

Member States to have identified measures to simplify permitting in their National Energy and Climate Plans.

The lack of harmonised guidance on licensing and permitting is a significant barrier to this deployment and could jeopardise the achievement of the renewable energy, energy efficiency and climate targets. The following factors contribute to delays:

- Complexity: Geothermal applications are engineered rather than manufactured and, therefore, require an understanding of current technologies. They need as well tools to measure environmental impacts as well as positive by-products (e.g., in the case of the sustainable extraction of lithium).
- Capacity: Skillsets required for geological assessment are often underutilised, or there is a lack of qualified professionals to undertake the necessary checks and approvals. This is compounded by a lack of harmonised terminology, sometimes within a Member State and across the internal market. These factors create avoidable administrative delays and bottlenecks.
- Engagement: There is a lack of consistency and clarity in the formation required from project developers, which causes delays. Furthermore, transparent and time-sensitive processes are required to manage potential legal challenges and subsequent mediation in an application.

Large-scale geothermal projects require uniform assessment. To ensure consistency across the internal market while helping to manage total project costs, guidelines for streamlining the permitting process should include the information outlined below.

(a) Development Plan, including:

(i) a technical report assessing the expected geothermal potential to be deployed in the area of the Geothermal License on the basis of the existing data (e.g., geological, geochemical and geophysical data, well data);

(ii) an overall development scenario based on a "decision tree" envisaging for each expected project: location, technical characteristics (e.g., number and depth of the wells, type and power capacity of the plant).

(b) Economic valuation of the overall project, including decommissioning.

(c) Strategic environmental impact assessment including:

(i) evaluation of any possible effect related to the execution of the activities included in the development plan on the atmosphere, the water environment, the soil and subsoil, the vegetation, flora and fauna, ecosystems, public health, noise and vibrations, radiation, landscape and material goods and related monitoring and mitigation measures;

(ii) description of the measures envisaged to avoid, reduce and possibly compensate for the adverse effect;

(iii) assessment of the development plan alternatives, including the so-called zero option, with the indication of the main reasons for the choice in terms of environmental impact;

(iv) background of the information and data used to evaluate the main impacts on the environment and on cultural heritage that the development plant can produce, both in the construction phase and in the operation exercise phase;

(v) a description of the measures envisaged for environmental monitoring.

(d) Technical and financial capability including:

(i) description of the experience in the geothermal sector;

(ii) skills and expertise of the project development team;

(iii) financial statements;

(iv) availability to submit a bank or insurance guaranty that covers the value of the submitted development plan.

EU guidelines should refer to licensing and permitting authorities to utilise the ‘simplified’ life-cycle assessment tool for which training material has been developed. This helps to build technical expertise for assessors as well as ensure consistency in their decision-making process.

A “one-stop-shop” or single administrative contact point is necessary for developers. To be effective, the European Commission must provide guidance on their requirements to ensure efficient, effective and consistent engagement with geothermal project developers.

Specifically, ‘one-stop shops’ must:

- Ensure that the data required from project developers meets the requirements of all the various ministries involved with permitting geothermal capacity. In this regard, EU’s guidelines must harmonise all relevant terminology, the stages of the approval process, and associated timelines and provide unambiguous indications of the information required.
- Provide precise information to project developers so that all the information required is provided at the outset for all stages of the project.
- Ensure, with the guidance from the European Commission, that all Member States provide simplified procedures for licensing and permitting.

This single contact point must centralise all permitting procedures required for effective and efficient engagement with a geothermal project developer. Geothermal projects sometimes require indeed input from different national or regional authorities within a Member State because they navigate through mining law, water, energy and mineral resource extraction. This result in a complex regulatory framework representing a barrier for businesses.

The purpose of the single point of access is to reduce project development costs by:

- Avoiding duplication of administrative work for multiple administrations
- Reducing the possibility of delay.

The guidance on permitting and licensing should include the following:

- The 'simplified' life-cycle assessment tool as developed by the European geothermal industry in collaboration with regional environmental assessment agencies.
- Traffic light system where local authorities indicate geographical areas where i) no drilling is permitted, ii) where drilling is permitted subject to approval, and iii) where drilling is permitted without the need for permits. Geological surveys or energy agencies are ideally suited to provide the core data to deliver this requirement.
- Relevant terminology identified in the guidelines to ensure consistency across the internal market.
- Transparent process established to manage civil disputes and mediation over licenses.
- Access to unused licenses. In some instances, developers are awarded licenses but do not develop projects. A cut-off date should thus be introduced. If no activity is recorded on the site of the permit, it should be made available to other entities to produce geothermal activities.
- Fast permitting for geothermal projects involving lithium extraction. Given its strategic economic importance, permits for geothermal lithium extraction from existing capacity must be processed within 3 months. New geothermal and lithium extraction capacity should be permitted within 6 months.

4.2. Implementing supportive legislation on the financing framework

"The right scheme for the right market maturity". This could be the maxim for financing geothermal energy projects as the geothermal sector is far from being uniform in terms of maturity and technology readiness across geographical, technology lines and uses.

As the figure below illustrates, to incentivise the scalability of geothermal technologies the exposure to market conditions should not anticipate their market maturity, but rather accompany the technologies towards this goal. Suitable support schemes and financial instruments allow for the cost reductions necessary for a technology to reach the market and for the consolidation of an emerging renewable industry in a market that remains very favourable to incumbent fossil technologies.

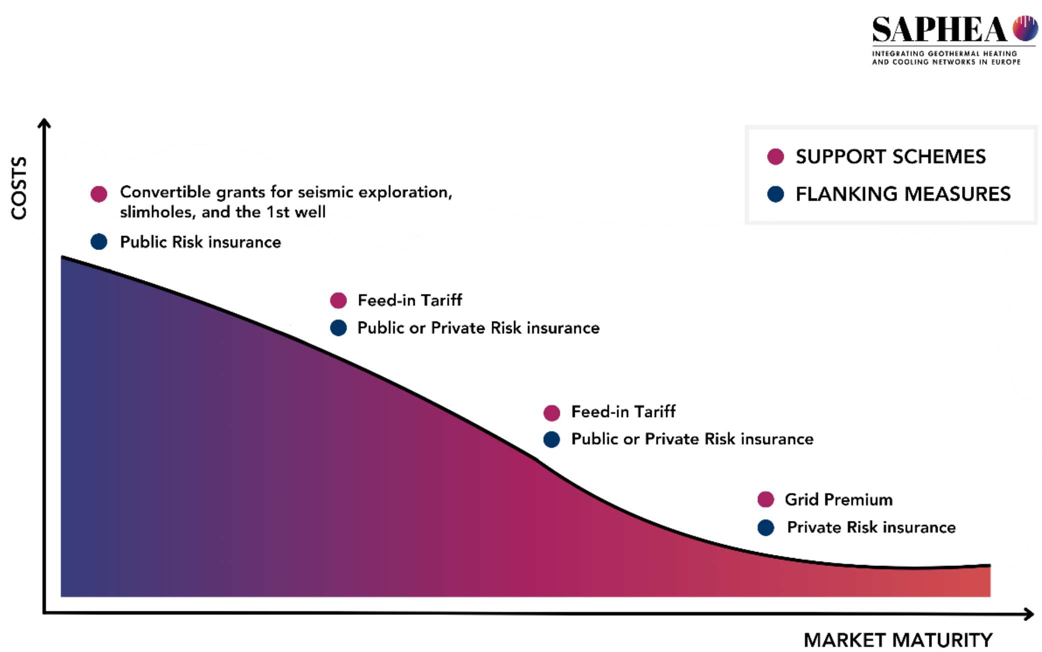

Figure 2: Support schemes for Geothermal adapted to technology maturity (2023). Source: EGEC

The financial and regulatory framework for geothermal energy must articulate four priorities:

- Setting a comprehensive national policy strategy for the development of geothermal energy;
- Mitigating the geological risk to facilitate project development;
- Providing incentives for project developers, in particular, to facilitate innovation;
- Enabling private investors through the right business models and financing schemes.

4.2.1. Overview of the different project phases

Different DHC project phases mean that different financing tools are needed, as summarised here:

- **feasibility and exploration**: the exploration phase can deal with various private (insurance, guarantee schemes) and public tools (risk mitigation schemes). In general, national exploration support campaigns are a valid instrument to facilitate the feasibility phase.
- **drilling**: this represents over 50% of the total cost of a project. By leveraging experience from oil and gas as well as laboratory research and industry and academic expertise, the actual challenge is to dramatically reduce drilling costs and help make geothermal cost competitive with other energy sources.
- **surface equipment and plants**: the investment costs for the surface part of a geothermal project include the costs of the geothermal fluid supply system and the costs of the plant unit. The investments for the geothermal fluid supply system contain the costs for the equipment such as pumps, pipes, valves, separators (where it applies) and filters. The costs depend on the flow rate of the geothermal fluid, as well as the temperature and pressure in the gathering system. Further parameters affecting cost are chemical compositions, gas content

and topography of the steam field. The investment for a plant generally depends on the installed capacity. The specific investments decrease with a larger capacity. The main items are the turbine and generator unit, the heat exchangers and the cooling unit.

- **grid infrastructure**: public funds can often be granted for the construction of new grids or the decarbonisation of existing grids.
- **operation and maintenance**: the operation and maintenance phase is mainly linked to how to deal with the energy produced consumer side. Various incentives, contracts and feed-in premiums can represent valuable solutions to invest during that phase.

4.2.2. The central role of geothermal derisking

Exploration is necessary to identify potential geothermal resources. However, beyond exploration, the bankability of a geothermal project is threatened by geological risk:

- The short-term risk of not finding an economically sustainable geothermal resource after drilling.
- The long-term risk of the geothermal resource naturally depleting, rendering its exploitation economically unprofitable.

Mitigating this risk is crucial for the profitability of a geothermal project (see Chapter 3). De-risking can be done at the technical level (e.g., improved exploration techniques) but also through non-technical measures (e.g., sharing geological data from existing projects). A widely proven solution to facilitate market uptake of geothermal energy against this challenge, however, is the establishment of geothermal derisking schemes.

Geothermal projects are very capital-intensive and require a significant share of the investment to be invested before the exact parameters of the resource are known. In the case of projects requiring stimulation or reservoir engineering, there is significant uncertainty on the potential capacity and output of the project until this task has been successfully completed. This means that between 25% and 50% of a geothermal project cost must be invested when there is a very high level of uncertainty about the success of the development. The consequences of such uncertainty often are higher capital costs (i.e. higher interest rates) or incapacity to access private financing.

Considering the large upfront investment necessary to launch a geothermal project, the cost of capital is a key factor in the final price of geothermal heating and cooling or geothermal electricity. Risk mitigation schemes are therefore required to support the development of geothermal energy technologies and market development. Derisking projects lowers the cost of capital for project developers and provides more cost-effective renewable energy for consumers. Annex II of the report on the Competitiveness of the Development of business model blueprints for geoHC networks provides an overview of de-risking instruments and their different applications.

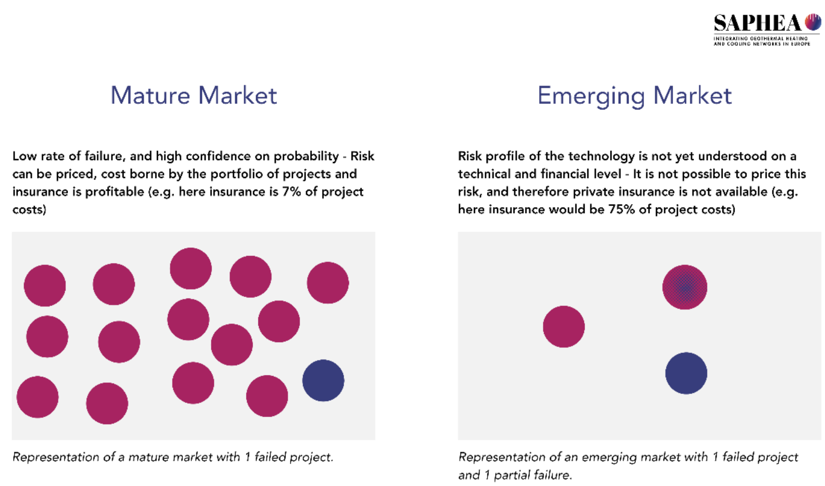

Figure 3: Representation of mature and emerging markets (2023). Source: EGEC

Examples of national risk mitigation schemes

The French case

Since the 1980s, the SAF Environment Fund has covered both the short-term risk (insufficient geothermal resources) and the long-term risk (reduced exploitability of the geothermal resource) for projects aimed at producing heat in the Paris region. It was based on one principle: successes pay for failures, and thanks to the very low rate of failure in well-resourced regions (like the Paris basin), wells entailing higher risks can be drilled in regions where little exploration has been conducted. For short-term risk the premium payment is 1,5 % of the covered cost, while for long-term risk an initial payment of 3.2% of insured costs is required. The current reform will allow to cover the geological risks all over France [9].

The Dutch case

The Dutch government provides a guarantee scheme (RNES Aardwarmte), under which investors are protected against the financial risks of potential unsuccessful drilling. It requires a premium payment equal to 7% of the maximum subsidy amount, with separate maximum amounts applying to regular and ultradeep geothermal energy projects [10].

[9] Ademe, Géothermie sous les pavés la solution, https://fondschaleur.ademe.fr/geothermie/.
[10] https://www.rvo.nl/subsidies-financiering/rnes.

5. Recommendations on participative and social perception aspects

5.1. Conducting awareness and educational campaigns

The perception of the public constitutes one of the potential reinforcement factors for geoHC network development, considering the fact that it affects the networks' acceptability and success. Thus, project developers will have to regard information and explanatory as well as persuasion strategies, and open interaction as important in the way of developing geoDHC networks. In order to raise the population's awareness and acceptance, developers need to apply simple, evidence-based, and strategically correct information. Appropriate communication of uncertainties and risks in addition to risk management options presented in an open and honest manner may build confidence.

Encouraging local people's participation in decision-making can be effective in creating acceptance and enjoyment in the community. Procedural justice, which has several key components that include a process that encourages participation, inclusion and equity among all the concerned stakeholders is very important.

Tailor-made communications do require getting to know who the audiences are, their cultural values, beliefs, and political philosophies.

Best practices: Germany, Denmark, and Sweden

Germany has successfully implemented community engagement strategies in various renewable energy projects, including geoDHC. By conducting comprehensive public consultations and involving local stakeholders in the planning and decision-making processes, Germany has been able to build trust and support for these projects. The country has also focused on transparent communication, providing clear information about the benefits and risks of geoDHC systems.

Denmark is renowned for its strong community involvement in renewable energy projects. The Danish approach emphasises procedural justice, ensuring that local communities are actively engaged in every stage of the project. By addressing public concerns transparently and incorporating community feedback into project plans, Denmark has fostered a high level of public acceptance and support for geoDHC networks.

Finally, Sweden has effectively used educational campaigns to increase public awareness and acceptance of geoDHC systems. The country has conducted extensive outreach efforts, including public information sessions, educational materials distribution, and collaboration with local media. These efforts have helped to inform the public about the benefits and impacts of geoDHC, building a positive perception and encouraging adoption.

5.2. Engaging with local communities

The Status report on the socio-environmental conditions for the implementation of geoDHC networks in Europe (D5.2) investigated the importance of engaging local communities as an element for the successful development of geoDHC projects.

Studies report that early engagement with the public allows for a better understanding of community concerns and provides an opportunity to incorporate feedback into the project planning stages. This proactive approach not only mitigates potential conflicts but also fosters trust and cooperation between the project developers and the community. Additionally, transparent communication through public meetings, social media platforms, newsletters and local media outlets, ensures that all stakeholders are well-informed and that misinformation is countered with factual and understandable information.

To build public support for geoHC systems, it is also important to implement comprehensive education and awareness programs. By providing the community with accurate and relevant information, these programs help build trust and overcome resistance coming from misinformation. Ideally, as in the case of energy communities, members from the local community should be actively involved in the decision-making process of geoHC projects, through, for example, the creation of platforms for collecting community inputs.

Best practices: Germany, Denmark, France and Sweden

Germany has been a leader in promoting citizen energy communities, particularly through initiatives that involve local populations in renewable energy projects. In the city of Munich, the municipal utility company, Stadtwerke München, launched a project to expand geothermal district heating. They engaged local communities by offering citizens the opportunity to invest in renewable energy shares. This not only raised capital but also increased public support and awareness about the benefits of geothermal energy.

The Danish model involves local residents as co-owners of energy projects. For instance, in the city of Thisted, a geothermal plant is partly owned by local cooperatives. This model ensures that the benefits of the energy produced are shared with the local community, fostering a sense of ownership and responsibility. Such cooperative models have proven effective in gaining public support and facilitating the integration of geoDHC systems into the local energy mix.

In France, local stakeholder engagement has been a key factor in the successful deployment of geoDHC systems. The city of Paris has implemented geothermal heating projects by actively involving local stakeholders, including residents, local authorities, and businesses, in the planning and development phases. Public consultations and informational meetings have been held to educate the community about the benefits and operation of geothermal systems. This transparent approach has helped to address concerns and build trust among the local population, resulting in higher acceptance and smoother project implementation.

Sweden's approach to geoDHC involves community-based energy solutions where local governments play a crucial role in project development. In cities like Malmö, the local government has partnered with private companies and research institutions to develop and expand geothermal district heating. They have engaged the local community through educational campaigns, workshops, and pilot projects that demonstrate the technology's effectiveness and environmental benefits.

5.3. Encouraging local heating and cooling plans

5.3.1. Legal obligation to develop local heat and cooling planning

The 2023 recast EU Energy Efficiency Directive[11] requires Member states to ensure that municipalities with more than 45,000 inhabitants prepare local heating and cooling plans. This obligation can become a game changer in decarbonising heating and cooling in large cities. However, in many cases, it might be highly relevant to engage even smaller municipalities, as all together they can create a strong network of resources, capacities, and knowledge. Some countries or regions have already taken this step to oblige smaller entities to develop heating and cooling plans. A network of municipalities would be able to exchange practices, share energy infrastructure, complement each other regarding

[11] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023L1791.

demand and supply, and exchange expertise and knowledge. On top of that, local heating and cooling plans may be carried out jointly by a group of several neighbouring local authorities provided that the geographical and administrative context, as well as the heating and cooling infrastructure, is appropriate. Coordinating efforts between municipalities, looking at common grounds, and shared resources is also key for efficient mobilisation of the resources and for an adequate supply.

A number of municipalities and other public bodies have already put into place integrated approaches to energy saving and energy supply, tackling spatial planning, all energy vectors, several sectors such as mobility, considering linkages to non-energy infrastructure, etc. Although an integrated approach seems essential for a coherent path towards a fully decarbonised economy, it also appears clearly that this might complexify rather than ease the process. Therefore, at the local level, focusing on a very specific sector like heating and cooling to plan and decarbonise has to be ensured.

To implement the directive and provide the local authorities with all signs to move ahead, a legally binding obligation to develop their heating and cooling plan should be considered a key success factor. It is assumed that such obligation should come from above governance levels (district, regional or national). The obligation should focus first on the municipalities above 45,000 inhabitants but should ideally consider an expansion of the scope to engage smaller entities.

The example of inter-municipal heat planning in the Lörrach District (DE)

An inter-municipal heat planning in the Lörrach District[12] (Germany, Bade-Wurtemberg) was launched in January 2021. The project was initiated and managed by the Lörrach District and was proactively supported by the state of Baden-Württemberg. The aim was to engage the 35 municipalities in the development of a roadmap towards a climate-neutral district in the heat sector by

[12] Landkreis Lorrach, Wärmewende im Landkreis Lörrach, https://www.loerrach-landkreis.de/Klimaschutz/Waermewende.

the year 2050. Obliging the municipalities by law was a key factor to successfully get their commitment, and then to engage the required efforts.
In Germany, some state's laws already oblige communities with a certain number of inhabitants to implement binding heat planning (e.g. Baden-Württemberg Climate Protection Act, Schleswig-Holstein Energy Transition and Climate Protection Act). At the federal level and in other federal states, a legal regulation did enter into force recently on 1.1.2024 (Wärmeplanungsgesetz, WPG[13]), providing for mandatory municipal heat planning for communities with more than 10,000 inhabitants (<2024). In Bavaria, the Energy Utilisation Plan[14] (ENP) supports transparently the Climate Protection Act as well as requirements from the decision of the Federal Constitutional Court and the subsequent amendment to the Federal Climate Protection Act. The creation of an ENP as well as the transformation or implementation of measures in the area of heat supply can therefore be viewed as a prerequisite for public services. Heat planning is therefore a central task for the municipality, some of which will be required by law.

5.3.2. Legal framework providing a strong mandate to local authorities to enforce local heating and cooling plans

To ensure that local governments can implement and enforce their local heating and cooling plans (LHCPs), they should be provided with the appropriate legal mandate to coordinate the phasing out of certain energy sources and technologies with the arrival of the new ones provided for in the plans. Different measures could be considered:

[13] Ein Service des Bundesministeriums der Justiz sowie des Bundesamts für Justiz (2023), Gesetz für die Wärmeplanung und zur Dekarbonisierung der Wärmenetze (Wärmeplanungsgesetz - WPG), https://www.gesetze-im-internet.de/wpg/WPG.pdf .

[14] Energy-Atlas Bayer, Energienutzungsplan, https://www.energieatlas.bayern.de/kommunen/energienutzungsplan.

- Local heating and cooling plans can be binding for Distribution Systems Operators (DSOs) and local energy and heating companies which must align their own development plans with the plan developed by the local government.
- Local authorities can ban certain energy sources or technologies with a zone or district approach by a certain date while at the same time guaranteeing an alternative solution for that district/area. This perspective avoids unnecessary investment for consumers and distribution companies.
- Local authorities can require a building to be connected to the district heating grid by a certain date and oblige the heat network management company to deliver heat to these areas.

6. Recommendations on sustainability aspects

6.1. Promoting environmental LCA approach and developing social LCA

The Life Cycle Assessment (LCA) is an evaluation method that examines the potential adverse effects that a product, process, or system has on the environment, through all of its stages from raw material extraction to disposal or recycling. Through the integration of the social dimension, the Social Life Cycle Assessment (S-LCA) will play an increasingly important role in the evaluation of the feasibility of geoHC projects. S-LCA offers indeed a methodical representation of the social implications of geoHC initiatives at every stage, including its planning, development, functioning and even decommissioning.

1. Integrating social impact assessment	Developing a comprehensive S-LCA for geoHC projects involves systematically evaluating the social impacts associated with all stages of the project.
2. Stakeholder engagement	Engaging a wide range of stakeholders in the S-LCA process to ensure diverse perspectives and concerns are considered.
3. Identifying relevant social indicators	Identifying and using relevant social indicators that reflect the specific social context and concerns associated with geoHC projects (e.g., labour rights, health and safety, community well-being, access to resources, and fair distribution of benefits).
4.Data collection and analysis	Collecting and analysing qualitative and quantitative data related to the identified social indicators by conducting surveys, interviews, focus groups, and using secondary data sources.
5. Continuous monitoring and reporting	Implementing continuous monitoring and reporting mechanisms to track the social impacts of the geoHC project over time. Transparent reporting can indeed help build trust and accountability with stakeholders.
6.Addressing social risks and opportunities	Identifying and addressing social risks and opportunities throughout the project lifecycle by, for example, improving working conditions, ensuring fair wages, enhancing community benefits, and promoting social equity.
7.Integrating S-LCA with environmental and economic assessments	Integrating the S-LCA with environmental and economic life cycle assessments to provide a holistic view of the project's sustainability and, therefore, understanding trade-offs and synergies between different sustainability dimensions.

Best practices: Denmark and Sweden

In Sweden, the integration of social considerations into geoDHC projects has been exemplified by extensive stakeholder engagement and transparent reporting. The Swedish Energy Agency has facilitated workshops and public consultations to gather input from local communities and other stakeholders. This approach has helped identify and address social impacts, ensuring that the benefits of geoDHC projects are shared equitably and that any negative effects are mitigated.

With a focus on labour rights and community well-being, Denmark has effectively used S-LCA in geoHC system development. The Danish Energy Agency has indeed developed guidelines for assessing social impacts while encouraging the use of social indicators in project planning and implementation. This has resulted in improved working conditions, enhanced community benefits, and increased public acceptance of geoHC projects.

6.2. Towards a sustainability approach with LCA

The shift towards sustainable energy systems is very important for dealing with problems facing the environment on a global scale and providing energy security in the future. Sustainably, geoHC systems are also appealing given that they can deliver clean, renewable, and dependable energy. Nonetheless, the sustainable development of geoHC projects requires a more in-depth understanding of its environmental, social and economical aspects.

Comprehensive Life Cycle Assessment (LCA)	Adoption of a holistic LCA approach that evaluates the environmental, economic, and social impacts of geoDHC projects throughout their entire lifecycle (including the extraction of raw materials, manufacturing, installation, operation, maintenance, and end-of-life disposal). A comprehensive LCA helps in identifying critical areas where improvements can be made to enhance overall sustainability.
Integration of environmental and social indicators	Integrating both environmental (e.g., greenhouse gas emissions, energy consumption, water usage and waste generation) and social indicators (labour conditions, community health and safety, equity and stakeholder engagement) into the LCA framework.

Stakeholder engagement and transparency	Engaging stakeholders, including local communities, regulatory bodies, and industry partners, in the LCA process. Transparency in methodology, data collection, and reporting builds trust and ensures that the LCA results are credible and widely accepted.
Continuous improvement and adaptive management	Informing continuous improvement and adaptive management strategies. Adaptive management allows for timely adjustments to practices and policies to enhance sustainability performance over time.
Use of Standardised LCA methodologies	Employing standardised LCA methodologies and tools to ensure consistency and comparability of results.
Promoting innovation and best practices	Encouraging innovation and promoting best practices in geoHC projects with the broader community to promote knowledge transfer and collaborative learning.
Education and capacity building	Investing in education and capacity building to build the necessary skills and knowledge to effectively conduct and utilise LCA in decision-making.

7. Conclusions

Through a broad analysis of different aspects impacting geoHC networks in Europe, this report calls for the development of a comprehensive approach to support the growth of these systems. Clarity in the regulation and policies at both the national and EU level as well as streamlining of the permitting processes would reduce uncertainties while promoting investments in geoHC initiatives. An adequate financing framework is also crucial in making geoHC projects economically feasible, making them a competitive and viable option compared to other energy sources. From a social perspective, community engagement is a key factor in creating acceptance of geothermal energy which in turn facilitates smoother project implementation. Local communities' concerns and support for geoHC projects can be addressed by conducting education campaigns at the early stages of project development. Local governments and municipalities are also key players in district heating and cooling systems development and hence, proper planning at the local level is crucial for the successful implementation of geothermal projects. The report further recommends that local authorities should be assisted with technical and financial resources allowing them to plan and implement geoHC systems.

Lastly, regarding sustainability, the report emphasises the need for geoHC projects to conform to higher environmental objectives by adopting tools such as the life-cycle assessments (LCA) to evaluate the environmental impact of geothermal projects during all the phases of their development. The inclusion of resource depletion, emission and waste management in standardised environmental assessments would indeed support policymakers and investors make informed decisions about the environmental benefits of geothermal energy compared to other energy sources.

References

- Ademe, Géothermie sous les pavés la solution, https://fondschaleur.ademe.fr/geothermie/.
- Ademe, Réseaux de chaleur, ca met tout le monde raccord, https://fondschaleur.ademe.fr/reseau-de-chaleur/.
- Ein Service des Bundesministeriums der Justiz sowie des Bundesamts für Justiz (2023), Gesetz für die Wärmeplanung und zur Dekarbonisierung der Wärmenetze (Wärmeplanungsgesetz - WPG), https://www.gesetze-im-internet.de/wpg/WPG.pdf .
- Energy-Atlas Bayer, Energienutzungsplan, https://www.energieatlas.bayern.de/kommunen/energienutzungsplan.
- European Commission (2004): Financial instruments and models for heating and cooling, Financial instruments and models for energy production - Publications Office of the EU (europa.eu).
- European Commission (2019), The European Green Deal, resource.html (europa.eu).
- European Investment Bank, Energy, https://www.eib.org/en/projects/topics/energy-natural-resources/energy/index.
- European Parliament (2024), Fit for 55 Package, EPRS_BRI(2022)733513_EN.pdf (europa.eu).
- Geoenvi, LCA tool, https://lca.geoenvi.eu/
- IRENA and CEM (2015), Renewable Energy Auctions – A Guide to Design, Renewable Energy Auctions A Guide to Design (irena.org).

- Landkreis Lorrach, Wärmewende im Landkreis Lörrach, https://www.loerrach-landkreis.de/Klimaschutz/Waermewende.
- Ministry of Environment, energy and the sea (2016), Energy transition for green growth act, Energy Transition for Green Growth Act in action - Regions, citizens, business (32 pages - juillet 2016 - Versions anglaise).pdf (ecologie.gouv.fr).
- Netherlands Enterprise Agency, RVO, Energy Investment Allowance (EIA), Energy Investment Allowance (EIA) | Business.gov.nl.
- SAPHEA (2023), Status quo report on regulatory and policy framework in the context of geoHC networks in Europe, D5.1_Regulatory-and-policy-framework.pdf (egec.org).
- ThinkGeoenergy (2023), GEL awarded the first-ever Contracts for Difference for geothermal, https://www.thinkgeoenergy.com/gel-awarded-the-first-ever-contracts-for-difference-for-geothermal/.
- UNECE (2021), LCA electricity generation technologies, Progress meeting June 2nd, 2021 (unece.org).
- World Resources Institute (2004), Corporate Guide to Green Power Markets, Corporate Guide to Green Power Markets | World Resources Institute (wri.org).

„SAPHEA will tackle this challenge to promote more geothermal energy supply heating and cooling networks to become a key element of the green and sustainable transformation of the European energy sector.“

Gregor Götzl – main proposer