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Deliverable D7.5
Exploitation plan to increase the commercial attractiveness and the penetration of geothermal energy systems

Grant Agreement number	**792355**
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Due date of deliverable	**30/09/2023**
Lead beneficiary	**PIETRE EDIL SRL**
Other authors	**UNIPD-DII, RED, RGS, FAU, SOL, CRES, UPV**

Dissemination Level

PU	**Public**	**X**
CO	Confidential, only for members of the consortium (including the Commission Services)	
CI	Classified, as referred to in Commission Decision 2001/844/EC	

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Disclaimer

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1 Abbreviations

ASHP	Air Source Heat Pump
BER	Building Energy Rating
BHE	Borehole Heat Exchanger
CANVAS	Collection of useful data for the exploitation
Cheap-GSHPs	Cheap and Efficient Application of reliable Ground Source Heat Exchangers and Pumps
DHW	Domestic Hot Water
DSS	Decision Support System
EIA	Environmental Impact Assessment
EP	Exploitation Plan
EPBD	Energy Performance in Buildings Directive 2002/91/EC (EPBD, 2003) & subsequent amendments
GHE	Ground Heat Exchanger
GEO4CIVHIC	Most Easy, Efficient and Low Cost Geothermal Systems for Retrofitting Civil and Historical Buildings
GSHP	Ground Source Heat Pump
HP	Heat Pump
HTHP	High Temperature Heat Pump
KER	Key Exploited Results
MCDA	Multi Criteria Decision Analysis
MPEPC	Maximum Permitted Energy Performance Coefficient
MPCPC	Maximum Permitted Carbon Performance Coefficient
Nzeb	Nearly Zero Energy Building
RER	Renewable Energy Requirement
R&D	Research and Development

2 Executive Summary

The ***GEO4CIVHIC*** D7.5 ***Exploitation plan to increase the commercial attractiveness and the penetration of geothermal energy systems*** is a public document delivered in the context of WP7, Task 7.4.

This document has the purpose to inform about the progress in the implementation of the actions included in the Exploitation Plan that have the role to increase the commercial attractiveness and the penetration of GSHPs and in particular in the retrofit market.

The Exploitation Plan is based on the business model creation that includes data such as:

a) commercially exploitable main project results;
b) potential market;
c) analysis of barriers for exploitation;
d) exploitation scenarios and client-based commercialization strategies to bench market launch steps;
e) methodology and strategy for management of knowledge generated;
f) the innovations and marketing interests in order to develop a mature project commercialization plan.

The Exploitation plan also includes the exploitation potential and strategy of the projects results, routes for exploitation, the target users and markets, competitor analysis, potential for investor, internal or external, and marketing strategies.

The **main conclusion** of the D7.5 - Exploitation plan to increase the commercial attractiveness and the penetration of geothermal energy systems:

All the 19 project partners: **CNR, UNIPD, UPV, RED, GEOSERV, GALLETTI, TECNALIA, TKI, UNESCO, FAU, RGS, CRES, HYDRA, UBeG, GEOGREEN, PIETRE, SOL, DLH and SUPSI** initiated different for Exploitation plan and customized their individual exploitation plan according to their specific business model and the market demand specific in their country.

3 Introduction

The GEO4CIVHIC project represents a pivotal step forward in the realm of GSHP systems. It is a visionary endeavor that aims to revolutionize the way we harness and utilize the Earth's geothermal energy for heating and cooling applications, particularly in the context of both new and renovated Civil and Historical Buildings. This ambitious undertaking is not merely a scientific pursuit; it is a strategic commercialization and innovation initiative designed to reshape the energy landscape in Europe and beyond. In this introduction, we set the stage for the profound impact that GEO4CIVHIC promises to deliver.

The growing *global demand* for sustainable and energy-efficient solutions has brought geothermal heat pump systems to the forefront of clean energy technologies. GSHP systems offer a unique advantage by tapping into the Earth's renewable geothermal energy to provide efficient heating and cooling for buildings. However, to fully realize the potential of GSHP systems and ensure their widespread adoption, innovation is key.

The GEO4CIVHIC project is built on the belief that the integration of innovative technologies and strategic commercialization is the way forward. By focusing on various aspects of GSHP systems, including application management, heat pump design, drilling methods, and market analysis, GEO4CIVHIC strives to address the critical *barriers and challenges* that have hindered the broader acceptance of GSHP systems.

The **objectives** of the GEO4CIVHIC project within the CANVAS of GSHP systems are manifold:

- ✓ To develop comprehensive business models that cater to various facets of GSHP systems, from application management to drilling methods.
- ✓ To conduct a thorough market analysis, both at the European level and within the participating countries, with the aim of identifying opportunities and challenges in the GSHP sector.
- ✓ To pinpoint barriers and challenges in the GSHP industry, and to propose innovative solutions that can propel its growth.
- ✓ To craft a robust exploitation plan that ensures the commercial attractiveness of GSHP systems and their penetration into both classic and retrofit markets.

In this introduction, we provide an overview of the key components of the GEO4CIVHIC project, outlining the strategic approach taken to address these objectives. We emphasize the importance of innovation not only in the technology itself, but also in the business models and strategies employed for its commercialization. The GEO4CIVHIC project is not just about advancing technology; it's about *shaping the future* of sustainable energy solutions.

4 Canvas Analysis

4.1 Objectives of CANVAS Analysis in context of GSHP systems

The primary aim of the CANVAS analysis is to:

- evaluate the current market landscape
- discern the appropriate channels and optimal methodologies for shaping the future business plan

The objectives of the CANVAS analysis are intricately connected to the identification of potential tools for leveraging the outcomes achieved within the GEO4CIVHIC project. The enumeration of Key Exploitable Results (KERs) in the subsequent section constitutes the primary dataset employed in discerning the principal objectives of the exploitation plan, predicated on the collated information.

Taking into consideration the collaboration with the GEO4CIVHIC partner Solintel and according to Deliverable 7.3 and 7.4, we have analysed the data gathered and we have obtained a Canvas Analysis applied to each KER as following.

From the data obtained we have observed that the key to the business are the revenue streams. This block represents the cash that a company generates from each customer segment (costs must be subtracted from revenues to create earnings) and a business model can involve two different types of revenue streams:

- Transaction revenues resulting from one-time customer payments
- Recurring revenues resulting from ongoing payments to either deliver a value proposition to customers or provide post-purchase customer support[1]

4.2 Canvas Business Model Developed

To develop the business models based on the Canvas methodology, all the project partners were consulted and in particular the developer partners (RED, Hydra, Galletti-Hiref and TKI).

Eight Canvas models have been developed for the following products/services:

- ✓ *Plug and play heat pump with variable or fixed speed drivers*
- ✓ *Heat pump for high temperature application and dual source application*
- ✓ *High temperature Heat Pumps for renovated Civil and Historical Buildings*
- ✓ *Versatile and compact drilling rig unit JOY 3P GEO4CIVHIC*
- ✓ *Semi-automatic feeder for drilling rods and co-axial tubes mounting*
- ✓ *Compact Vibration-rotation drilling components*
- ✓ *Efficient co-axial heat exchangers for piling with vibration-rotation drilling head (HYDRA-RED METHOD*
- ✓ *GEO4CIVHIC integrated solution*

[1] Osterwalder, Alexander, Pigneur, Yves. Business Model Generation. Tim

INTEGRATED CANVAS BUSINESS MODEL FOR "PLUG-AND-PLAY HEAT PUMP WITH VARIABLE OR FIXED SPEED DRIVERS", "HEAT PUMP FOR HIGH TEMPERATURE APPLICATION AND DUAL SOURCE APPLICATION", "HIGH TEMPERATURE HEAT PUMPS FOR RENOVATED CIVIL AND HISTORICAL BUILDINGS"				
Owner: Galleti-Hiref, Contributors: UNIPD-DII, CNR-ITC - Patent				
Key Partners • Technological suppliers • GEO4CIVHIC project Partners ***Key Activities*** • Manufacturing • Further research • Sales, Distribution • Using the results in standardization activities ***Key Resources*** • Own investment • European Project • Test Sites (Results) • Employees • Prescribers network • Presence in forums and networks • Knowledge, experience and professionalism	***Value Proposition*** Geothermal Solutions: • Sale of products and tools to perform the geothermal installation • Make drilling cheaper on unconsolidated soils with tools and drilling techniques developed by the company • Post sales services **Segment 1** • Technical solutions • Technical and technological support • Differentiation **Segment 2** • Training • Technical solutions • Technical and technological support • Drilling services **Technical and economic advantages/improvements, considering the current market:** • The possibility to match high temperature water • Multi sources units • Geothermal probes	***Customer Relationships*** • Technical solvency • Reliability • Optimum Quality / Price Ratio • Training • Presentations at fairs, congresses, conferences and other events ***Customer Segments*** European market in general: 1. Current customers • Drillers 2. New customers: • Geothermal engineering companies • Geothermal installer • companies • Architects • People working in culture world	***Channels*** • Workshops with specialists and non-specialists: Architects, Engineers associations and private stakeholders' involvement in the process of dissemination • Communication campaign - focused on the market (newsletter, press, info days, technical meetings, participation in conferences, demonstration activities, webpage, etc.)	***Cost Structure*** • Personnel • Promotion and sale • Infrastructures • Financial • Training • Hired services • Mobility • Equipment (purchase, license, rental) ***Revenue Streams*** • Products and tools to perform the geothermal installation • Training

- The target is offering a commercial product for the heating (and eventually cooling) of buildings with historical or architecture relevance, and consequently the impossibility of change the modality of heating and/or cooling. This fact imposes frequently the operation with high temperature water (higher than 50°C).
- Expected technical and/or non-technical barriers for the exploitation and knowledge transfer - The cost of geothermal probes.
- Equipment - Data of the number of buildings in which is needed high temperature water and consequently the market dimension
- Co creation value - As described above, the project is strictly connected with geothermal probes: so, if you need this kind of unit, you have to calculate if is possible to install a certain number of them, to cover also partially the annual load. In fact, is not requested that geothermal probes must satisfy all the annual thermal load because some of these units have the possibility to switch the dissipation heat exchanger from geothermal side to air coil.
- Impact - The impact of these units can be very high where it is not possible to change the radiant heat distribution system: in the Union's territory, which is rich in buildings of historical and architectural significance, to achieve the net-zero goal, this capacity is essential. With this project, we have responded to this need by proposing a concrete way to achieve climate goals in all buildings.

<table>
<tr><th colspan="5">CANVAS BUSINESS MODEL FOR “VERSATIL AND COMPACT DRILLING RIG UNIT JOY 3P GEO4CIVHIC”</th></tr>
<tr><th colspan="5">Owner: Hydra, No contributors – Patent / Utility model</th></tr>
<tr>
<td>Key Partners
Suppliers
Technological: Drillers involved in shallow geothermal installations
Key Activities
Design
Manufacturing of drilling machines and equipment
Consultancy
Training
Distribution
Focus on high savings during the life of the product
Key Resources
European Project
Own financial resources
Employees
Prescribers network
Presence in forums and networks
Knowledge, experience and professionalism</td>
<td>Value Proposition
Geothermal Solutions:
Sale of products and tools to perform the geothermal installation
Make drilling cheaper on unconsolidated soils with tools and drilling techniques developed by the company
Post sales services
Segment 1
Technical solutions: handling safe and fast drilling equipment
Technical and technological support
Differentiation
Segment 2
Training
Technical solutions
Technical and technological support
Drilling services
Other info
Current market scenario - This kind of product is not widely used for the purpose of the mounting of drilling rods and shafts. Manual operation is still preponderant, so the product has a very high market potential.</td>
<td>Customer Relationships
Technical solvency
Reliability
Optimum Quality / Price Ratio
Training
Presentations at fairs, congresses, conferences and other events
Customer Segments
European market in general:
Current customers
Drillers
New customers:
Geothermal engineering companies
Geothermal installer companies
Architects
People working in culture world</td>
<td>Channels
Segment 1:
Fairs
Presence in network
Technical magazines
Specialized training
Segment 2:
Fairs
Presence in network
Workshops, courses, network
Other info
Expected technical and non technical barriers - Customer may not be aware about the cost savings and the low pay-back time.

Recently the costs of many raw materials has dramatically increased. Moreover, availability of materials is very uncertain. Such situation might affect the manufacturing and the final price of the product.</td>
<td>Cost Structure
Personnel
Promotion and sale
Infrastructures
Financial
Training
Hired services
Mobility
Equipment
Revenue Streams
Products and tools to perform the geothermal installation
Training</td>
</tr>
</table>

<table>
<tr><th colspan="5">CANVAS BUSINESS MODEL FOR “SEMI-AUTOMATIC FEEDER FOR DRILLING RODS AND CO-AXIAL TUBES MOUNTING”</th></tr>
<tr><th colspan="5">Owner: Hydra, No contributors – Patent / Utility model</th></tr>
<tr>
<td>Key Partners
Suppliers
Technological: Drillers involved in shallow geothermal installations
Key Activities
Design
Manufacturing of drilling machines and equipment
Consultancy
Training
Distribution
Focus on high savings during the life of the product
Key Resources
European Project
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Training
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Drilling services
Other info
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<td>Customer Relationships
Technical solvency
Reliability
Optimum Quality / Price Ratio
Training
Presentations at fairs, congresses, conferences and other events
Customer Segments
European market in general:<ol start="3">
Current customers
Drillers
New customers:
Geothermal engineering companies
Geothermal installer companies
Architects
People working in culture world</td>
<td>Channels
Segment 1:
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Presence in network
Technical magazines
Specialized training
Segment 2:
Fairs
Presence in network
Workshops, courses, network
Other info
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Recently the costs of many raw materials has dramatically increased. Moreover, availability of materials is very uncertain. Such situation might affect the manufacturing and the final price of the product.</td>
<td>Cost Structure
Personnel
Promotion and sale
Infrastructures
Financial
Training
Hired services
Mobility
Equipment
Revenue Streams
Products and tools to perform the geothermal installation
Training</td>
</tr>
</table>

INTEGRATED CANVAS BUSINESS MODEL FOR "COMPACT VIBRATION-ROTATION DRILLING COMPONENTS"				
Owner: TKI, Contributors: Hydra (first one), TKI (the other two) – Trade secret				
Key Partners • Suppliers • Technological: GEO4CIVHIC project Partners ***Key Activities*** • Promotion and sale • Presence in forums and media • Training and technical update • Supply products and tools to perform the geothermal installation • Post sales services ***Key Resources*** • European Project • Test Sites (Results) • DSS • Employees • Prescribers network • Presence in forums and networks • Knowledge, experience and professionalism	***Value Proposition*** Geothermal Solutions: • Sale of products and tools to perform the geothermal installation • Make drilling cheaper on unconsolidated soils with tools and drilling techniques developed by the company • Post sales services **Segment 1** • Technical solutions • Technical and technological support • Differentiation **Segment 2** • Training • Technical solutions • Technical and technological support • Drilling services	***Customer Relationships*** • Technical solvency • Reliability • Optimum Quality / Price Ratio • Training • Presentations at fairs, congresses, conferences and other events ***Customer Segments*** European market in general: 1. Current customers • Drillers 2. New customers: • Geothermal engineering companies • Geothermal installer companies	***Channels*** **Segment 1:** • Fairs • Presence in network • Technical magazines • Specialized training **Segment 2:** • Fairs • Presence in network • Workshops, courses, network	***Cost Structure*** • Personnel • Promotion and sale • Infrastructures • Financial • Training • Hired services • Mobility • Equipment (purchase, license, rental) ***Revenue Streams*** • Products and tools to perform the geothermal installation • Training

CANVAS BUSINESS MODEL FOR "EFFICIENT CO-AXIAL HEAT EXCHANGERS FOR PILING WITH VIBRATION-ROTATION DRILLING HEAD"				
Owner: RED-HYDRA, Contributors: N/A – Patent granted 9/11/20				
Key Partners • Suppliers • Technological: GEO4CIVHIC project Partners ***Key Activities*** • Promotion and sale • Presence in forums and media • Training and technical update • Supply products and tools to perform the geothermal installation • Post sales services ***Key Resources*** • European Project • Test Sites (Results) • DSS • Employees • Prescribers network • Presence in forums and networks • Knowledge, experience and professionalism	***Value Proposition*** Geothermal Solutions: • Sale of products and tools to perform the geothermal installation • Make drilling cheaper on unconsolidated soils with tools and drilling techniques developed by the company • Post sales services **Segment 1** • Technical solutions • Technical and technological support • Differentiation **Segment 2** • Training • Technical solutions • Technical and technological support • Drilling services	***Customer Relationships*** • Technical solvency • Reliability • Optimum Quality / Price Ratio • Training • Presentations at fairs, congresses, conferences and other events ***Customer Segments*** European market in general: 1. Current customers • Drillers 2. New customers: • Geothermal engineering companies • Geothermal installer companies	***Channels*** **Segment 1:** • Fairs • Presence in network • Technical magazines • Specialized training **Segment 2:** • Fairs • Presence in network • Workshops, courses, network	***Cost Structure*** • Personnel • Promotion and sale • Infrastructures • Financial • Training • Hired services • Mobility • Equipment ***Revenue Streams*** • Products and tools to perform the geothermal installation • Training

<table>
<tr><th colspan="5">CANVAS BUSINESS MODEL FOR “GEO4CIVHIC INTEGRATED SOLUTION”</th></tr>
<tr><th colspan="5">Owner: Individual KER owners, Contributors: Individual KER contributors – Non-equity strategic alliance</th></tr>
<tr>
<td>Key Partners
Suppliers
Technological: GEO4CIVHIC project Partners
Key Activities
Promotion and sale
Presence in forums and media
Training and technical update
Supply products and tools to perform the geothermal installation
Post sales services
Key Resources
European Project
Test Sites (Results)
DSS
Employees
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Technical and technological support
Differentiation
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Training
Technical solutions
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Drilling services</td>
<td>Customer Relationships
Technical solvency
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Infrastructures
Financial
Training
Hired services
Mobility
Equipment
Revenue Streams
Products and tools to perform the geothermal installation
Training</td>
</tr>
</table>

4.3 GEO4CIVHIC Business Model

Customer segments:

In the GEO4CIVHIC project, customer relationships are not just a by product/service of business; they are the essence of sustainability. By understanding the customer journey, prioritizing effective communication, embracing feedback, and fostering loyalty, GEO4CIVHIC ensures that its mission of commercializing GSHP systems is not just a transaction, but a lasting partnership with its customers.

These relationships are not only the key to the project's success, but also the driving force behind a more sustainable and green future. Through nurturing these connections, GEO4CIVHIC truly becomes a catalyst for change and a beacon of sustainability in the renewable energy landscape.

The Eco-conscious homeowners – Attracting awareness: They represent a substantial customer base for GEO4CIVHIC. Their commitment to the environment and willingness to embrace cutting-edge technologies align perfectly with the project's objectives. By offering seamless solutions that address their needs, GEO4CIVHIC not only attracts, but also retains a clientele that can be influential in advocating for renewable energy systems. For instance, the project's application for easy energy management is a beacon, guiding eco-conscious homeowners to GEO4CIVHIC, since it aligns perfectly with their commitment to the environment.

The sustainability pioneers – Building interest: They are a key driving force behind the adoption of renewable energy solutions. Their desire to project a green image aligns harmoniously with GEO4CIVHIC's mission. The project's ability to offer comprehensive feasibility studies and ensure legal compliance plays a pivotal role in attracting and retaining this segment.

The innovative developers – Facilitating decision-making: They represent an intriguing customer segment for GEO4CIVHIC. While cost considerations are paramount, their adaptability to eco-friendly solutions offers a unique opportunity.

For innovative developers, cost-effectiveness is key. For instance, the project's plug-and-play heat pump and the high-temperature Heat Pumps for renovated Civil and Historical Buildings are meant to offer a transparent solution to their cost considerations align with their unique projects, making GEO4CIVHIC an invaluable partner in embracing sustainable solutions. Also, the DSS developed is also useful in facilitating decision-making, since it helps offering heating and cooling solutions for civil and historical buildings, depending on the building's conditions and parameters.

The technical connoisseurs – Ensuring satisfaction: Comprising engineering and architecture firms, they require intricate technical support and insights to outshine their competitors. GEO4CIVHIC's role as a knowledge repository and solution provider is indispensable in satisfying this segment's thirst for technical excellence.

Engineering and architecture firms require intricate technical support, and the modular design of a vibratory hammer drill and efficient co-axial heat exchangers for piling with a vibration-rotation drilling head, developed in the project, cater to their thirst for technical excellence. The seamless delivery and installation of the project's solutions will be ensured, exceeding their expectations.

The builders of tomorrow – Post-installation support: They represent the cornerstone of construction projects. Their quest for cost-efficiency and timely project delivery aligns with GEO4CIVHIC's commitment to providing reliable GSHP systems. By catering to their needs, the project secures its role as a valuable partner in shaping the buildings of the future.
Timely maintenance and support are crucial for builders. The project's compact vibration-rotation drilling head and semi-automatic feeder for drilling rods and co-axial tubes mounting contribute to efficient project delivery. Our project partners provide ongoing support to ensure the longevity of their GSHP systems, securing their role as valuable partners in shaping the buildings of the future throughout GEO4CIVHIC.*The installation experts – Ensuring satisfaction:* Often plumbers and HVAC specialists, they are vital players in bringing our developed systems to life.

Effective communication is key to nurturing a symbiotic relationship with installation experts. Our comprehensive training and technical support, combined with our GEO4CIVHIC integrated solution, provide them with the tools they need to bring the systems that were developed in the project to life. In addition, the application for easy energy management streamlines their work processes, ensuring efficiency and success.

The GEO4CIVHIC project hinges on a deep understanding of its diverse customer segments. By addressing the unique characteristics, aspirations, and needs of each segment, GEO4CIVHIC positions itself as a formidable force in driving the adoption of sustainable, renewable energy solutions. These segments are not just customers; they are the pillars upon which the project's success is built, making their inclusion and satisfaction paramount. The figure below shows the value proposition that best fits each customer segment, adapted from previous research.

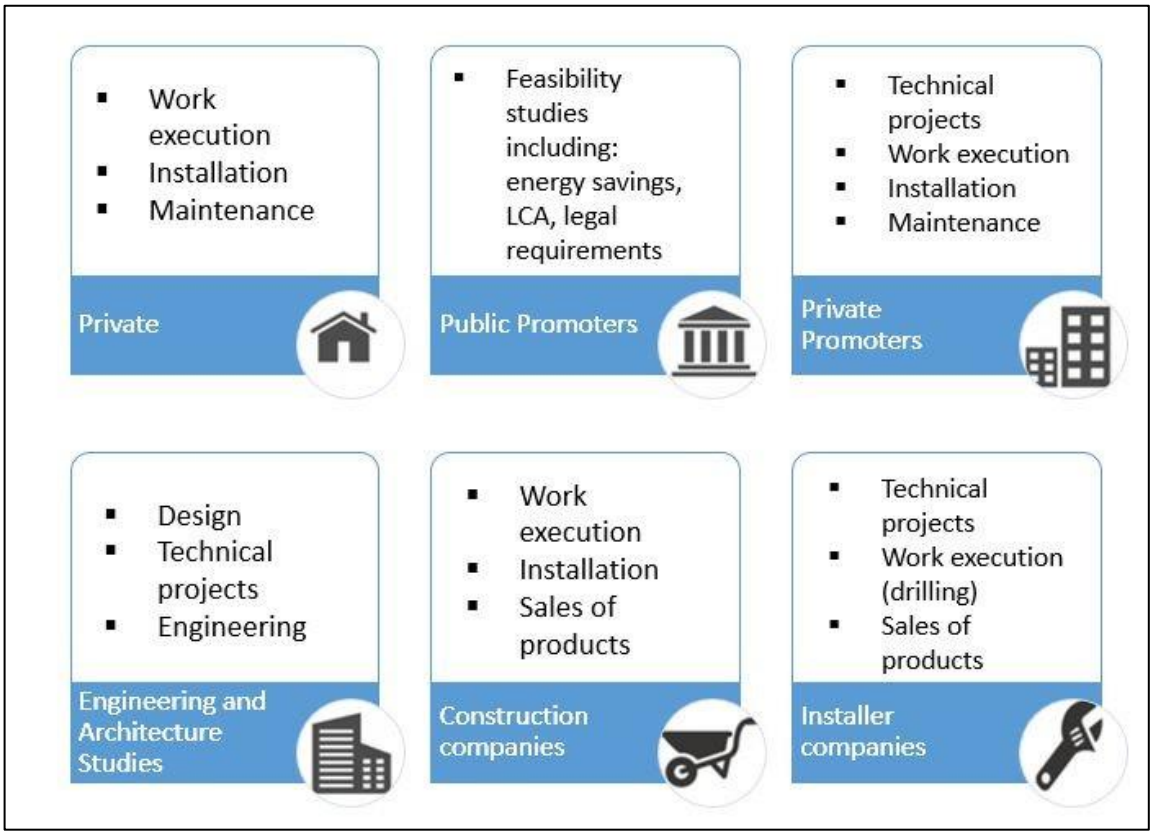

Figure 1 - Value proposition by customer segment
(Source: Deliverable 8.2 – Cheap-GSHP)

Customer relationships:

The first step taken into consideration in cultivating meaningful customer relationships is understanding the customer journey. In GEO4CIVHIC, the customer journey encompasses various touchpoints, from the initial inquiry to post-installation support.

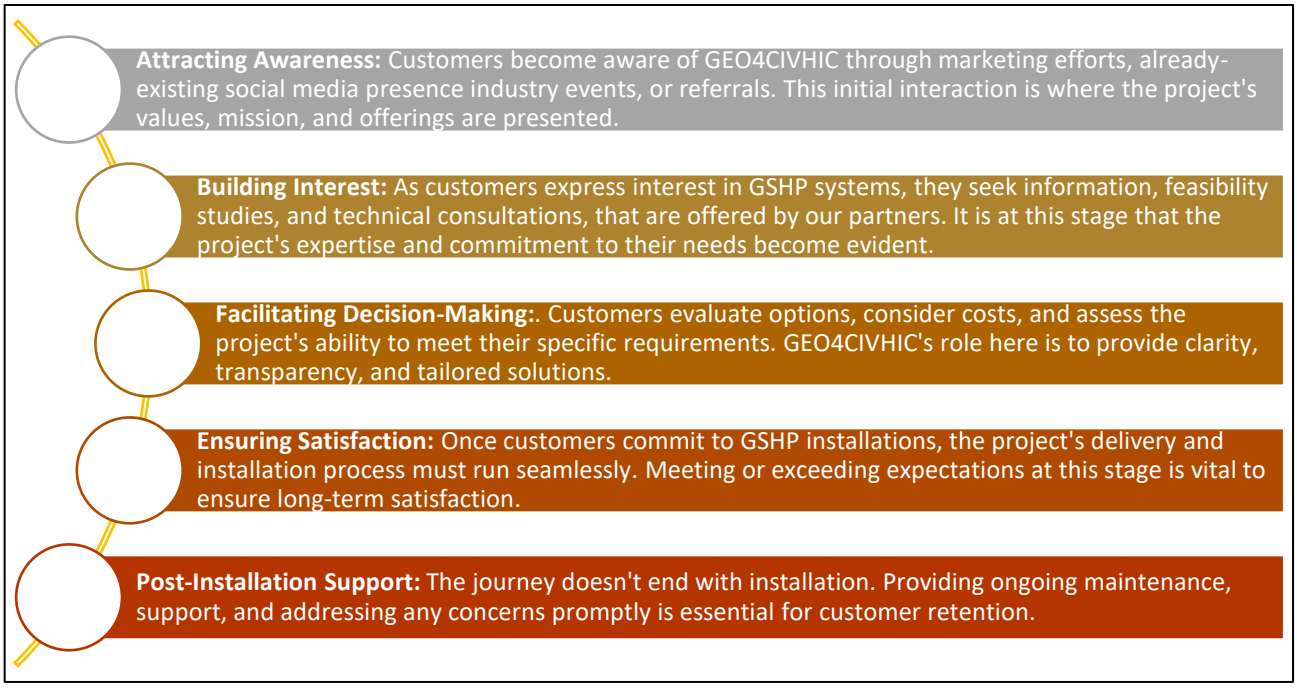

Figure 2 - Customer journey

In this business model, we have matched in the next section these 5 main touchpoints to the targeted customer segments, for a better understanding of their needs and what innovations of GEO4CIVHIC can be applied to each segment. This significantly highlights the fact that our project partners have taken their time in order to understand the customer journey.

Returning to this section, effective communication is the cornerstone of nurturing customer relationships within GEO4CIVHIC involving actively listening to customers' concerns, feedback, and evolving needs.

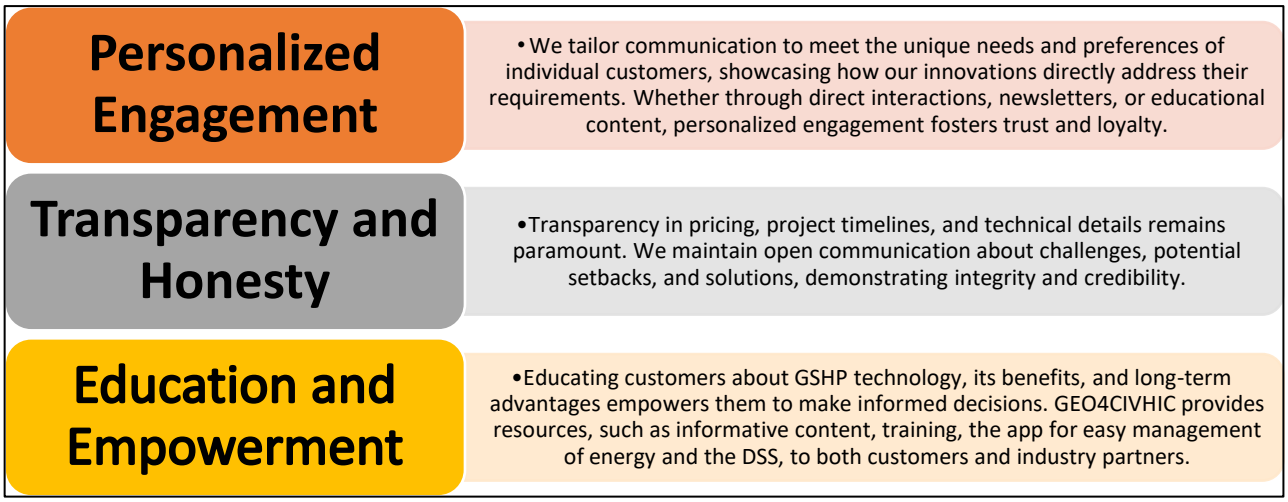

Figure 3 - Communication as the Cornerstone

In addition, building customer relationships is not just about acquiring new customers; it's also about retaining them and fostering loyalty. GEO4CIVHIC achieved this through:

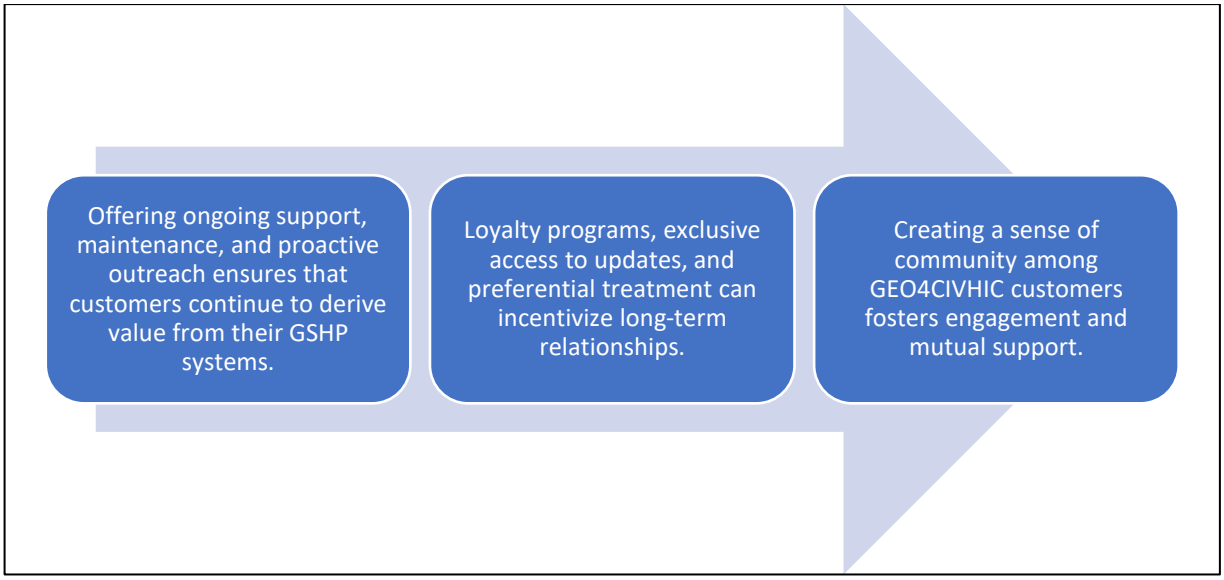

Figure 4 - Retention and Loyalty

In the GEO4CIVHIC project, customer relationships are not just a by product/service of business; they are the essence of sustainability. By understanding the customer journey, prioritizing effective communication, embracing feedback, and fostering loyalty, GEO4CIVHIC ensures that its mission of commercializing GSHP systems is not just a transaction, but a lasting partnership with its customers.

These relationships are not only the key to the project's success, but also the driving force behind a more sustainable and green future. Through nurturing these connections, GEO4CIVHIC truly becomes a catalyst for change and a beacon of sustainability in the renewable energy landscape.

Channels:

The primary conduit for the GEO4CIVHIC consortium is through which the business model interacts with clients and where the GEO4CIVHIC firms present their offerings. These conduits are divided

into direct and indirect types. Key responsible individuals oversee the direct conduit, establishing customer connections to present the value to the end-users. This direct pathway operates through recognized market leaders. On the other hand, the indirect conduit involves promotional and marketing strategies to connect the offering with the clientele.

The project partners have identified channels through which GEO4CIVHIC can effectively reach its customers and promote the commercialization of its products, apps and methodologies:

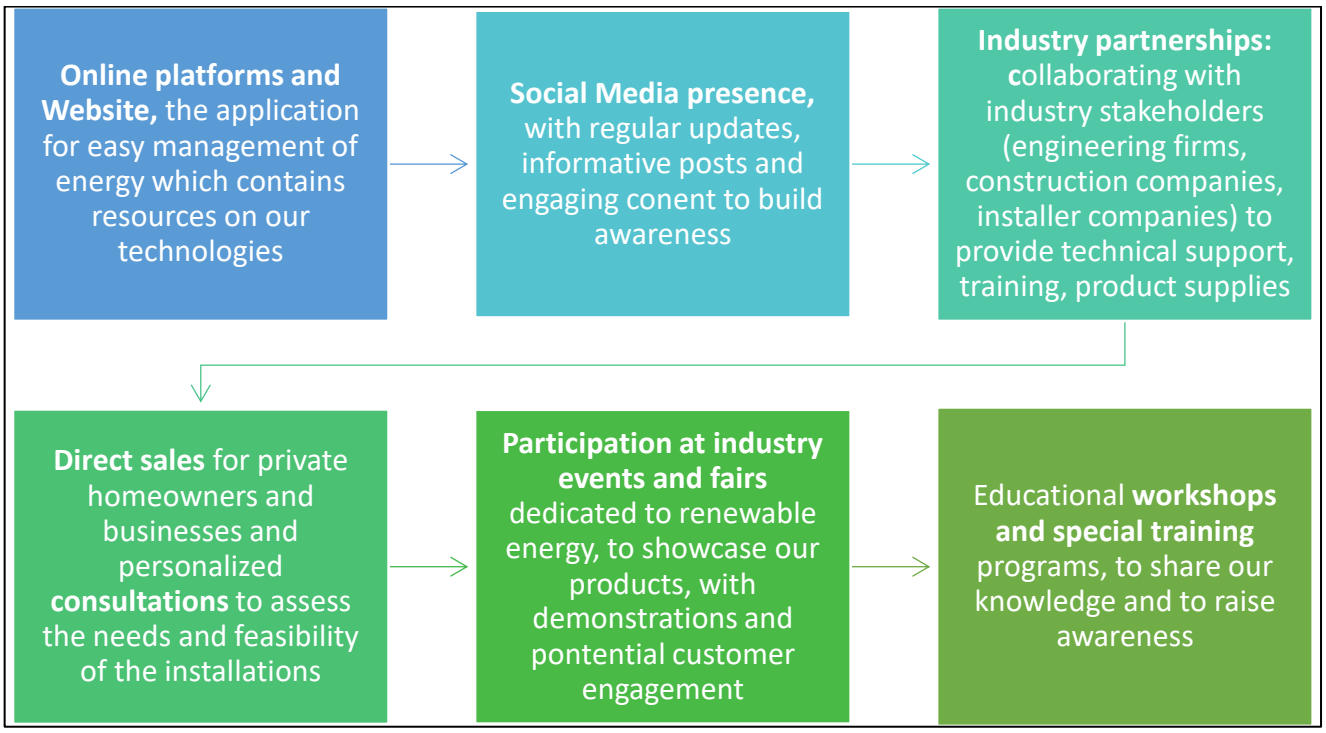

Figure 5 - GEO4CIVHIC Reaching customers channels

Key Activities:

The following key activities form the backbone of GEO4CIVHIC, driving its success and fostering sustainability at every step. They were also distributed to our project partners, considering their area of expertise and intentions with their KERs, and will be mentioned further, along with customer segments, key resources and everything else, in the individual canvas business models.

1. Research and Development (R&D)

- **Activity:** Continuous research and development are at the heart of the GEO4CIVHIC project. This involves staying abreast of the latest advancements in GSHP technology, exploring innovative solutions, and enhancing the efficiency and effectiveness of our existing products.
- **Significance:** R&D activities ensure that GEO4CIVHIC remains at the forefront of GSHP technology, offering cutting-edge solutions to its customers. It allows the project to adapt to evolving industry standards and regulatory requirements.

Figure 6 - Research&Development

2. Feasibility Studies and Technical Consulting

- **Activity:** GEO4CIVHIC conducts in-depth feasibility studies and provides technical consulting services to its customers. This involves site assessments, energy modeling, and feasibility assessments to determine the suitability of GSHP systems for specific projects.
- **Significance:** These activities empower customers with the knowledge needed to make informed decisions about adopting GSHP technology. They also enable GEO4CIVHIC to customize solutions that align with each project's unique requirements, enhancing the overall success of GSHP implementations.

Figure 7 - Feasibility Studies and Technical Consulting

3. Product Development and Innovation

- **Activity:** GEO4CIVHIC invests in continuous product development and innovation. This includes designing and refining GSHP systems, developing ancillary products and tools, and exploring eco-friendly materials and energy-efficient components.
- **Significance:** Staying on the cutting edge of product development ensures that GEO4CIVHIC can offer customers the most efficient and environmentally friendly GSHP solutions available. Innovation drives improvements in energy efficiency, reliability, and overall system performance.

Figure 8 - Product Development and Innovation

4. Customer Training and Support

- **Activity:** Providing comprehensive training and support to customers and industry partners is a core aspect of GEO4CIVHIC's operations. This includes educating customers on our technologies, offering installation training, and providing ongoing technical assistance.
- **Significance:** Effective training and support ensure that GSHP systems are installed and operated correctly, maximizing their efficiency and longevity. It also fosters strong customer relationships and builds trust.

Figure 9 - Customer Training and Support

5. Marketing and Promotion

- **Activity:** GEO4CIVHIC actively engages in marketing and promotional activities to create awareness about GSHP technology. This involves creating marketing materials, participating in industry events, and having presence on the social media platforms and on the Internet.
- **Significance:** Effective marketing raises awareness about the benefits of GSHP systems, attracting potential customers and partners. It also helps position GEO4CIVHIC as a leader in the field of renewable energy.

Figure 10 - Marketing and Promotion

Figure 11 - Other Key Activities

To sum it all up, **these key activities** form the intricate tapestry that propels the GEO4CIVHIC project forward in its mission to commercialize efficient GSHP systems. Each activity plays a pivotal role in ensuring the sustainability, efficiency, and success of our installations, ultimately contributing to a more eco-conscious and energy-efficient future.

Crucial actions for the execution of the integrated business model encompass marketing endeavors and overseeing tasks from client engagement to the solution package's deployment. Marketing efforts aim to incorporate this business model into civil structures, notably historical customer categories. Within this model, two primary responsible groups oversee these activities.

Group 1 catered to the drilling innovations customer segment, while **Group 2** focused on the innovative heat pumps customer segment, reaching out to new customers and integrating the business model for them. From a marketing standpoint, these groups symbolize the GEO4CIVHIC consortium.

This model provides a comprehensive system to customer segments, encompassing management tasks from initiating to installing the GEO4CIVHIC solutions (KERs). The consortium oversaw the plug-and-play concept with its members. The detailed operations behind this business model, including the value proposition for the market and responsible parties for each activity within the GEO4CIVHIC consortium, are elaborated in the service system map section.

Furthermore, activities advancing the value proposition include consultancy tasks managed by a unified team comprising **UBEG, RED, GEOSERV, GEOGREEN, SOLINTEL, DIN L-ART HELWA (DLH) and PIETRE**. Both Group 1 and Group 2 manage these consultancy activities, aiming to meet client segment requirements and suggest market solutions tailored to those unique needs.

In addition, universities **(UPV, FAU, SUPSI)** and research institute **(CNR-ITC, TECNALIA, RGS, CRES)** from the GEO4CIVHIC consortium oversee supplementary activities, fostering the development of the GEO4CIVHIC project package solutions.

Key Resources:

The GEO4CIVHIC project, on its journey to usher in a sustainable revolution through the commercialization of GSHP systems, relies on a multitude of key resources. These resources are the essential building blocks that not only drive the project forward, but also empower it to innovate, manufacture, and deliver cutting-edge solutions in the realm of renewable energy.

Table 1 - Key Resources in GEO4CIVHIC

Name	Resource	Significance
R&D Team	An expert R&D team – our partners, specializing in renewable energy and GSHP technology	The R&D team is the creative powerhouse behind GEO4CIVHIC, continuously pushing the boundaries of GSHP technology. They are the architects of innovation, developing new solutions and optimizing existing ones to align with the project's sustainability goals.
Technical Expertise	A team of engineers, technicians, and industry experts	Technical expertise is the cornerstone of GEO4CIVHIC's ability to deliver efficient, reliable GSHP systems. This resource ensures that feasibility studies are conducted flawlessly, technical consulting is top-notch, and every installation meets rigorous regulatory and environmental standards.
Manufacturing Facilities	State-of-the-art manufacturing facilities for producing GSHP systems and related components	These facilities are the birthplace of precision and quality. They enable GEO4CIVHIC to control the entire production process, ensuring that each GSHP system meets exacting standards of efficiency and dependability.
Supplier Relationships	Established relationships with suppliers for sourcing components and materials	Strong supplier relationships form the arteries through which vital components flow into the project's production process. These relationships ensure a seamless supply chain, reducing delays and ensuring the uninterrupted availability of GSHP systems.
Marketing and Branding Assets	Marketing materials, branding assets, and a dedicated marketing team	Marketing assets and strategies are the megaphones through which GEO4CIVHIC's message of sustainability resonates. They create brand awareness, attract potential customers, and position the project as a trusted leader in the GSHP industry.

The solution offers a comprehensive plug-and-play package for implementing shallow geothermal systems, which vary based on the building's function, climate, and underground geological conditions. This geothermal system primarily focuses on drilling techniques and the latest generation of heat pumps.

These pioneering technologies incorporate highly effective, cost-efficient drilling methods and equipment, specifically designed for urban settings. They mark a notable progression and innovation from earlier projects. This streamlined approach eases its incorporation into building renovations, tackles various challenges, and ultimately brings down drilling expenses across varied geological terrains.

Every member of the GEO4CIVHIC consortium plays a role in different stages, from attracting new clients to delivering solutions. The robust collaboration and mutual agreements among these members fortify the GEO4CIVHIC consortium's ability to offer a compelling value proposition to customers.

Key Partners & Responsibilities:

In the intricate tapestry of the GEO4CIVHIC project, the significance of key partnerships cannot be overstated. These collaborative alliances are the linchpin of sustainability, enabling the project to harness expertise, resources, and networks that drive the commercialization of our technologies and systems.

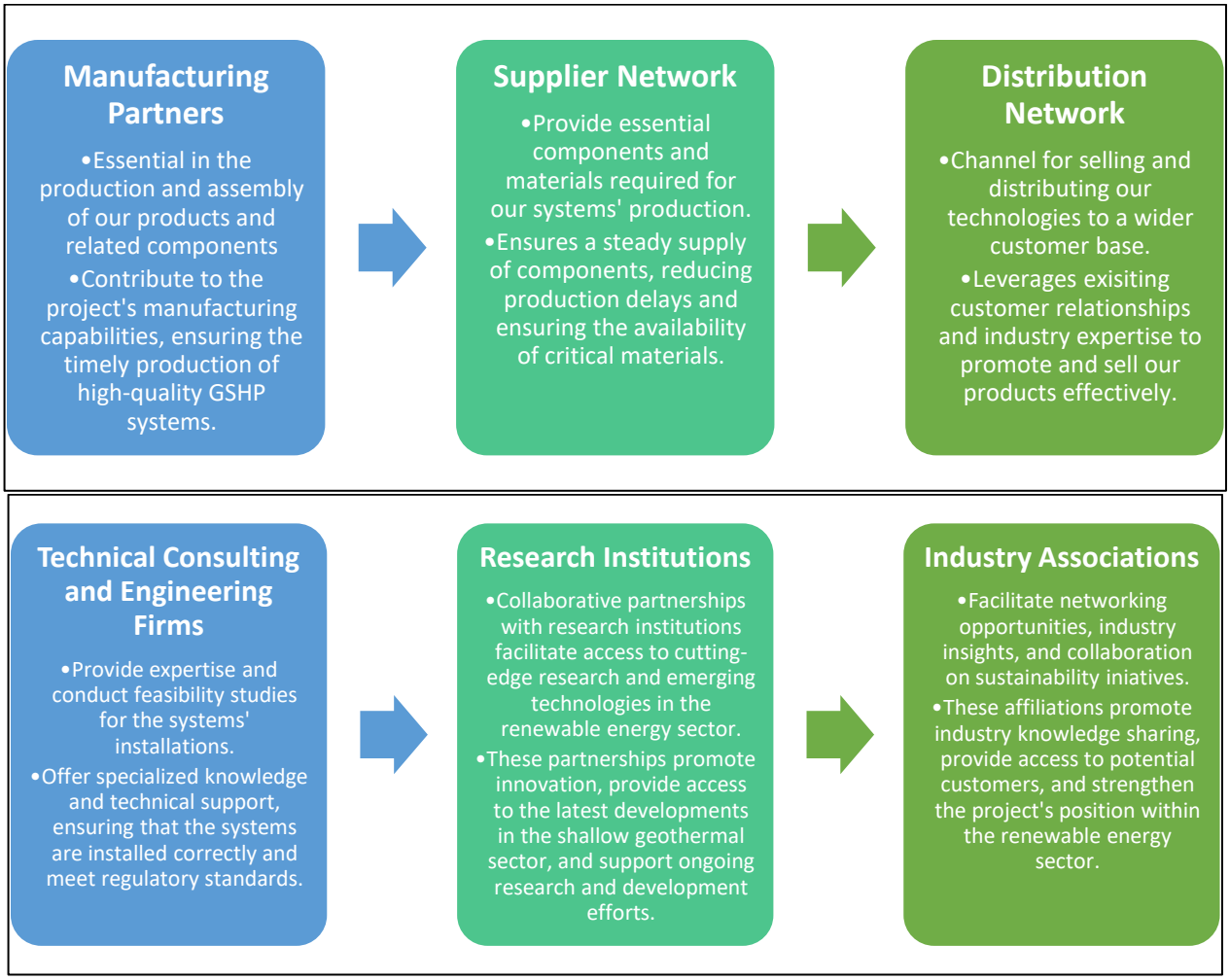

Figure 12 - Key Partners in GEO4CIVHIC

As part of the GEO4CIVHIC consortium, integral members encompass various relevant stakeholders. Beyond the consortium itself, these stakeholders encompass municipalities, energy associations, consultancy firms, and energy-saving companies (ESCOs) closely collaborating with GEO4CIVHIC.

Moreover, beyond these primary external partners, there exists potential for cooperation with national drilling associations, energy firms, planning authorities, property developers, and mechanical installers. These entities hold the potential to become valuable allies in advancing GEO4CIVHIC's objectives and initiatives. Their engagement and support have the potential to significantly enhance the project's success and influence within the broader energy and construction sectors.

The key partnerships forged within this project not only strengthen GEO4CIVHIC's foundation, but also provide the catalyst for innovation, growth, and positive change in the renewable energy landscape. As our project continues to drive the commercialization of our products, it does so with a network of partners dedicated to the common goal of advancing sustainability and environmental stewardship.

The central monitoring hub aggregates information and requirements of new clients. It operates in collaboration with consultancy, engineering companies, universities, research centers, and associations. The key roles of the involved project partners are the following categories:

1. **Central Monitoring level project partners**

- **CNR-ISAC**: Apart from managing geothermal projects, CNR-ISAC's core contributions are environmental, climatic, and energy efficiency aspects, specifically in the Cultural/Historical Buildings domain where shallow geothermal energy application knowledge is limited.

- **UNIPD – DII**: UNIPD's Industrial Engineering Department (DII) brings expertise in heat pump system modeling, patent creation, regulations, and energy assessments. They've evaluated performance across 12 European demonstration facilities, highlighting the benefits of GEO4CIVHIC's innovative solutions.

- **RED**: Leading the WP5 project work package, RED is in charge of the energy monitoring system and outcome evaluations.

2. **Technical Solution Providers**

- **HYDRA SRL**: They produce the compact drilling rig and semi-automatic feeder. Their role also includes promoting and offering drilling operation services for the integrated solutions.

- **TERRA INFRASTRUCTURE**: They manufacture the efficient vibro drill heads and other components. Similarly, TERRA promotes drilling operation services for the package.

- **GALLETTI / HIREF**: They develop and deploy a new generation of dual source heat pumps. Additionally, they provide installation and maintenance services for these pumps.

3. **Consultancy & Engineering Firms**

- Companies like **UBEG, RED, GEOSERV, GEOGREEN, SOLINTEL, DIN L-ART HELWA**, and **PIETRE** support the GEO4CIVHIC consortium in promoting the integrated solution and offering engineering services. These firms interact closely with central monitoring and tech providers, and their technical insights are invaluable to clients. Being part of the consortium, they're well-versed with the innovations and can recommend or design efficient building installations for customer needs.

4. **Universities, Research Centers, and Associations**:

- Institutions like **UPV, FAU, SUPSI, CNR-ITC, TECNALIA, RGS,** and **CRES** manage R&D activities for the project. Beyond R&D, they also focus on spreading information about the project. The models they develop will be documented in scientific papers and presented at national and international conferences.

Revenue streams:

As the GEO4CIVHIC project endeavors to pioneer a sustainable revolution through the commercialization of GSHP systems, its financial foundation is woven from a rich tapestry of revenue streams. The revenue model primarily relies on the sale of the comprehensive integrated package, catering to all types of built environments, both civil and historical. The generated revenues will be distributed among the consortium members based on the percentages allocated for package sales. These percentages will be determined by the specific activities that each actor is responsible for within the consortium.

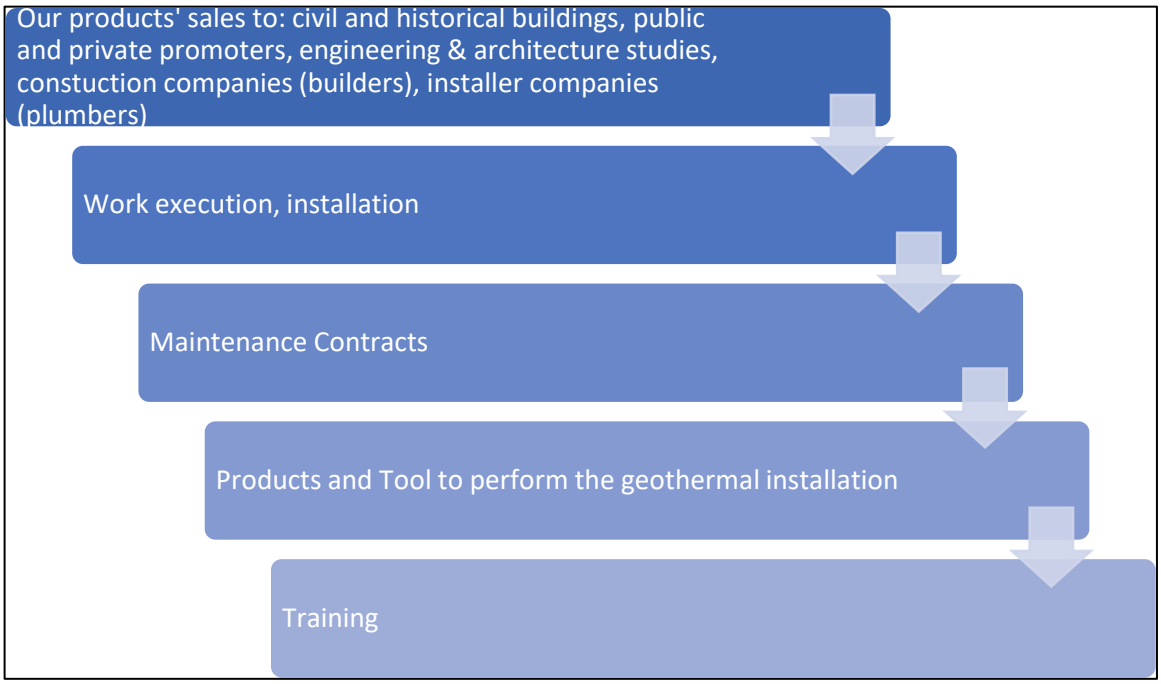

Figure 13 - Revenue streams for GEO4CIVHIC

Cost structure:

In this business model, the cost structure is established through a comprehensive assessment of the GEO4CIVHIC's integrated solution. The total cost of this integrated solution encompasses various components, which include expenditures related to the heat pump, drilling technologies and services, installation and commissioning, as well as engagement activities with potential customers. In essence, it comprehensively covers all financial aspects associated with the implementation and operation of the proposed integrated solution, offering a holistic perspective of the investment required for its successful deployment.

The cost elements that determine the total cost of this solution are meticulously defined in terms of the activities that all partners must undertake to offer the integrated solution to the market. For instance, specific main cost elements of the packages can be further detailed and include:

- Design elements (comprising energy design for building and energy design for HP system with heat exchangers).
- Drilling and installation, which encompasses heat exchanger installation, pipework installation, and testing.
- Installation of the heat pump system and the associated building circuits.
- Commissioning and comprehensive testing of the entire heat pump installation.
- Warranty and maintenance of the heat pump installation.

Business Model Implementation:

The execution of the general business model within the project distinguishes between two types of partners and their respective agreements:

- **Developer Partners**: These partners provide access to the technologies and extend support through their network infrastructure.
- **Consultant Partners**: These collaborators assume responsibility for catering to customers within their designated geographical and activity scopes.

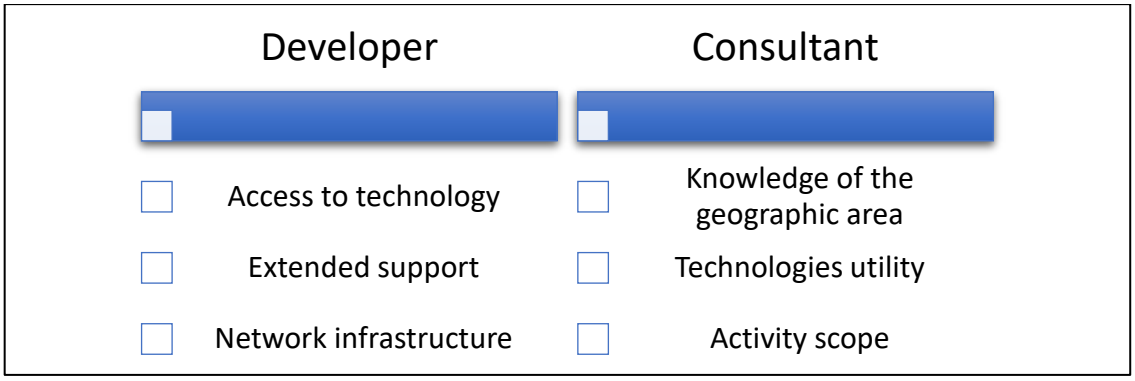

Figure 14 - Developer Partners vs Consultant Partners

Figure 15 - Business implementation

The process unfolds as follows: whether the client is an expert or not, their interest in the solution prompts them to reach out to the relevant consulting partner operating within their geographic area. This consulting partner evaluates the client's needs and proposes the most suitable technical solution.

If the client accepts, the consulting partner proceeds to contract with developer partners to execute the installation, while also providing ongoing technical support during the implementation phase.

Once the installation is successfully completed and commissioning is approved, the collaborating partners present a maintenance contract to the client, ensuring the long-term efficiency and reliability of the system[2].

The GEO4CIVHIC project has been a dynamic exploration of business models and strategies to advance GSHP systems. It aimed to foster innovation and facilitate the commercialization of GSHP technologies, spanning a range of canvas models. These models were the foundation for envisioning new business opportunities and kickstarting innovation.

The project's culmination was the development of an integrated GEO4CIVHIC Business Model, reflecting our commitment to sustainability and excellence in the GSHP industry. It encompassed mission and values, customer segments, key activities, resources, and more, providing a comprehensive framework for sustainable growth.

However, the journey doesn't end here. Successful implementation of these plans requires collaboration from stakeholders, entrepreneurs, investors, and policymakers. The GEO4CIVHIC project envisions a future where GSHP systems are accessible, efficient, and environmentally friendly, but this vision requires ongoing commitment and action.

The GEO4CIVHIC business plan, as outlined previously, will rely on six primary KERs, which will be marketed as distinct products. These products fall into major categories:

Heat Pump Technology:

1. A plug-and-play heat pump that offers both variable and fixed speed drivers.
2. A heat pump tailored for high temperatures and dual-source operations.
3. Heat pumps specially designed for refurbished civil and historical buildings.

[2] Cheap-GSHPs D8.2 “Business Model Report” - Teresa Magraner (UPV), Nick O’Neill (SLR), Fabio Poletto (GALLETTI), A. Bernardi (CNR-ISAC)

Drilling Technology:

4. A versatile, compact drilling rig JOY 3P GEO4CIVHIC.
5. A semi-automatic feeder designed for mounting drilling rods and co-axial tubes.
6. Compact components for vibration-rotation drilling, including: a. VD80 b. VD105 Additional parts include: i. The vibratory hammer drill, specifically concerning its excitation cell. ii. An unbalanced shaft that maintains consistent frequency and eccentricity adjustments, ensuring a constant centrifugal force and hydraulic input conditions.

Methodology:

7. Effective co-axial heat exchangers paired with a vibration-rotation drilling head, utilizing the HY-DRA-RED method.

The business model based on Canvas also delves into the reasons potential customers might opt for GEO4CIVHIC's products and technologies. Additionally, it outlines the critical factors driving its success. The evaluation takes into consideration the following aspects of GEO4CIVHIC products and technologies:

- An overview of the product, including the context of its creation within the GEO4CIVHIC project.
- Highlighted benefits and features.
- Distinctive selling propositions.
- Benefits for customers.
- Potential limitations or areas of improvement.
- Anticipated future advancements (if any are projected).

In the Deliverable 7.4, there are gathered the main characteristics for each product adjusted to the business models based on Canvas. They are applied according to the main categories presented above in order to show the efficiency for each product developed.

5 Market analysis in the shallow geothermal sector

This market analysis has been undertaken in two distinct time frames. It delves into the historical perspective of geothermal heat pump installations and sales figures within the European market. This examination provides insights into the past performance of this technology. The analysis shifts its focus towards the future, investigating various factors that will influence the deployment of geothermal technology.

In summary, this comprehensive market analysis spans both past and future perspectives, offering a holistic view of geothermal heat pump trends in Europe. It not only assesses historical data, but also aims to guide the future development and deployment of this eco-friendly technology.

5.1 Heat pump market analysis at European level and in the participating countries

According to the most recent analysis by the IEA[3], global heat pump sales experienced an 11% growth in 2022, marking the second consecutive year of double-digit expansion for this pivotal technology in the world's pursuit of secure and sustainable heating solutions[4].

This impressive growth can be attributed to heightened policy support and incentives, driven by rising natural gas prices and concerted efforts to curtail greenhouse gas emissions. In Europe, heat pumps achieved a record-breaking year, witnessing nearly a 40% surge in sales. Notably, air-to-water models, compatible with conventional radiators and underfloor heating systems, saw a remarkable upswing of almost 50% in sales across Europe[5].

In 2021, heat pumps covered approximately 10% of the world's space heating requirements. However, the adoption rate is rapidly accelerating.

When examining annual growth in heat pump sales across different regions in 2021, it becomes evident that the European Union experienced exceptional progress. Heat pump sales in the EU soared by a remarkable 33.8% over the previous year, solidifying its position as the fastest-growing market globally for this transformative heating technology[6].

In 2022, global heat pump sales surged by 11% compared to the prior year, following a 13% increase in 2021 over 2020 figures. Specifically, data from the European Heat Pump Association for 2022 revealed an impressive sales growth of nearly 38%.

The sales figures for early 2022, gathered from 16 European nations by EHPA, indicate a notable 38% surge in heat pump sales, surpassing the 34% growth observed in annual sales during 2021.

Presently, Europe boasts approximately 20 million interconnected heating heat pumps, encompassing both air-to-air and hydronic (water-based) systems, along with hot water heat pumps. These collectively provide heating solutions for roughly 16% of residential and commercial buildings across the continent[7].

[3] IEA – International Energy Agency

[4] https://www.iea.org/commentaries/global-heat-pump-sales-continue-double-digit-growth

[5] Report about global heat pump sales on IEA 2022

[6] IEA, The Future of Heat Pumps, 2022

[7] EHPA, Heat pump record: 3 million units sold in 2022, contributing to REPowerEU targets, 2023

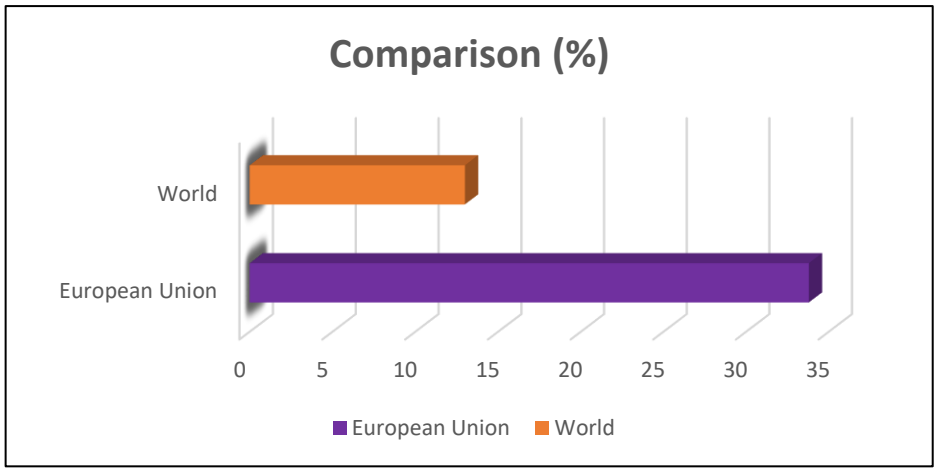

Figure 16 - EU and world annual growth in sales of heat pumps
(Source: IEA – *The Future of Heat Pumps,* 2022)

In 2022, European heat pump sales experienced remarkable growth, surging by +38.9%, achieving a new record with 3.00 million units sold throughout the continent. Considering an average lifespan of around 20 years, the current European heat pump inventory stands at approximately 19.79 million units, of which 17.86 million cater to space heating needs. This signifies that heat pumps now play a crucial role in over 16% of the heating solutions within Europe's vast residential landscape, encompassing roughly 120 million residential buildings.

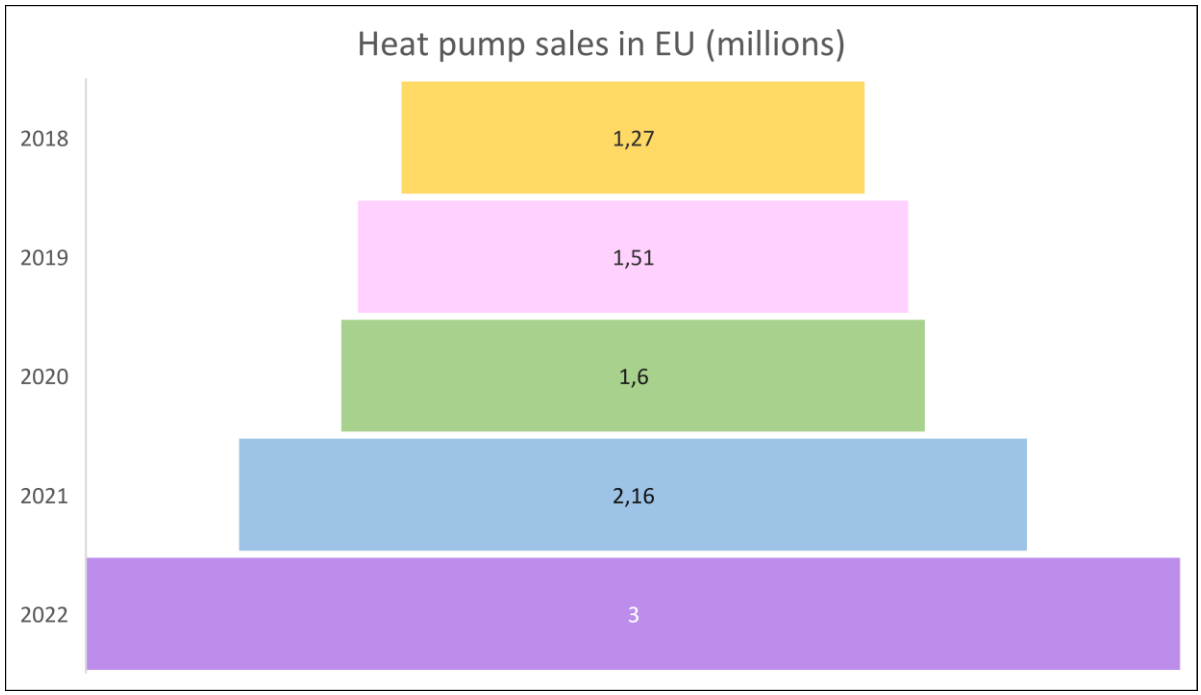

Figure 17 - Heat pumps sales evolution
(*Source: Statistics Report of EHPA, 2023*)

This impressive heat pump market expansion can be attributed to the following influential trends:

- Technological advancements have widened the capabilities of modern heat pumps, enabling them to operate efficiently across a broader temperature range. They can still function at -25°C while increasingly providing hot water at 65°C, making them

applicable in a much larger variety of buildings than a decade ago. Hybrid systems have further facilitated heat pump adoption, even in renovation projects.

- The imperative to expedite the energy transition, especially in the heating and cooling sector, has thrust heat pumps into the spotlight of policymakers. Recent legislation enacted over the past eight years has been implemented across all member states, impacting the industry positively. Building standards now prescribe maximum heat demand per square meter, mandate renewable energy integration, and favor smart building solutions. This is often complemented by institutional and financial incentives, which simplify market development.
- The continually increasing sales volume has resulted in cost reductions. Economies of scale are becoming evident both at the component and product levels. Additionally, the rapid decline in the production costs of photovoltaic (PV) systems has influenced the heating market significantly. Combining self-produced electricity with heat pump systems offers an exceptionally cost-effective energy source for buildings. Moreover, the potential for demand response services provided to the grid, which could evolve into a viable business model and income source, is on the horizon, although it has not fully materialized yet.

These developments collectively contribute to the evolution and growth of Europe's heat pump markets[8].

Table 2 - Sales of heat pumps in 2022 in selected countries
(Source: EHPA Statistics, 2023)

Country	Heat pumps sales 2022	Growth in sales 2021 to 2022 (% units sold)	Growth in sales 2021 to 2022 (no. units sold)
Austria	49,204	+59%	+18,227
Belgium	32,965	+66%	+13,121
Czechia	60,065	+99%	+29,886
Denmark	88,833	+20%	+14,892
Finland	196,359	+52%	+66,984
France	462,672	+20%	+76,176
Germany	236,000	+53%	+82,000
Italy	502,349	+37%	+134,429
Netherlands	123,208	+80%	+54,796
Norway	156,295	+25%	+31,267
Poland	195,480	+102%	+98,540
Portugal	29,969	+17%	+4,357
Switzerland	41,209	+22%	+7,505
Spain	161,800	+21%	+28,129

As seen in the previous table, Poland exhibits a substantial lead in the growth of heat pump sales compared to 2021, with a remarkable increase. It is followed closely by Czechia, the Netherlands, Belgium, Austria, Germany, and Finland, all of which also experienced significant sales upticks.

[8] European Heat Pump Market and Statistics Report, 2023

Another group of countries demonstrates robust growth, ranging from 20% to 40%. These include Italy, Norway, Spain, Switzerland, Denmark, and France, all of which registered noteworthy expansions in heat pump sales.

Another important aspect that has to be taken into consideration is that heat pumps help in reducing the carbon emissions. So, the transition from fossil fuels to heat pumps aids the advanced economies, in the European Union, to reduce their heating-related carbon emissions thanks to the heat pumps, as the report *The Future of Heat Pumps*, by IEA, suggests. In the following, there is presented the projection for carbon emissions reduction from 2021 figures to 2030 forecasts.

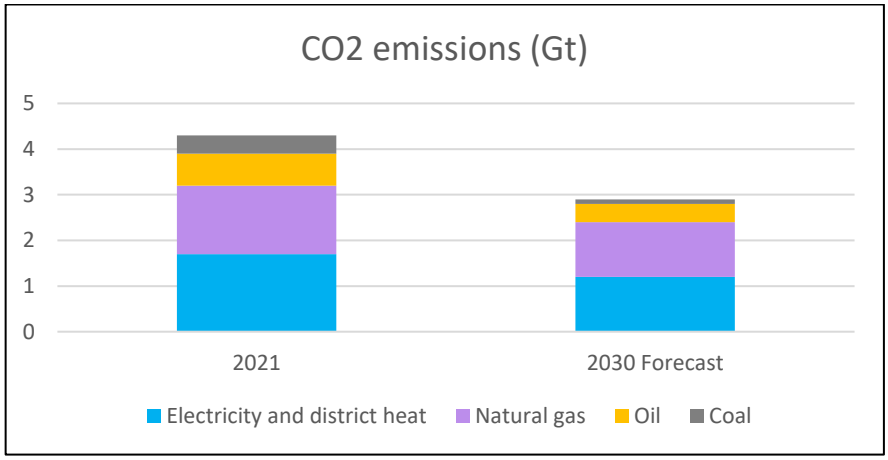

Figure 18 - CO2 emissions from 2021 to 2030 forecasts
(Source: EHPA, Heat Pumps in Europe – Key Facts & Figures, 2023)

5.1.1 Belgium

In Belgian residential buildings, the primary energy source is natural gas, closely followed by fuel-oil. In non-residential buildings, electricity is the most commonly used energy source, with limited usage of district heating.

Belgium had a final energy consumption of 67.0 TWh in 2020, while the total consumption of all the 27 countries in the European Union is 1784.4 TWh, which results in a 3.75% of the total.

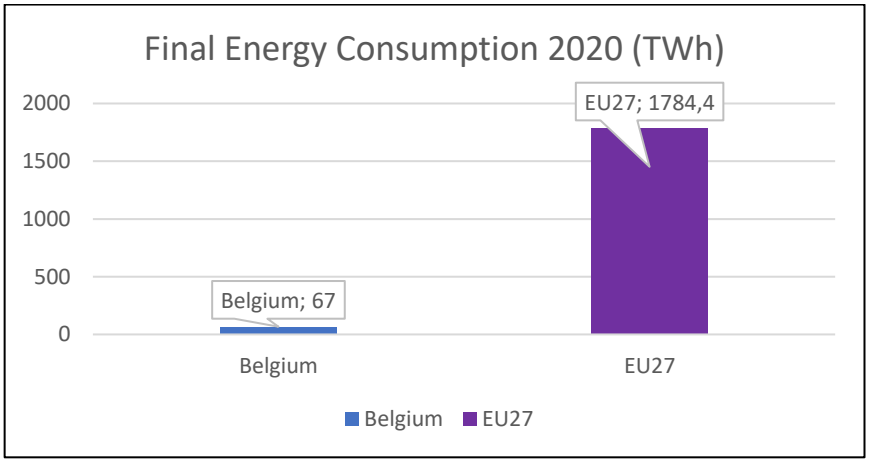

Figure 19 - Belgium vs. EU in energy consumption
(Source: BPIE, 2023)

In the following table, it is provided the saving potential by energy carrier at the level of final energy consumption showing that over half of the savings cause a decrease of the final consumption of fossil fuels (coal, natural gas, oil). As shown, in Belgium, most of the potential savings come from fossil fuels.

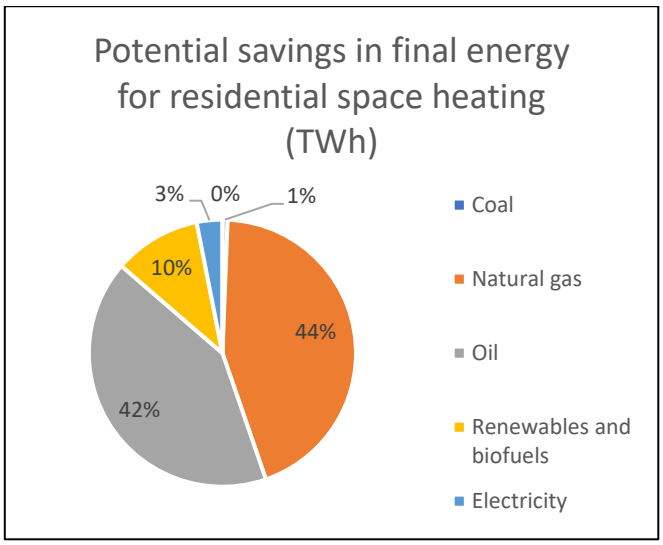

Figure 20 - Potential savings in energy for residential space
(Source: BPIE, 2023)

Summing all these potential savings up, we achieve a value of 16.1 TWh, which represents 2.07% of the total potential savings in the European Union countries.

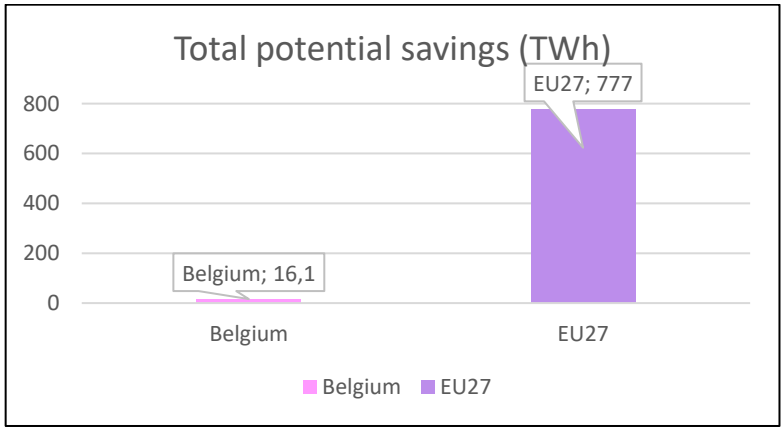

Figure 21 - Total potential savings in final energy
(Source: BPIE, 2023)

5.1.2 France

In 2020, France had a final energy consumption of approximately 283.1 TWh, so 15.86% of the total energy consumption of the EU countries.

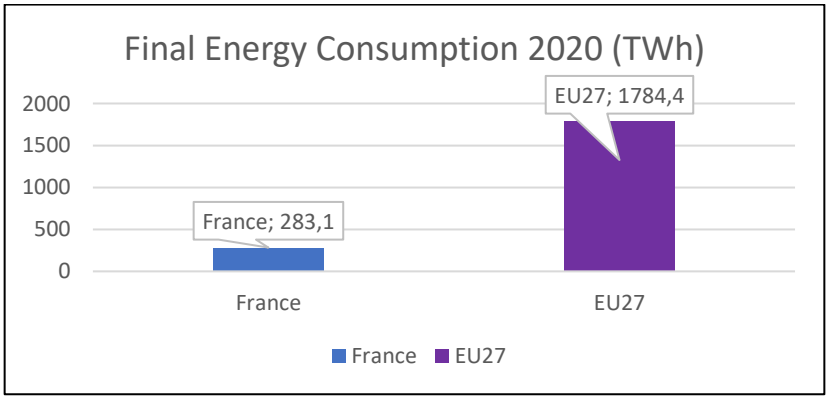

Figure 22 - France vs. EU in energy consumption

(Source: BPIE, 2023)

The next figure provides the saving potential by energy carrier at the level of final energy consumption showing that over half of the savings cause a decrease of the final consumption of fossil fuels (coal, natural gas, oil). In France, most of the potential savings come from renewables and biofuels and fossil fuels (natural gas).

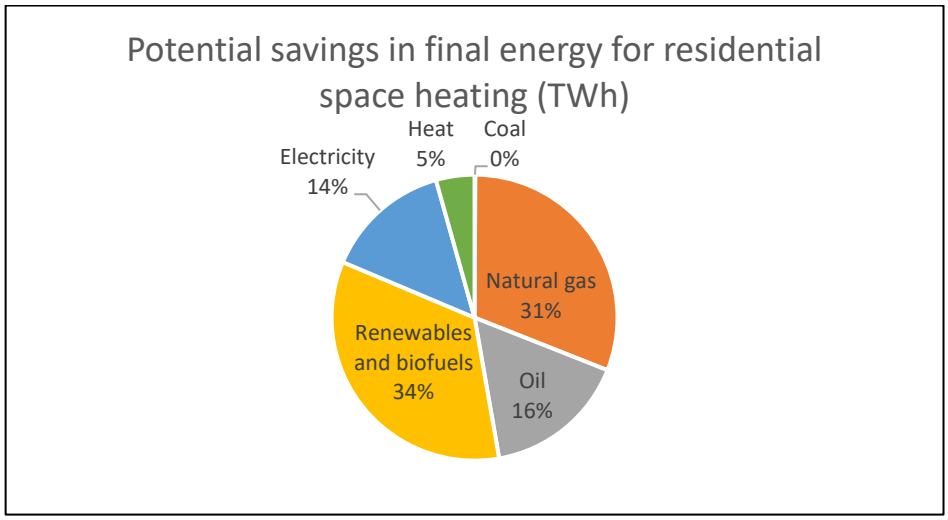

Figure 23 - Potential savings in energy for residential space

(Source: BPIE, 2023)

In total, France achieved 112.6 TWh of potential savings, which represents 14.49% of the European Union's total value of 777 TWh.

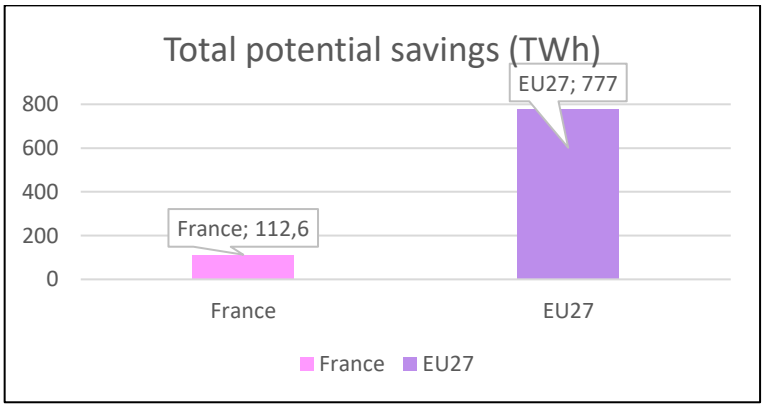

Figure 24 - Total potential savings in final energy
(Source: BPIE, 2023)

5.1.3 Germany

As shown below, representing 25.36% of the total energy consumption of EU countries in 2020, Germany had a final consumption of 452.6 Twh.

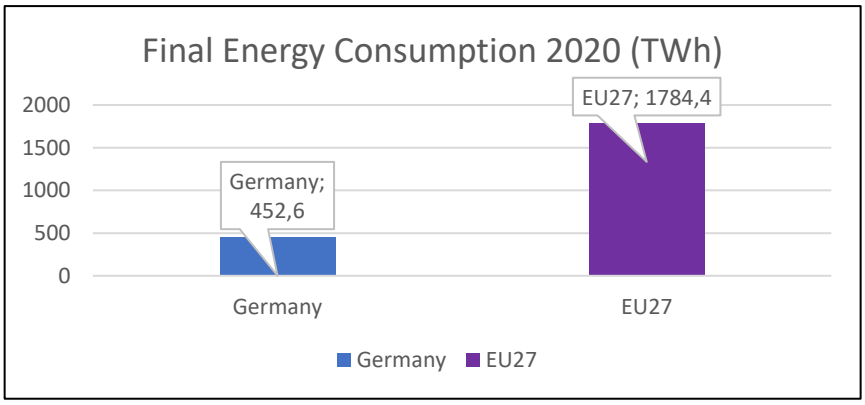

Figure 25 - Germany vs. EU in energy consumption
(Source: BPIE, 2023)

In Germany, almost three quarters of the potential savings in final energy were fossil fuels, followed by renewables and biofuels, as provided in the graph below.

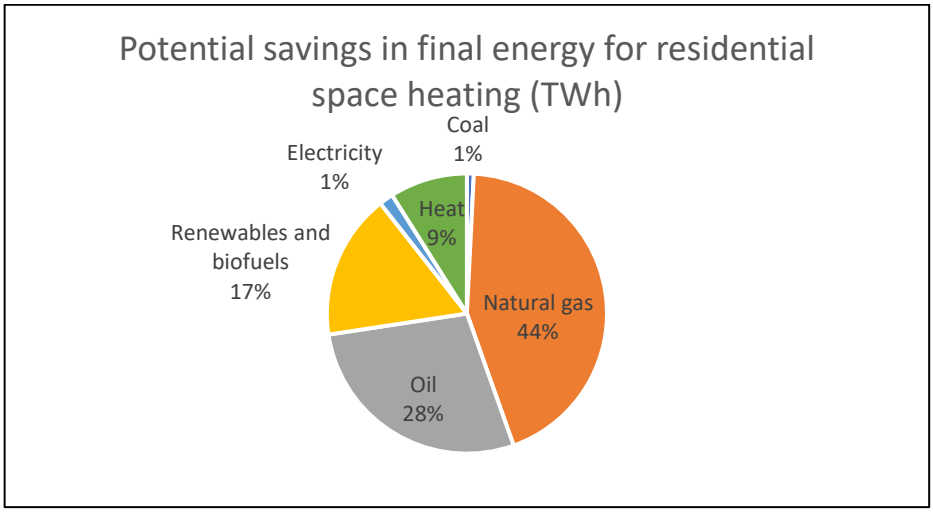

Figure 26 - Potential savings in energy for residential space
(Source: BPIE, 2023)

In conclusion, Germany had a total of 214.3 TWh potential savings, which represent 27,58% of the 777 TWh value of EU countries.

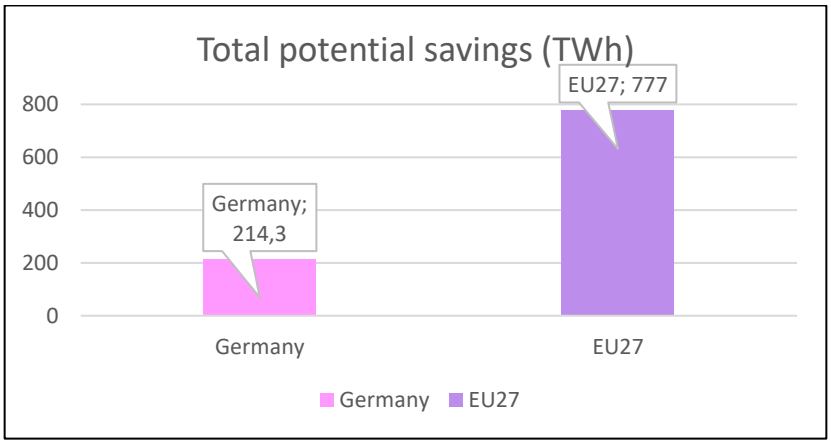

Figure 27 - Total potential savings in final energy
(Source: BPIE, 2023)

5.1.4 Greece

Statistics show that Greece had a final energy consumption of 28.3 TWh in 2020, so 1.58% of the 1784.4 TWh consumed by all the countries that are part of the EU.

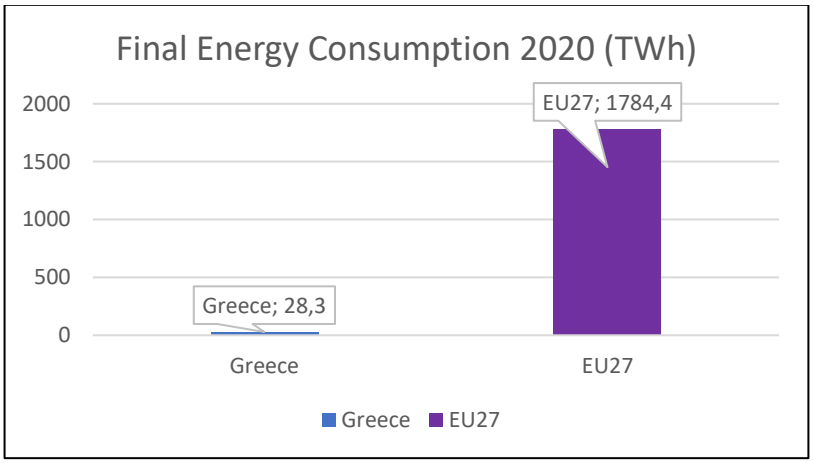

Figure 28 - Greece vs. EU in energy consumption
(Source: BPIE, 2023)

The saving potential by energy carrier at the level of final energy consumption shows that most of the savings cause a decrease of the final consumption of fossil fuels (especially natural gas) in Greek residential buildings.

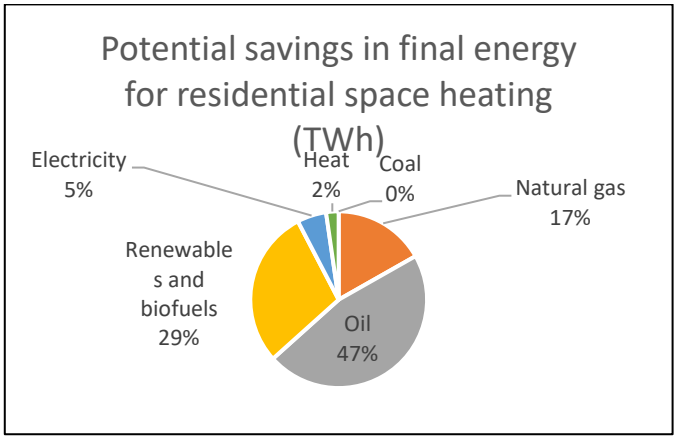

Figure 29 - Potential savings in energy for residential space
(Source: BPIE, 2023)

Summing all these values up, we obtain 13.1 TWh, that are 1.68% of the total European potential savings.

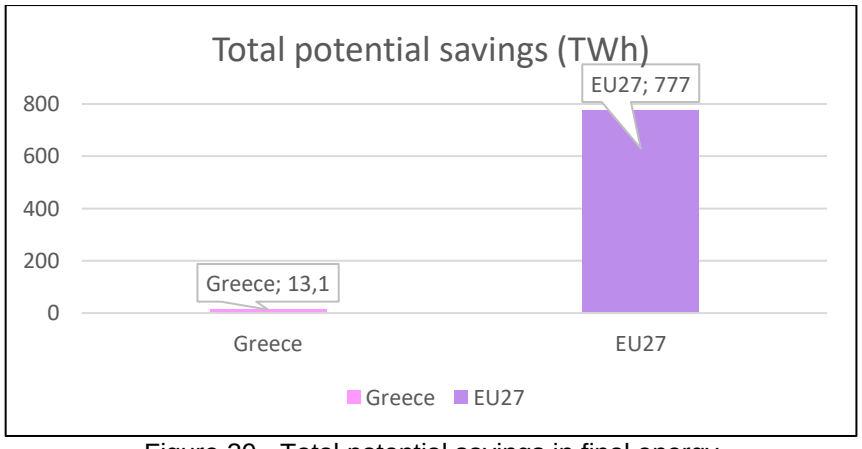

Figure 30 - Total potential savings in final energy

(Source: BPIE, 2023)

5.1.5 Ireland

In 2020, Ireland had a final energy consumption of approximately 22.1 TWh, so 2.84% of the total energy consumption of the EU countries.

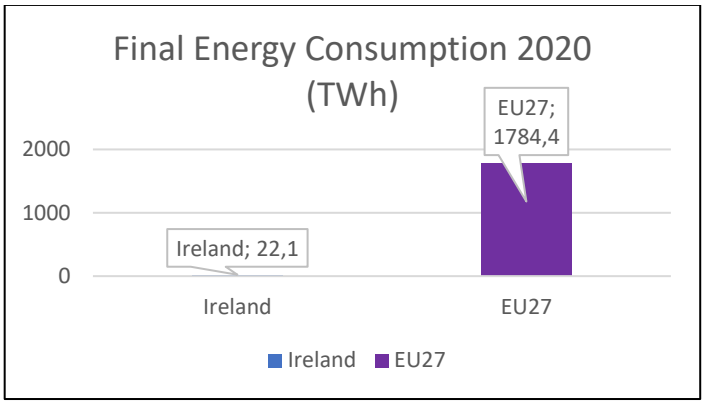

Figure 31 - Ireland vs. the EU in energy consumption
(Source: BPIE, 2023)

The saving potential by energy carrier at the level of final energy consumption shows that most of the savings cause a decrease of the final consumption of fossil fuels (especially oil) in Irish residential spaces.

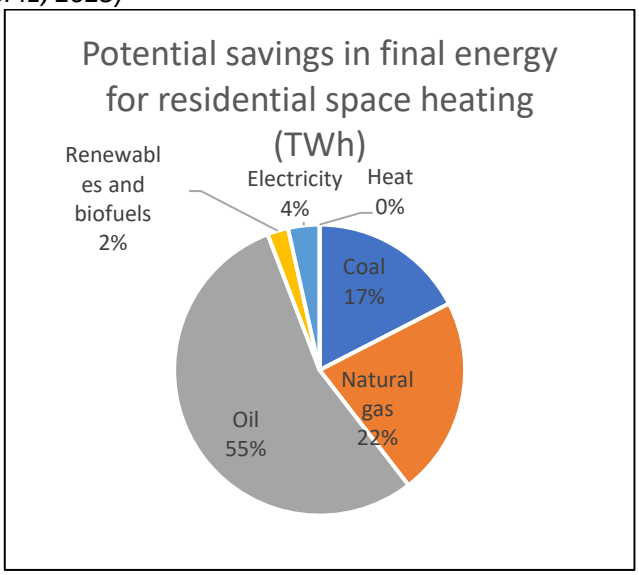

Figure 32 - Potential savings in energy for residential space
(Source: BPIE, 2023)

Ireland achieved 8.7 TWh of potential savings in energy, which is 1.12% of the European total value.

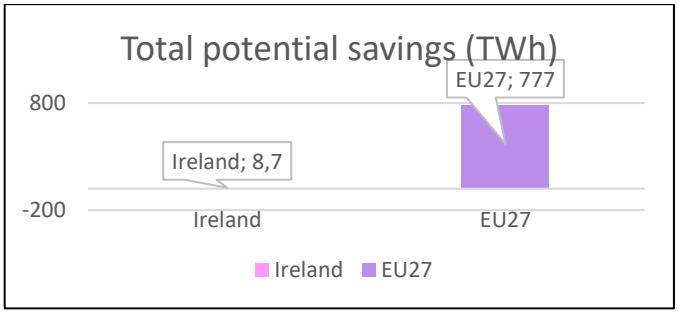

Figure 33 -Total potential savings in final energy
(Source: BPIE, 2023)

5.1.6 Italy

In 2020, Italy consumed 13.07% of all the EU countries' final energy, which results in 233.3 TWh.

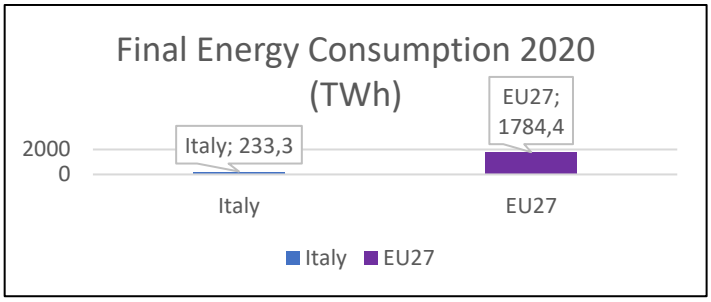

Figure 34 - Italy vs. EU in energy consumption
(Source: BPIE, 2023)

As shown in the graph below, the saving potential by energy carrier at the level of final energy consumption shows that more than half of the savings cause a decrease of the final consumption of natural gas in Italian residential buildings.

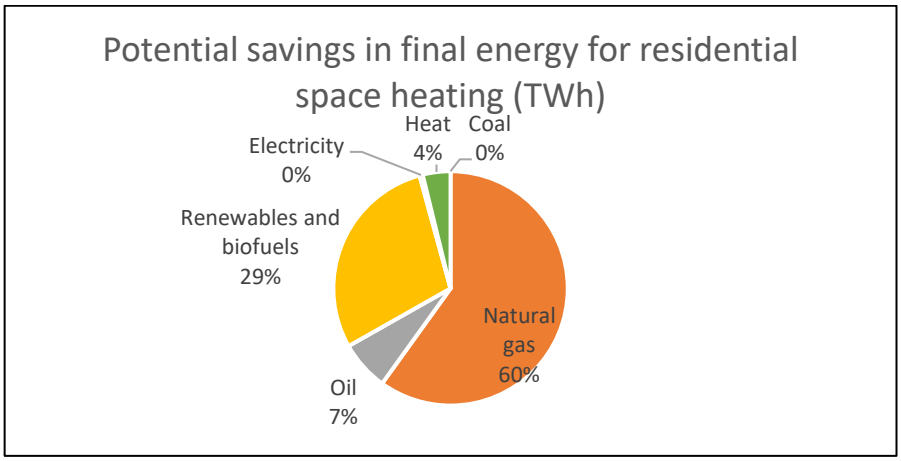

Figure 35 - Potential savings in energy for residential space
(Source: BPIE, 2023)

Summing all these values up, we obtain 114.8 TWh, which is 14.77% of the total potential savings in final energy for residential space heating of the EU countries.

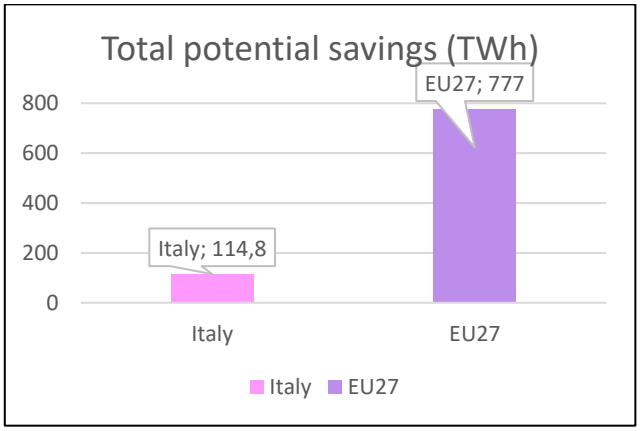

Figure 36 - Total potential savings in final energy
(Source: BPIE, 2023)

5.1.7 Malta

Comparing to the final energy consumption of the EU countries in 2020, Malta consumed only 0.01% of it and it equals 0.2 TWh.

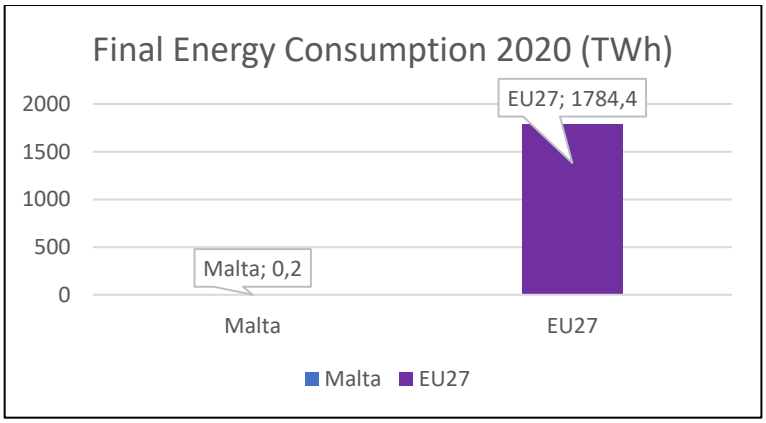

Figure 37 - Malta vs. EU in energy consumption
(Source: BPIE, 2023)

The saving potential by energy carrier at the level of final energy consumption shows that most of the savings cause a decrease of the final consumption of renewables and biofuels in the residential buildings of Malta, since the other categories are either not used or used in insignificant quantities.

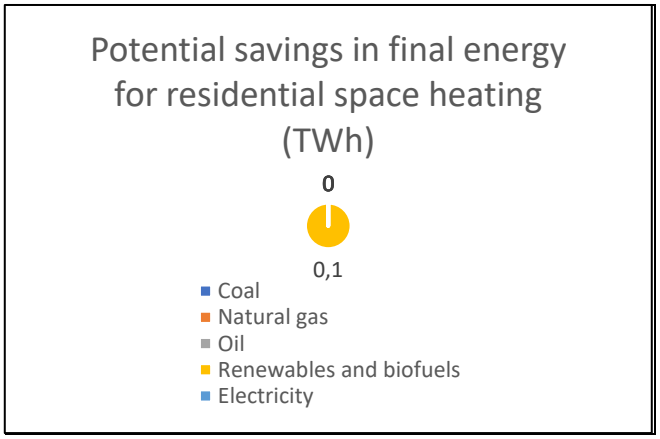

Figure 38 - Potential savings in energy for residential space
(Source: BPIE, 2023)

In total, Malta had 0.1 TWh of potential savings (of renewables and biofuels), which is only 0.01% of the total obtained by all the countries in the European Union.

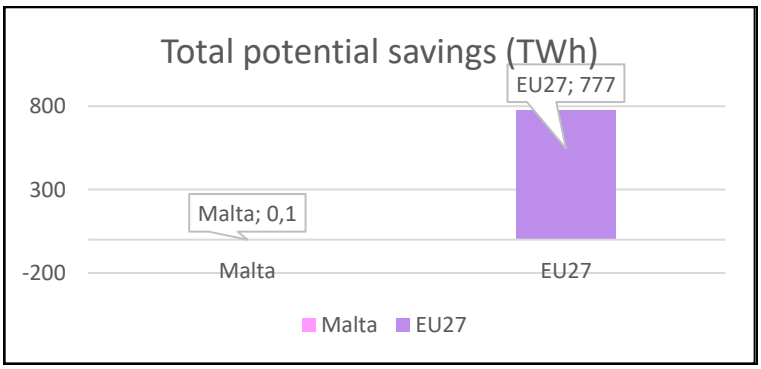

Figure 39 - Total potential savings in final energy
(Source: BPIE, 2023)

5.1.8 Romania

In the year 2020, Romania consumed 3.23% of the 1784.4 TWh consumed by all the European Union countries.

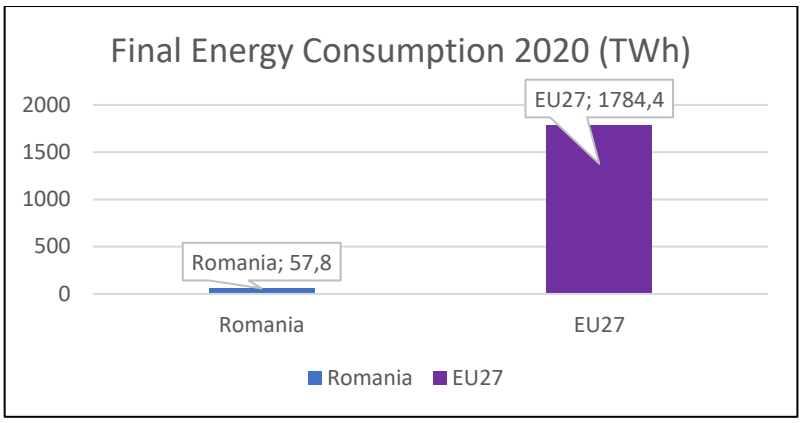

Figure 40 - Romania vs. EU in energy consumption
(Source: BPIE, 2023)

The saving potential by energy carrier at the level of final energy consumption shows that most of the savings in Romania cause a decrease of the final consumption of renewables and biofuels, followed by natural gas and heat in residential buildings.

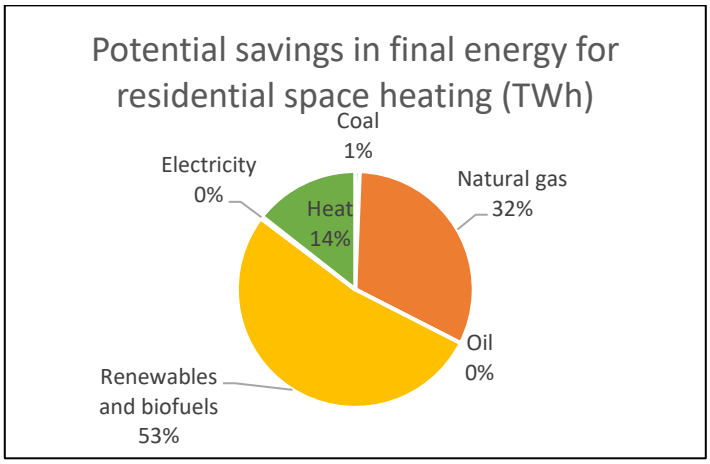

Figure 41 - Potential savings in energy for residential space
(Source: BPIE, 2023)

Romania's total value in TWh of potential savings is 32.5, which represents 4.18% of all the EU countries summed up.

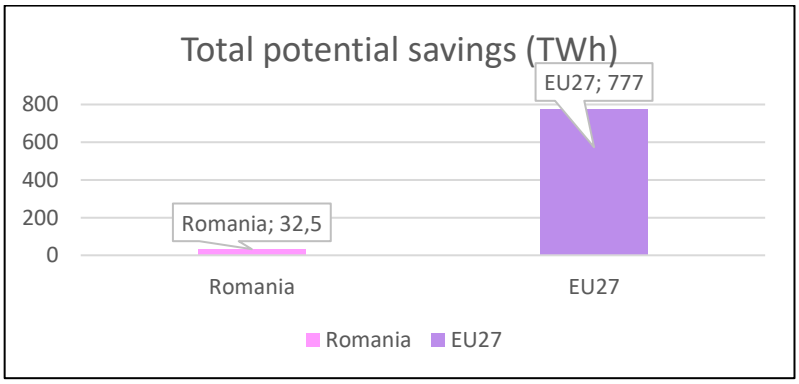

Figure 42 - Total potential savings in final energy
(Source: BPIE, 2023)

5.1.9 Spain

Out of all the EU countries' final energy consumption, Spain consumed in 2020 a percentage of 3.82% of the total value.

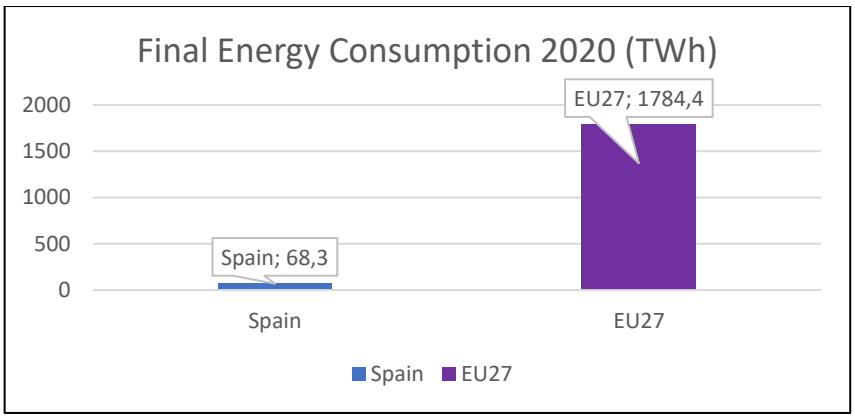

Figure 43 - Spain vs. EU in energy consumption
(Source: BPIE, 2023)

In Spanish residential buildings, the saving potential by energy carrier at the level of final energy consumption shows that more than half of the savings cause a decrease of the final consumption of fossil fuels (mostly oil and natural gas), followed by renewables and biofuels.

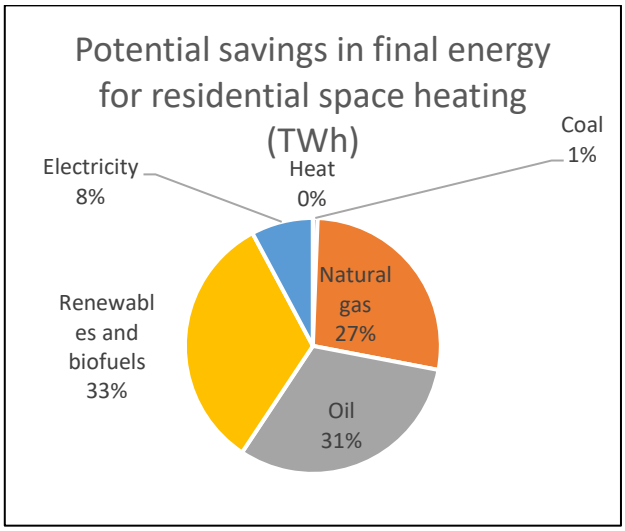

Figure 44 - Potential savings in energy for residential space
(Source: BPIE, 2023)

All these savings in Spain of 2020 contribute in the European Union's total value of potential savings in residential buildings with 4.27%

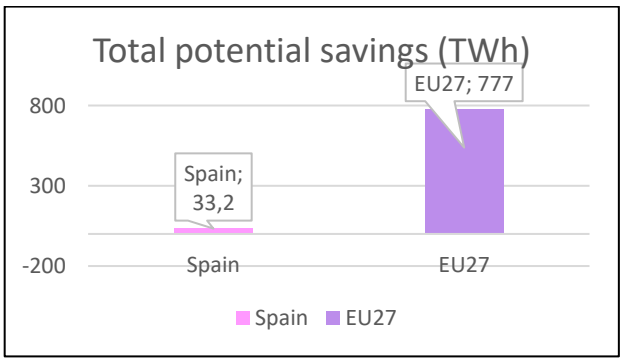

Figure 45 - Total potential savings in final energy
(Source: BPIE, 2023)

5.1.10 Switzerland

The analysis conducted in Switzerland relied on alternative statistical sources since no data were discovered in the commonly used sources.

Switzerland is presently executing its energy transition via the Energy Strategy 2050, aiming to achieve climate neutrality. As of 2020, only four out of the country's five nuclear power plants remain operational, and renewable energies accounted for approximately 28% of the total final energy consumption by 2021.

In 2022, Switzerland saw a 3.9% year-on-year reduction in its final energy consumption, which amounted to 765,070 terajoules (TJ). This decline was mainly attributed to the milder weather experienced that year compared to its predecessor[9].

The dip in energy consumption, at 3.9% from the previous year, is chiefly tied to the milder climate. There was a 17.2% year-on-year decrease in the number of heating degree days, a key metric gauging energy use for heating. Additionally, the national energy conservation campaign and a significant surge in energy prices are believed to have played a part in the decreased energy usage in 2022. However, factors influencing the persistent upward trend in energy consumption saw minor increases: the constantly residing population grew by 0.8%, the gross domestic product by 2.1%, the count of motor vehicles by 0.5%, and there was also growth in the housing sector (exact figures pending).

On the other hand, advancements in efficiency and substitution effects are tempering the rise in energy demand. Detailed analyses set to be published in October 2023 will offer deeper insights into the elements steering energy consumption trends[10].

As of 2022, the Swiss consumed mostly motor fuels and electricity as energy sources, with fuel oils and gas occupying a smaller percentage in importance.

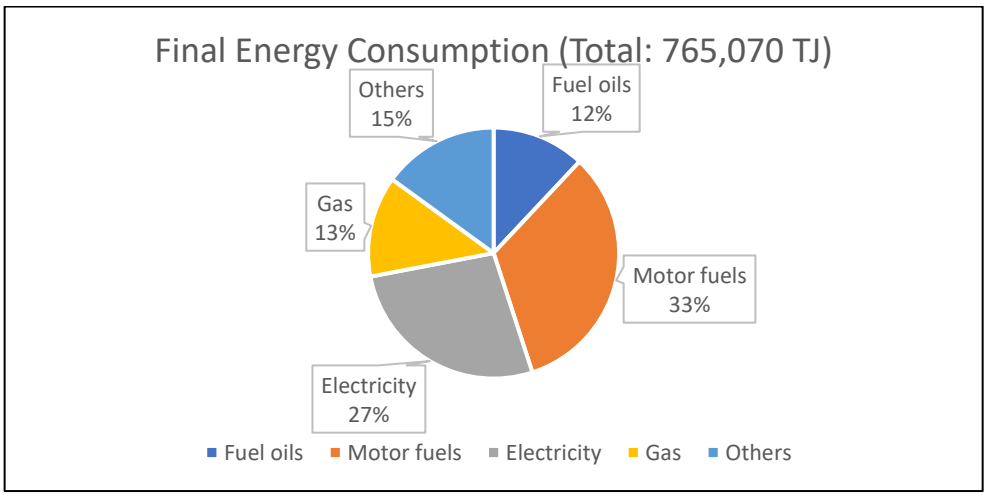

Figure 46 - Final Energy Consumption, 2022
(Source: Swiss Federal Office of Energy 2023)

Milder temperatures impacted the consumption of renewable energy sources meant for heating. Both energy wood and district heating saw reductions by 12.0% and 7.5%, respectively. Additionally,

[9] Swiss Federal Office of Energy
[10] Swiss Federal Office of Energy

the use of ambient heat via heat pumps declined by 4.5%. Solar heat consumption remained almost unchanged from the prior year with a slight decrease of 0.4%. Together, these sources account for 11.3% of the overall final energy consumption, broken down as: energy wood at 5.4%, ambient heat at 2.7%, district heating at 2.8%, and solar heat at 0.3%[11].

5.2 Implementation criteria on the GSHP market

Ground Source Heat Pumps (GSHP) in the Shallow Geothermal Energy is confirmed to be one of the most sustainable and lucrative technology. Though broadly accessible, its market maturity varies amongst EU member states and even within individual countries.

In the EU, heating and cooling account for half of the total energy consumption, with 75% originating from fossil fuels. In a move to curtail energy use and mitigate the impacts of climate change, the European Green Deal was sanctioned by the European Commission in September 2020.

Through this directive, the EU Commission has set forth an ambitious roadmap aiming to decrease GHG emissions by 55% by 2030, relative to the 1990 figures. The objective is to reach climate neutrality by 2050.

Notably, the EU is heavily reliant on energy produced outside its boundaries. This dependency has seen an uptick, growing from 56% in 2000 to 61% in 2019[12].

The shallow geothermal resource, available almost everywhere, operates as a constant renewable energy source. Ground Source Heat Pumps (GSHP) harness this energy to offer renewable space heating and cooling (H&C) as well as domestic hot water[13]. Between 2019 and 2024, the IEA forecasted a growth of over 40% in direct surface geothermal.

The EU's GSHP market faced challenges due to the COVID-19 pandemic, yet managed to sell around 100,000 units[14].

In the future, this type of energy is awaited to increase due to the heating and cooling demand that keeps on growing each year.

5.2.1 General future guidelines for heating and cooling demand

According to the Heat Roadmap Europe 2050, the heating market isn't anticipated to see growth in the upcoming years. In fact, a slight decline is projected in the residential sector due to enhancements in construction quality, such as insulation.

[11] Swiss Federal Office of Energy

[12] European Comission COM. 51 Final. An EU Strategy on Heating and Cooling. Communication from the Comission to the European Parliament, The Council, the European Economic and Social Committee and the Comittee of the Regions. 2016. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52016DC0051

[13] European Commission COM. 562 Final. Stepping up Europe's 2030 Climate Ambition Investing in a Climate-Neutral Future for the Benefit of Our People. 2020. Available online: https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A52020DC0562

[14] Marco Torregrossa, *Energy-efficiency investment with special regard to the retrofitting of buildings in Europe*

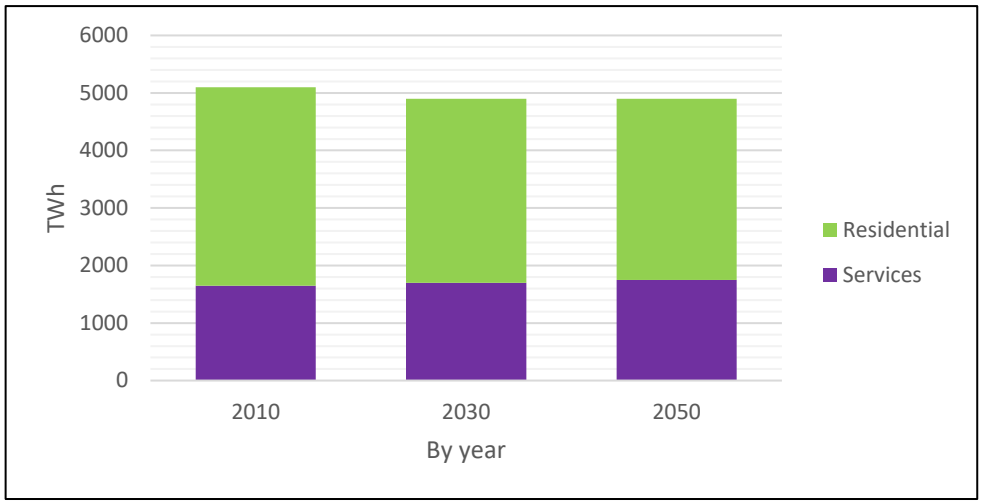

Figure 47 - Heating EU market estimation
(Source: Heat Roadmap Europe)

In contrast to the heating market, forecasts indicate that the cooling market will expand in the coming years. Studies from RESCUE predict that from 2010 to 2030, its value will double. Also, the Europe cooling market overpassed 44.3 billion in 2022; this market will expand with 3.2% CAGR in the period 2023-2032.

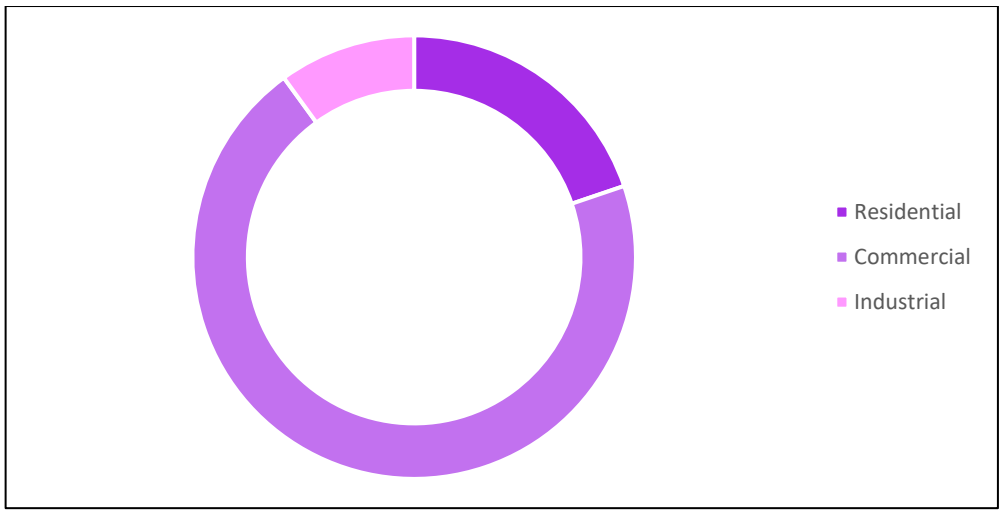

Figure 48 - Europe District Cooling Market Revenue Share, by Application (2022)
(Source: www.gminsights.com)

This growth is anticipated in both the residential and services sectors, with the former seeing a more significant surge. The primary takeaway from this demand projection is the need to promote reversible GSHPs to ensure they play a role in this burgeoning cooling market.

5.2.2 Building market analysis in Europe

The building inventory in the EU urgently requires energy-efficient refurbishments to diminish its operational carbon footprint. As for the opinion of the European Environment Agency (EEA) in deepening their comprehension of the behavioural aspects that impact decisions related to energy efficiency in building renovations. This assistance aims to mitigate the disparity in greenhouse gas (GHG) emissions within Europe's buildings.

Emphasis on the current market reveals that almost 75% of all buildings in Europe are allocated for residential purposes, with the remaining 25% dedicated to the tertiary sector, encompassing services and offices. Within the residential category, there is a division between single-family homes and apartment complexes, with single-family houses being the predominant choice.

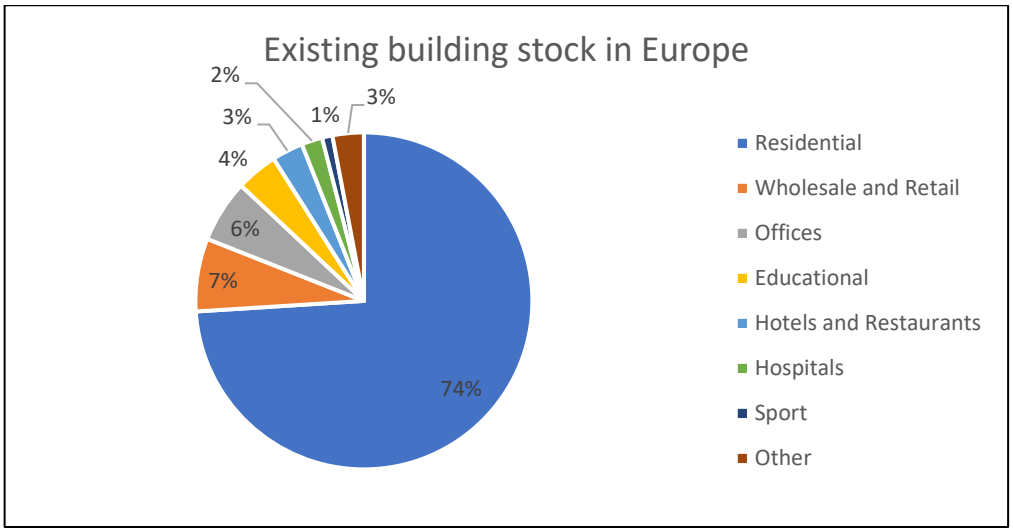

Figure 49 - Existing building stock in EU
(Source: Ecorys)

The age of the building stock is a crucial factor to consider, as the year of construction often determines the need for refurbishments and updates to air-conditioning systems. A BPIE study breaks down the age of the European housing stock into three regions: southern, central, and eastern[15]. The study categorizes houses into three construction timeframes: those built before 1960, those constructed between 1961-1990, and those erected between 1991-2010.

Across Europe, 38% of residences were built in the first period, 45% in the second, and 17% in the most recent period. The southern region predominantly features older houses (constructed before 1990), yet it's the central area that has the majority of homes built before 1960. The eastern region's figures are somewhat similar to the southern region, but with a higher proportion of newer constructions (from 1991-2010)[16].

In the European Union, there are almost 131 million buildings, most of them are residential; for example, out of 10 buildings, 9 are residential and 1 is with another purpose. Among the EU countries at residential level, France has 21 million buildings, followed by Germany with 19 million, Italy and Spain with 10 million each. The other 39 million buildings are divided in the other 23 countries in the EU.

Currently, 20% of the European residential buildings have been renovated in order to adapt to the climate changes and 9% of the non-residential stock has been upgraded as well for this purpose[17].

As observed, it is needed to renovate a lot of buildings due to the age of the built stock and to the energy efficiency targets that need to be reached.

[15] Cheap-GSHP D8.1
[16] Cheap GSHP D8.1
[17] RICS Data Services, 2022

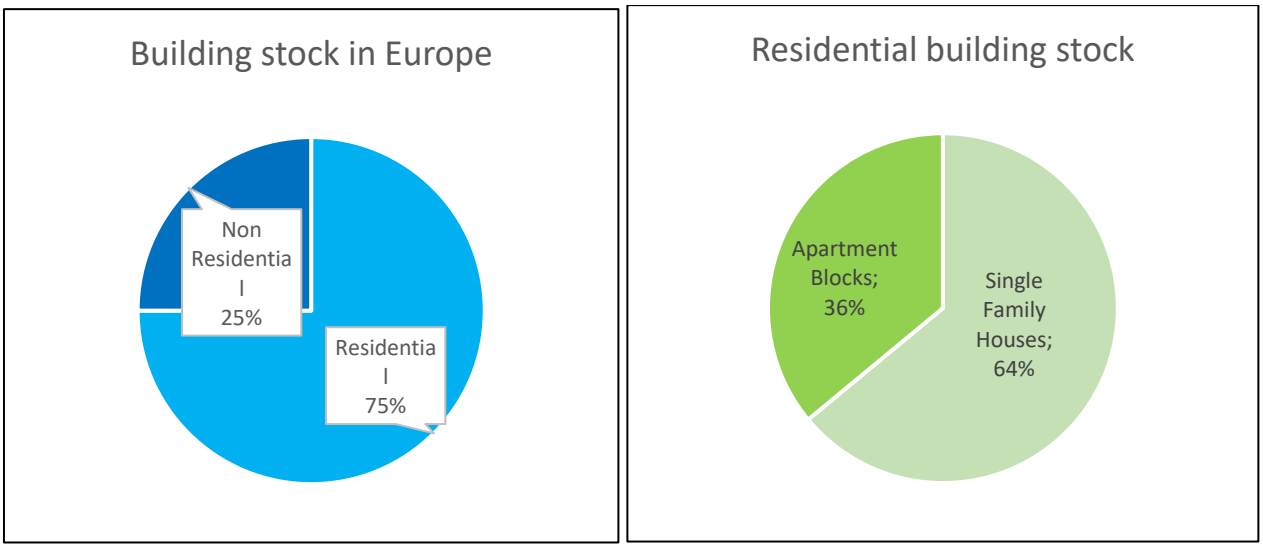

Figure 50 - Breakdown European building stock
(Source: Research Gate)

In Europe, when examining the significance of the refurbishment market relative to the market for new housing constructions, it's evident that the former holds substantial weight. This assessment is based on the activity volume (in million euros) for specific countries representing different European zones: southern (Italy and Spain), eastern (Romania), and central (Germany and France).

From the data, it's clear that the refurbishment market is notably dominant in Germany, Italy, and Romania. Between 2018 and 2021, an upward trajectory is evident for all countries, except Romania, for which data is missing. Interestingly, the refurbishment sector in France and Italy is growing at a faster rate than the new construction market. In contrast, Germany and Spain see parallel growth for both markets.

In the past years, the non-residential building stock has faced different challenges. In some countries, there have been developed many non-residential buildings, especially in South-Eastern Europe. In Western and Central Europe, the main actors on this market have focused more on residential buildings. Below, you can see a schema with the non-residential building stock, in order to have an overview on this subject.

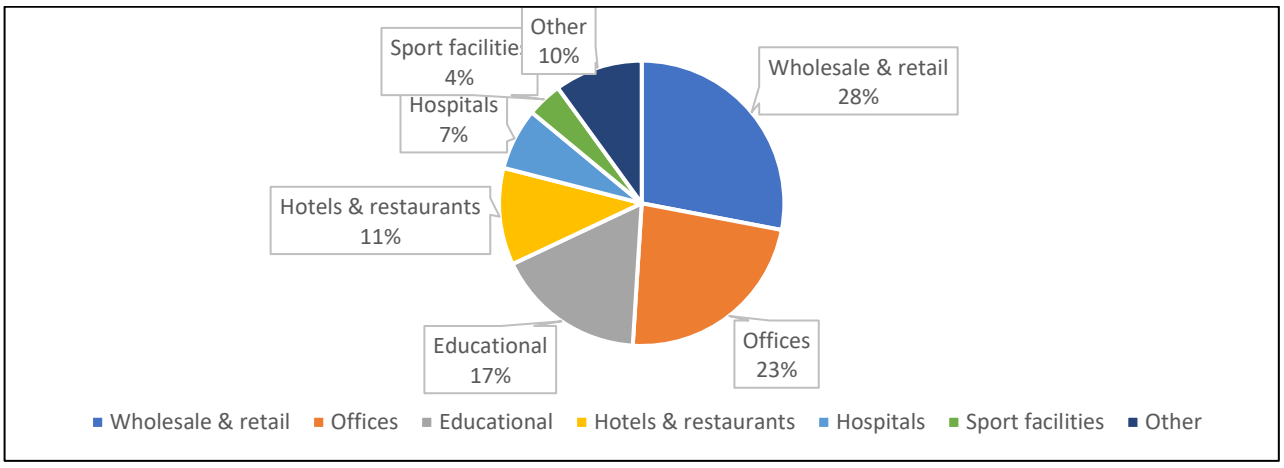

Figure 51 - Non-residential building stock (m^2)
(Source: ResearchGate)

The data indicates a great opportunity for energy efficiency retrofits to both residential and non-residential buildings located in the European Union. Since 2002, there have been introduced the EPC (Energy Performance Certificate), in order to see which buildings are most efficient and which are least efficient. In the EU, the statistics in the RICS organization present a percentage of 35% of buildings that have been rated as very low efficient, so they need to improve their energy efficiency rating.

In conclusion, the refurbishment sector presents a promising avenue for GSHP development. While the new construction market remains appealing—especially as renewable energy sources can be seamlessly integrated—the available data indicates post-crisis market expansion in most participating countries.

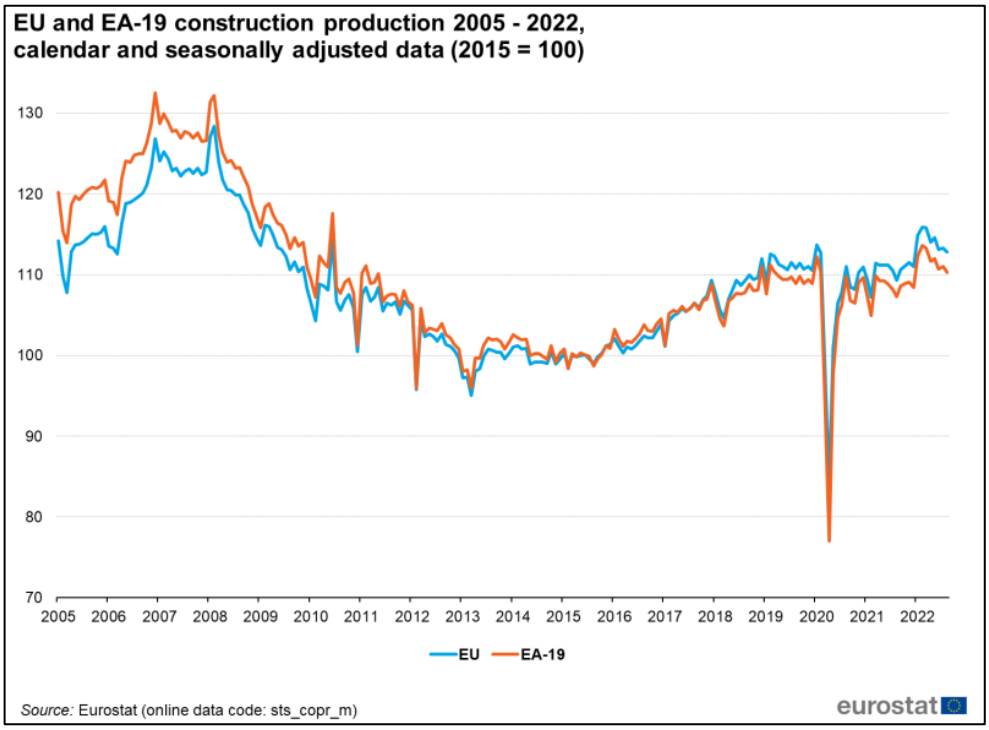

Figure 52 - Construction production index overview
(Source: Eurostat)

5.2.3 Retrofit market aspects in the EU buildings area

Energy efficiency holds immense potential for reducing emissions in the EU, with the capacity to achieve a substantial 33 percent reduction in emissions across the economy by 2020. Notably, buildings contribute significantly to the EU's energy consumption, making them a crucial target for greenhouse gas reduction efforts.

To reach energy efficiency targets, substantial annual investments of up to 65 billion euros are required for building retrofits until 2020, and a staggering 4.25 trillion euros are needed for energy efficiency investments across the economy between 2011 and 2050, aiming for an 80 percent reduction in EU greenhouse gas emissions. However, despite this promising potential, energy efficiency remains underinvested, accounting for only 7 percent of global clean technology investment in 2011[18].

[18] Marco Torregrossa, *Energy-efficiency investment with special regard to the retrofitting of buildings in Europe*

The current approach to implementing energy efficiency measures is proving ineffective. While commercial investors are recognizing the economic advantages of energy efficiency, there is a scarcity of tangible, large-scale investment opportunities in this sector.

Even Bloomberg New Energy Finance's analysis revealed limited investment in real-world retrofit projects, focusing instead on corporate research and development, venture capital, and private equity.

The potential for investment in energy efficiency is abundant, and according to the Marginal Abatement Cost (MAC) Curve by McKinsey & Co, the costs of energy efficiency initiatives are relatively modest compared to investments in power generation.

However, significant barriers hinder the realization of this potential, including misconceptions about the costs involved in energy efficiency projects. These barriers need to be addressed to unlock the substantial environmental and economic benefits of energy efficiency in the EU.

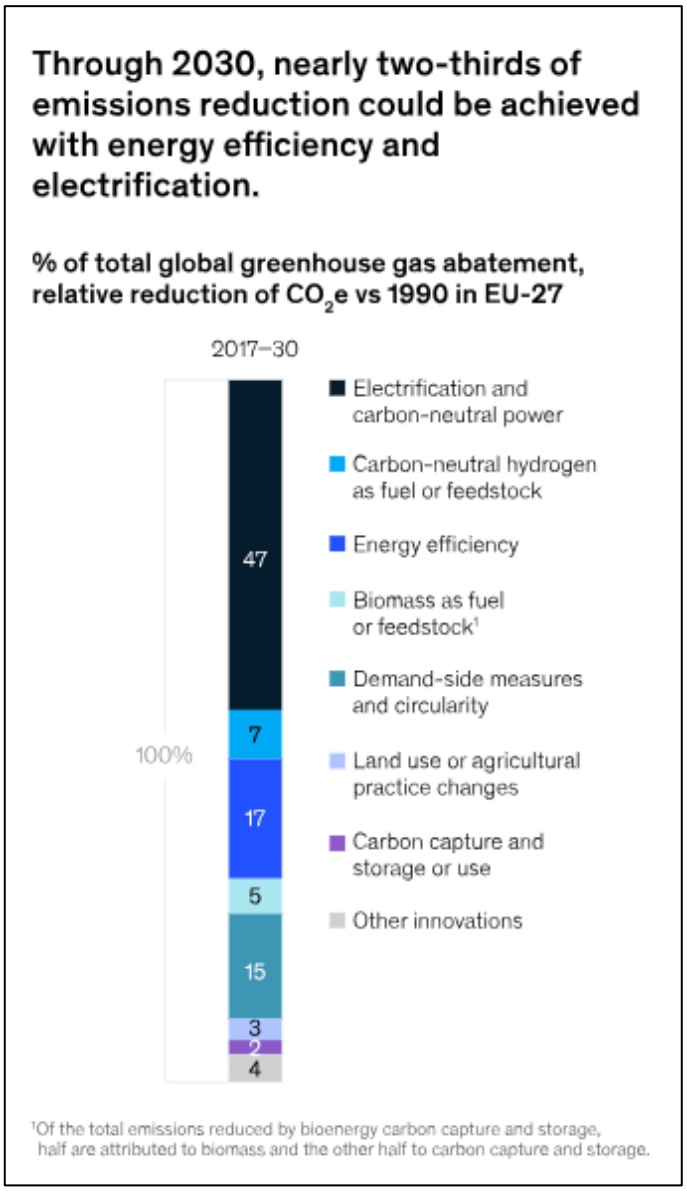

Figure 53 - CO2

(Source: McKinsey & Co.)

The Ground Source Heat Pump market expansion faces challenges, notably in its utilization for retrofitting buildings in urban settings. In order to address these challenges, the partners in this project offered multiple solutions tailored to shallow geothermal energy application in retrofit environments. These solutions took into account factors like building type, climate, and geological conditions below the ground, encompassing various aspects of the geothermal system such as drilling techniques, ground heat exchangers, grouting, and heat pumps[19].

Below, there is a suitable map for the technologies regarding shallow geothermal energy, especially establishing the main areas from Europe where the drilling is proper. This map offers insights at measure of 1 square kilometer, spanning across European countries.

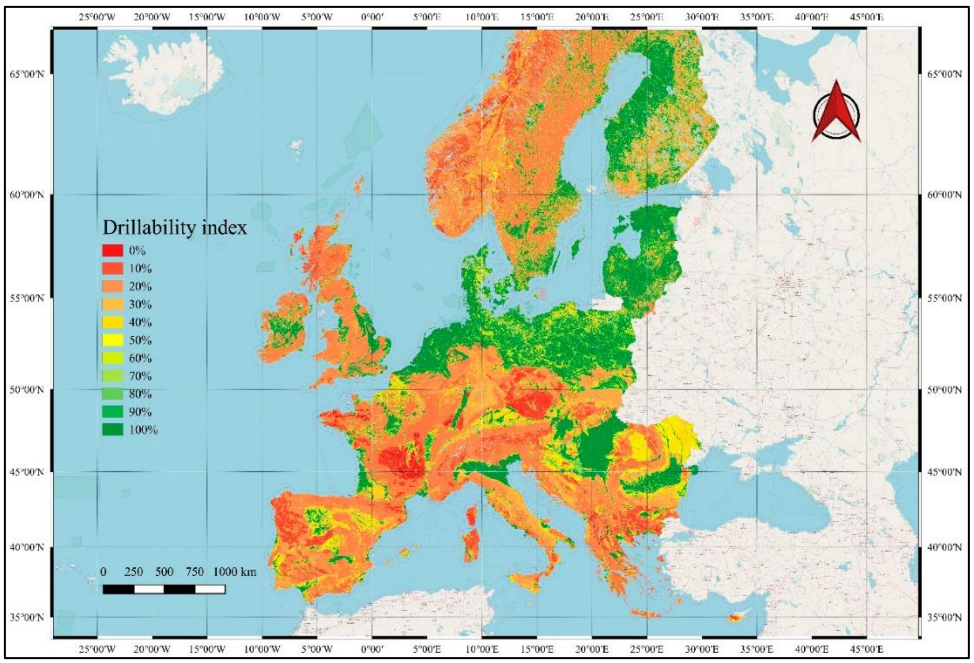

Figure 54 - Probability of suitable conditions for Europe drilling
(Source: Suitability Evaluation of Specific Shallow Geothermal Technologies[20])

The findings pinpoint specific regions in Europe that are particularly well-suited for the implementation of the proposed combination of GSHP technologies. These regions encompass various urban areas, alluvial plains, and areas with a Central-European climate.

5.2.4 GSHP market development

In 2022, the European GSHP market overpassed 900 million dollars and is yet to expand up to 5% in the next 10 years. The main reasons for this expansion are:

1) The need to use clean energy technology for residential buildings;

[19] Michele de Carli, Adriana Bernardi, *The H2020 project GEO4CIVHIC – Most Easy, Efficient and Low Cost Geothermal Systems for Retrofitting Civil and Historical Buildings* (August 2019)

[20] Francesco Tinti, Sara Kasmaee, Mohamed Elkarmoty, Stefano Bondua, Villiam Bortolotti – University of Bologna

2) The need for commercial application;
3) Low energy consumption devices implemented;
4) States' policies.

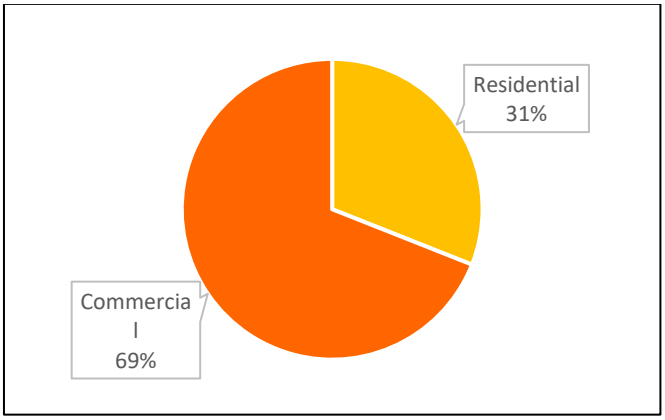

Figure 55 - Europe Geothermal Heat Pump Market Revenue Share (2022)
(Source: Analysis Report, gminsights.com)

In addition, market evolution is not solely reliant on technological familiarity, but also on potential rival technologies, as such it's vital to amplify the benefits of GSHP systems to sustain growth.

In 2022, 14 new systems in this field became operational. Out of the geothermal heating and cooling systems, 261 are located in the European Union, with 12 of them being commissioned in 2022. The upward trajectory is anticipated to persist, with 316 projects presently under review. This could potentially contribute more than 700 MW to the existing capacity of 5,608 MW[21].

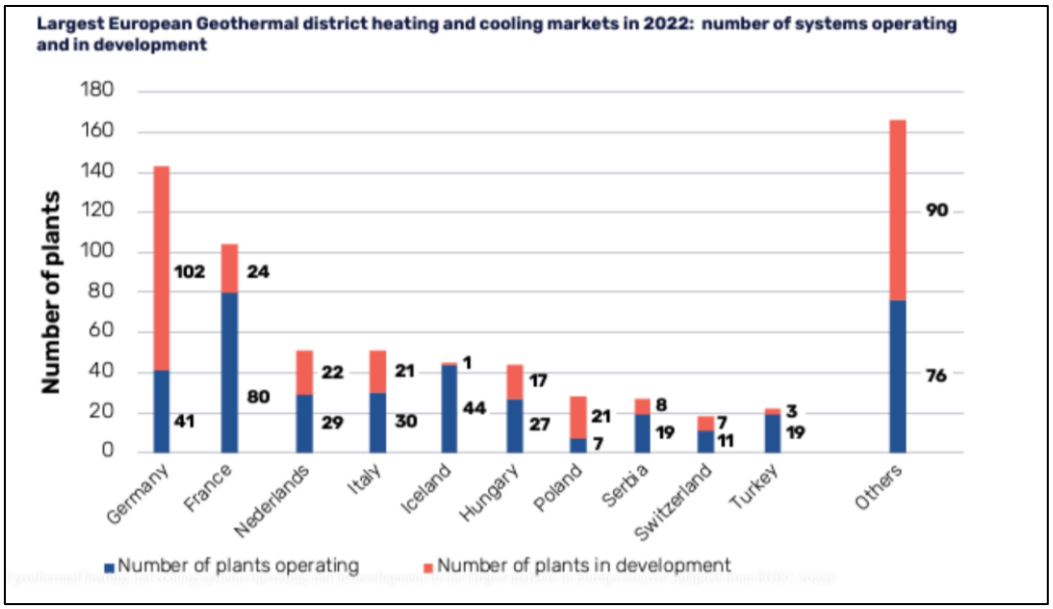

Figure 56 - Geothermal heating and cooling systems no. in Europe
(Source: Adapted from EGEC, 2023)

[21] EGEC Geothermal Market Report, 2022

The REPowerEU goals set by the EU mandate that the number of newly connected heat pumps should double annually. Based on EHPA's calculations, this would result in an additional 60 million heat pumps by 2030, a significant increase from the 17 million units in place when REPowerEU was introduced in 2021.

In 2022, a significant milestone was reached with the installation of over 141,300 geothermal heat pump systems, marking a record-breaking year for this technology. What's even more promising is that the momentum appears to be continuing, as evidenced by the first-quarter data of 2023 in Germany and Sweden. These two countries are at the forefront of geothermal heat pump sales in Europe.

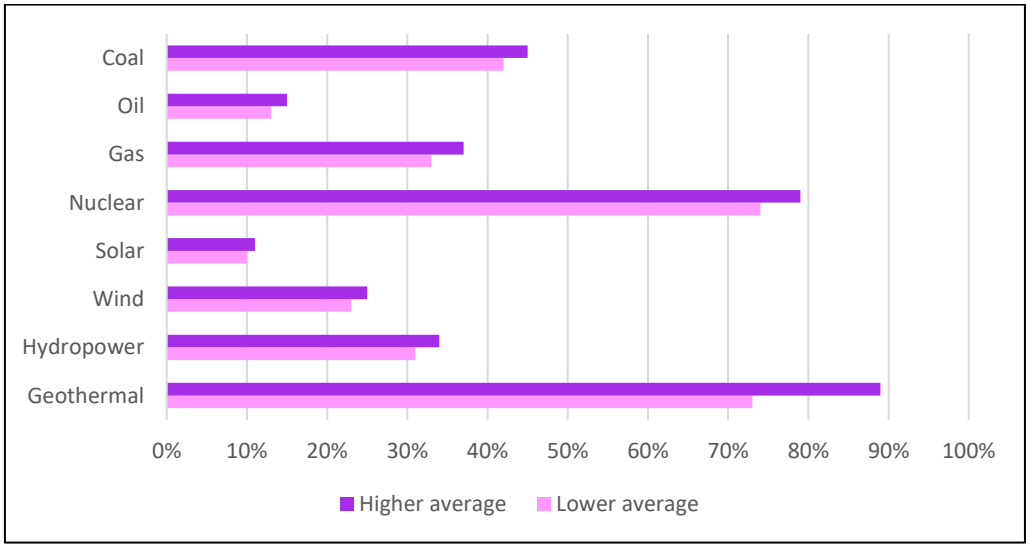

Figure 57 - Average European capacity/per electricity sources, 2022
(Source: EGEC)

The outlook for geothermal energy, particularly with respect to geothermal heat pumps, is highly promising. The European Commission is set to launch a strategy for heat pumps in 2023, aimed at streamlining regulations to align with its objective of deploying 30,000 hydronic heat pumps by 2030. This indicates a positive trajectory for the future of geothermal technology in Europe[22].

5.3 Barriers, challenges and innovative solutions for GSHP systems

The journey to successful exploitation of these systems may encounter various technical and non-technical barriers. However, these challenges should be viewed as opportunities for innovation and growth. By implementing forward-thinking solutions, such as advanced geological assessments, remote monitoring technologies, public education campaigns, innovative financing models, streamlined permitting processes, collaborative partnerships, and incentive programs, the barriers can be surmounted.

[22] Key Findings for GSHP Report by EGEC, 2023

Through these strategies, the seamless knowledge transfer and adoption of GSHP systems can be achieved, ushering in a future where sustainable heating and cooling solutions become integral components of a resilient and eco-conscious energy landscape.

5.3.1 Technical and non-technical barriers identification for GSHP systems' exploitation

In this subchapter, we have compressed the main technical and non-technical barriers identified in the exploitation of the GSHP systems in the building sector. Another aspect that has been taken into consideration is analyzing the barriers identified for the historical buildings.

Technical barriers for buildings:

When developing shallow geothermal energy systems (SGE) for pre-existing structures, designers face limitations in their choices regarding methods, parameters, sizes, and more. These constraints arise from the need to accommodate existing equipment and spatial restrictions, significantly reducing the design flexibility compared to new construction projects. This subchapter provides a concise overview and assessment of these obstacles that affect the design of SGE systems in existing buildings.

Table 3 - Technical barriers for buildings

Design of SGE for existing buildings	Building energy needs, insulation, windows, etc
	Improved insulation in existing buildings
	Existing distribution systems and emission units
	Space constraints for technical rooms and distribution
	Limitations for design of underground system
	Other barriers (eg. Negative interference with other renewable energy systems)
Difficulties for drilling and GHE installation in built environment	Space constraints, accessibility
	Existing underground infrastructure
	Energy, material supply and waste removal
	Noise, dirt, vibration
	Dangerous remains of previous conflicts
	Other barriers (eg. Drilling problems, built environment)
Difficulties with heat pump integration in existing buildings	Limited space for the installation
	High temperature terminals
	High thermal peak load and load balancing
	Constraints in electric power supply
	Specific issues with some heat pump types

(*Source: Deliverable D1.1, Report on different kind of barriers for shallow geothermal in deep renovation*)

The main categories of technical barriers identified in this project showed that most of the buildings face problems with the already existing technologies, space constraints issues, accessibility, problems in the electric power supply and other limitations for the systems' design.

Non-technical barriers:

The non-technical barriers have been identified as follows, given into account the main categories of which they are part of, such as objections from stakeholders, regulatory, economic and environmental issues.

Table 4 - Non-technical barriers for buildings

Objections from stakeholders	Owners
	Architects
	Planners/installers of HVAC systems
	General contractors for engineering and/or turn-key-construction
	Administrators of apartment building blocks, facility managers
	Public authorities and policy makers
	Insurance companies
	Other stakeholders
Regulatory issues	General licensing
	Licensing of ground system
	Permitting of ancillary operations
	Other regulatory issues
Economic issues	Increased installation cost due to given constraints
	Increased operation cost
	Problems with cost-benefit analysis in retrofitting
	Other economic issues
Environmental issues	Influence of energy efficiency
	Environmental issues related to drilling and installation of GHE
	Environmental issues related to working media
	Environmental issues due to normal operation
	Other environmental issues

(*Source: Deliverable D1.1, Report on different kind of barriers for shallow geothermal in deep renovation*)

The various participants in a building project possess diverse and sometimes conflicting interests, often lacking familiarity with SGE (shallow geothermal energy) technology. To address potential objections effectively, it is crucial to comprehend their perspectives and communicate appropriately, even when dealing with perceived concerns. To mitigate these challenges, it is essential to engage SGE stakeholders at the project's outset. Often, SGE considerations come later in the project when conceptual designs and drawings are already well-advanced, making the integration of SGE more complex.

The regulatory framework for building and implementing SGE systems is complex. It involves different legislative requirements for various parts of the system, with ground heat exchangers and building services often overseen by different authorities. This complicates the integration of SGE into existing buildings, especially when dealing with older infrastructure and historical structures, which have additional preservation and restoration regulations. In emerging markets, ground heat exchangers may lack specific regulations, which might seem flexible, but other related regulations like groundwater, mining, or underground construction may still apply. Understanding

and complying with these regulations is essential to avoid issues. Additionally, a loosely regulated or unregulated environment may not provide adequate protection for the installation. It's crucial to engage with relevant authorities early in the design and installation process, especially in the absence of specific regulations.

Economic viability for SGE systems is typically less feasible in existing buildings compared to new construction. Several factors contribute to this difference, including performance decline and asset substitution, opportunity costs, energy prices, inflation rates, and building characteristics. To determine economic viability, methodologies such as net present value, return on investment, and payback period are commonly applied, accounting for technical and economic key performance indicators. These analyses assess the potential savings and costs over time, factoring in energy prices and inflation rates. Additionally, building characteristics and the initial installation cost play significant roles in evaluating SGE's economic feasibility.

SGE is typically considered an environmentally friendly technology that helps reduce harmful emissions, including CO2. Nevertheless, when implementing such technology in the ground and groundwater, there are inherent risks. These risks may include issues like pollution (such as leakage), alterations in flow patterns, and long-term temperature changes.

Particular barriers for historical buildings

This section addresses barriers hindering the application of GSHP technologies in cultural heritage buildings. These buildings are defined as structures with heritage significance and do not need official cultural heritage designation. The integration of geothermal technology in any building depends on building characteristics, thermal energy needs, and ground properties.

Table 5 - Particular barriers for historical buildings

Barriers to SGE in non-listed buildings	Unsuitable Volumes and Construction Characteristics
	Limited Availability of Free Surface
	Refurbishment Timing
	Space Constraints for Heat Pump Installation
Barriers to SGE in listed buildings	Aesthetic Preservation Requirements
	Limitations on External Façade Changes
	Preservation of Architectural and Aesthetic Value
	Compatibility with Existing Infrastructure
	Use of Water Source Heat Pumps
Underground situation and remains	Historical Remains Verification
	Artefact Recovery
Possible conflicts with local regulations	Lack of Specific Standards
	Cultural Heritage Preservation
	Heritage Significance Assessment
	Variability in Regulations
	Multidisciplinary Approach

(*Source: Deliverable D1.1, Report on different kind of barriers for shallow geothermal in deep renovation*)

For historical buildings, preservation of architecture and archaeology is vital. Hence, in our project, installations in these buildings were detailed case-by-case assessments. Beyond ideological skepticism, technical barriers to adopting these systems in Cultural Heritage contexts were already explored. Each study case presented in the GEO4CIVHIC project was well-analysed and defined in accordance with the already identified barriers and in order to find solutions to overcome them.

5.3.2 Innovative solutions – KERs for GSHP systems

GEO4CIVHIC's main goal was built around the idea of developing and demonstrating easier-to-install and more efficient GSHEs. The products that were developed in this project were compact drilling machines specific for built environments and for developing and adapting heat pumps and hybrid solutions for retrofit market.

In this way, over 40 results were obtained by implementing the project, of which the consortium decided on 12 ER and 8 KERs, in order to accelerate the deployment of shallow geothermal systems for heating and cooling in retrofitting existing and historical buildings.

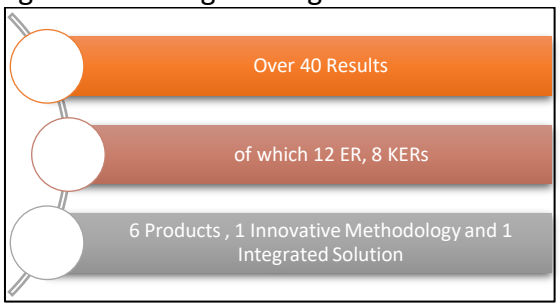

Figure 58 - Main results and solutions

The specialists implied in this project obtained as final KERs: 6 products, 1 innovative methodology and 1 integrated solution. The KERs have been grouped as following:

Table 6 - KERs of the GEO4CIVHIC project

No. KER	Title of KER	Exploitation Potential	Type of ER	IP owner	IP contributor	IPR strategy
1	Plug and play heat pump with variable or fixed speed drivers	Commercial	Product	Galletti-Hiref	UNIPD-DII, CNR-ITC, CRES	Patent
2	Heat pump for high temperature application and dual source application	Commercial	Product	Galletti-Hiref	UNIPD-DII, CNR-ITCm CRES	Patent
3	High temperature Heat Pumps for renovated Civil and Historical Buildings	Commercial	Product	Galletti-Hiref	UNIPD-DII, CNR-ITC	Utility Model/trade secret
4	Versatil and compact drilling rig unit Joy 3P GEO4IVHIC	Commercial	Product	Hydra	NA	Patent/ Utility model

5	Semi-automatic feeder for drilling rods and co-axial tubes mounting	Commercial	Product	Hydra	NA	Patent/ Utility model
6	Compact Vibration-rotation drilling components	Commercial	Product	TKI	Hydra	Trade secret
7	Efficient co-axial heat exchangers for piling with vibration-rotation drilling head (HYDRA-RED METHOD)	Commercial	Process and Methodology	RED-HYDRA		Patent granted (9/11/20)
8	GEO4CIVHIC integrated solution	Commercial	Service/ Product/ Methodology	Individual KER owners	Individual KER contributors	Non-equity strategic alliance

The GEO4CIVHIC main results that were obtained are products as well as processes and services, like:

- ✓ Vibration-rotation drill head;
- ✓ Compact, versatile drilling machine;
- ✓ Semi-automatic feeder for drilling machine;
- ✓ Co-axial heat exchangers (steel and plastic);
- ✓ Adaptation of Wellpoint;
- ✓ Dual-source heat pumps;
- ✓ Two-stage heat pump for high-temperature terminals;
- ✓ Low mid-term GWP refrigerant heat pump working at low temperature;
- ✓ European drilling maps;

The systems installed in the demo sites proved to be easy to install in built environments, in particular, if different constraints are present, efficient in different contests and geological conditions, and finally capable of giving positive effects on jobs development and environment protection. It can be observed that the project has a great influence to the European regulatory framework with regard to shallow geothermal applications, thus supporting the market transformation and the European policy in the domain of renewable energies and heating and cooling efficiency.

Therefore, the innovative geothermal systems developed during the GEO4CIVHIC project make geothermal energy a viable and cost-competitive renewable energy source for heating and cooling in existing and new buildings.

5.3.3 SWOT Analysis

The assessment of the GSHP market has been successfully conducted by employing a SWOT analysis, which is a widely employed approach in strategic planning. This analysis offers a structured framework for classifying

various inputs, including technical, environmental, and financial aspects. To ensure comprehensive coverage, all market stakeholders actively participated in this analysis. Consequently, the results of this analysis serve as a valuable foundation for the exploitation plan and for the creation of a business model.

Figure 59 - SWOT Analysis
(Source: Rhythm System)

Strengths:

The strengths are derived from an internal assessment of GSHP technology, signifying competitive advantages that can and should be leveraged to capitalize on opportunities. The following table provides a list of the identified strengths:

1) **Energy Efficiency and Cost Savings**: One of the primary strengths of GSHP systems is their exceptional energy efficiency. They tap into the stable temperature of the earth, which remains relatively constant throughout the year. This allows GSHP systems to provide both heating and cooling with significantly lower energy consumption compared to traditional HVAC systems. By harnessing this natural heat exchange process, GSHP systems can reduce energy bills by a substantial margin, which is especially beneficial in the long run.
2) **Environmental Benefits**: GSHP systems are eco-friendly heating and cooling solutions. They produce little to no greenhouse gas emissions during operation, making them a sustainable choice that contributes to mitigating climate change. Reduced energy consumption also lessens the demand for fossil fuels, further diminishing the carbon footprint associated with heating and cooling in buildings. This aligns with global efforts to reduce environmental impact and supports the transition toward greener, more sustainable energy sources.
3) **Reliability and Longevity**: GSHP systems are known for their reliability and long lifespan. Properly designed and maintained systems can last for decades. Their robustness and durability translate into fewer maintenance requirements and lower lifecycle costs. This reliability can be particularly appealing to building owners and managers looking for cost-effective, low-maintenance solutions.
4) **Versatility and Comfort**: GSHP systems can provide both heating and cooling, making them versatile for various climate conditions and building types. They offer precise temperature control and consistent comfort levels, enhancing the indoor environment for occupants. Additionally, GSHP systems can integrate seamlessly with other HVAC components, such as radiant floor heating or forced air systems, further improving comfort and flexibility.
5) **Reduced Dependency on Fossil Fuels**: GSHP systems reduce reliance on fossil fuels for heating and cooling. This not only decreases exposure to fuel price fluctuations, but also enhances energy security. As energy grids transition to cleaner and more sustainable

sources, GSHP systems are well-positioned to take advantage of these changes, ensuring a stable and environmentally friendly energy supply for buildings.

Weaknesses

These technical and non-technical weaknesses in GSHP system implementation used a multidisciplinary approach, involving collaboration among engineers, architects, regulators, and building stakeholders.

Effective communication, innovation, and a commitment to sustainability were keys to overcoming the challenges and unlocking the potential of GSHP systems in both new and existing buildings.

1) **Design Challenges**: Designing the Ground Source Energy (GSE) for existing buildings is a multifaceted task. It involves assessing the specific energy needs of the building, considering insulation levels, window quality, and other factors to optimize the GSHP system's performance. This complexity can pose challenges in ensuring that the GSHP system is appropriately sized and integrated with the building's existing infrastructure.
2) **Installation Challenges**: The process of drilling and installing Ground Heat Exchangers (GHE) can be intricate and demanding, particularly in built environments. Space constraints, limited accessibility, and the presence of existing underground infrastructure can complicate the installation process. Additionally, logistical concerns such as managing energy and material supply, waste removal, and mitigating noise, dirt, and vibration must be carefully addressed to avoid disruptions and minimize environmental impact.
3) **Heat Pump Integration**: Integrating GSHP systems into existing buildings may face several limitations. Limited space for heat pump installation can necessitate creative solutions or structural modifications. Managing high-temperature terminals and balancing thermal peak loads can be challenging, requiring specialized equipment or load management strategies. Constraints in electric power supply may require infrastructure upgrades. Additionally, specific building types or configurations may be less compatible with certain types of heat pumps, adding complexity to the integration process.
4) **Stakeholder Objections**: Resistance from various stakeholders, including building owners, architects, administrators, and facility managers, can impede the acceptance and progress of GSHP projects. Addressing these objections requires effective communication, education, and demonstrating the long-term benefits of GSHP systems, both in terms of energy savings and environmental impact.
5) **Regulatory Issues**: Navigating regulatory hurdles, including licensing and permitting processes, can be time-consuming and bureaucratic. Delays in obtaining necessary approvals can lead to project setbacks and increased costs. Advocating for streamlined and supportive regulations can help overcome this barrier and expedite project implementation.
6) **Economic Issues**: The initial installation cost of GSHP systems can be higher than conventional HVAC systems, especially in retrofitting existing buildings. Additionally, ongoing operational costs, while lower than traditional systems, may still pose challenges for some building owners. Conducting a thorough cost-benefit analysis and exploring financing options can help address these economic concerns and demonstrate the long-term financial advantages of GSHP systems.

7) **Environmental Concerns**: Environmental issues, such as drilling impacts, the choice of working media, and the ecological impact of normal system operation, must be carefully managed. Implementing mitigation measures, conducting environmental impact assessments, and ensuring compliance with environmental regulations are essential to address these concerns and ensure responsible GSHP system implementation.

Opportunities

Government support, technological innovation, and heightened public awareness represent promising avenues for advancing GSHP systems. These opportunities mitigate economic and regulatory barriers, enhance system efficiency, and drive demand for environmentally friendly heating and cooling solutions identified in GEO4CIVHIC project.

By capitalizing on these prospects, GSHP systems gain broader acceptance and contribute significantly to sustainable building practices, offering long-term benefits for both the environment and building owners.

1) **Government Support**: Government incentives and policies play a pivotal role in shaping the renewable energy landscape, including the widespread adoption of GSHP systems. These initiatives can encompass a range of measures, such as tax credits, grants, rebates, and preferential financing options. The support provided by governments not only makes GSHP systems more financially accessible for building owners, but also sends a clear signal of commitment to sustainability. It fosters an environment where the economic and regulatory barriers associated with GSHP implementation can be mitigated, encouraging more projects and accelerating the transition toward cleaner and more efficient heating and cooling solutions.
2) **Technological Innovation**: The GSHP industry is characterized by ongoing innovation, driven by the quest for improved efficiency, cost-effectiveness, and ease of installation. Technological advancements extend to various aspects, including drilling methods, heat pump design, ground heat exchanger materials, and system controls. As these innovations continue to mature, they hold the promise of overcoming technical barriers that have traditionally hampered GSHP system implementation. Enhanced drilling techniques, for instance, can minimize disruption and cost during installation, while more efficient heat pump designs can optimize energy transfer. Furthermore, these innovations contribute to making GSHP systems more versatile, adaptable, and suitable for a broader range of building types and environments.
3) **Public Awareness**: Raising public awareness about the environmental benefits of GSHP systems is a key opportunity for driving their implementation. As people become increasingly concerned about climate change and the need for sustainable practices, they are more likely to support and demand green technologies like GSHP systems. Effective educational campaigns, outreach efforts, and case studies showcasing successful GSHP installations can help inform the public about the advantages of these systems, not only in terms of reducing carbon emissions, but also in providing long-term cost savings. As public awareness grows, building owners and developers are more inclined to consider GSHP systems as a responsible and forward-thinking choice for their heating and cooling needs, further catalyzing their adoption in both residential and commercial settings.

Threats

Navigating these threats required a proactive approach in this project that included effective marketing and education to distinguish GSHP systems from alternatives, engagement with regulatory authorities to stay informed and advocate for supportive policies, financial planning to address cost concerns, and strict adherence to environmental regulations to mitigate potential setbacks.

By addressing these threats strategically, the GSHP industry enhanced its resilience and continued to advance sustainable heating and cooling solutions.

1) **Competition from Alternatives**: While GSHP systems offer significant benefits, they face competition from other renewable energy sources and conventional HVAC systems. Solar photovoltaic (PV) systems, wind turbines, and biomass boilers, among others, provide alternative solutions for meeting heating and cooling needs. Conventional HVAC systems, although less energy-efficient, may still be favored due to their familiarity and lower initial installation costs. As such, GSHP projects must not only demonstrate their advantages, but also compete for attention and resources in a crowded marketplace.

2) **Regulatory Uncertainty**: The regulatory environment for renewable energy projects, including GSHP systems, can be subject to change and uncertainty. Shifting policies, incentives, and permitting processes at the local, regional, or national level can create challenges. These fluctuations may lead to project delays, additional administrative burdens, and difficulties in predicting the regulatory landscape, making it harder for investors and developers to commit to GSHP projects with confidence.

3) **Economic Viability**: The high upfront costs associated with GSHP systems, especially in retrofitting existing buildings, can be a significant deterrent for potential adopters. While these systems offer long-term cost savings and environmental benefits, the initial investment may discourage building owners, particularly when compared to the lower initial costs of traditional HVAC systems. Overcoming economic viability concerns often requires careful financial planning, exploring financing options, and conducting comprehensive cost-benefit analyses to demonstrate the long-term value of GSHP systems.

4) **Environmental Compliance**: Stricter environmental regulations and guidelines can add complexity and costs to GSHP projects, particularly in terms of drilling and the choice of working media. Compliance with environmental standards and mitigation measures for potential impacts, such as groundwater contamination or habitat disruption during drilling, must be meticulously addressed. Ensuring that GSHP systems adhere to these regulations is crucial to avoid legal challenges and environmental harm, which can impact project timelines and budgets.

STRENGTHS	WEAKNESSES
+ Energy Efficiency + Cost Savings + Environmental Benefits + Reliability + Longevity + Versatility + Comfort + Reduced Dependency on Fossil Fuels	- Design Challenges - Installation Challenges - Heat Pump Integration - Stakeholder Objections - Regulatory Issues - Economic Issues - Environmental Concerns
OPPORTUNITIES	**THREATS**
+ Government Support + Technological innovation + Public Awareness	- Competition from Alternatives - Regulatory Uncertainty - Economic Viability - Environmental Compliance

Table 7 - SWOT Analysis Overview for GSHP systems

6 Exploitation plan for commercial attractiveness of GSHP systems and penetrating the classic and retrofit market

The exploitation plan is a vital component of the project's overall strategy, designed to maximize the reach and impact of Ground Source Heat Pumps (GSHPs) in the retrofit market. Its primary goal is to create a roadmap that not only boosts the commercial appeal of GSHPs, but also ensures successful market penetration.

To achieve this, the plan will begin by showing the key project results that have already been identified to have commercial potential. This involves assessing the innovative aspects of GSHP technology developed within the project and how they can be leveraged for business success.

Understanding the potential market is another crucial aspect. The plan will analyze market dynamics, demand trends, and potential niches where GSHPs can thrive. It will also consider geographical variations and market maturity.

The barriers that have been highlighted before to exploitation are essential for a smooth market penetration. The plan delves into regulatory, technical, or economic challenges that hinder the adoption of GSHPs and propose strategies to overcome them.

Exploitation scenarios and client-based commercialization strategies are outlined to provide a clear path from project completion to market launch. Managing the knowledge generated throughout the project is integral to its success. The plan presents methods to capture, preserve, and disseminate this knowledge effectively, ensuring it remains a valuable asset.

Innovations and marketing considerations are integrated into the plan to craft a mature and well-rounded commercialization strategy. This involves showcasing the unique features of GSHPs and creating compelling marketing campaigns to attract potential users and investors.

Furthermore, the exploitation plan is not only focused on strategies, but also on the practical aspects of execution. It explores various routes for exploitation, ranging from direct sales to partnerships or licensing agreements. Competitor analysis helps in positioning GSHPs effectively in the market. To secure necessary funding for growth, the plan outlines the potential for internal and external investment sources, highlighting the project's attractiveness to investors.

Finally, the plan defines marketing strategies, including branding, pricing, and distribution channels, to ensure GSHPs can compete effectively in the chosen markets.

Each project partner will have the flexibility to customize the exploitation plan to align with their specific business model and cater to the unique demands of their respective countries. Task 7.4 is dedicated to implementing the strategies outlined in this comprehensive exploitation plan, contributing to the project's overall success.

6.1 Relevant project results

As follows, it will be presented the main KERs that have been achieved through this project among with the involved partners and also a short analysis regarding the importance of implementing IPR strategies in order to protect the content for each KER.

By embracing robust IPR strategies, stakeholders not only secure their intellectual assets, but also contribute to a thriving ecosystem where ideas are protected, innovations are nurtured, and economic growth is catalyzed.

6.1.1 KERs overview

GEO4CIVHIC has been structured to generate outcomes that can utilized across several tiers:

1) Advancing Innovative Technologies and Methods: The project developed and enhanced innovative technologies (HEs, Machines, HPs) and methodologies for obtaining several products that can be applied in the industry.

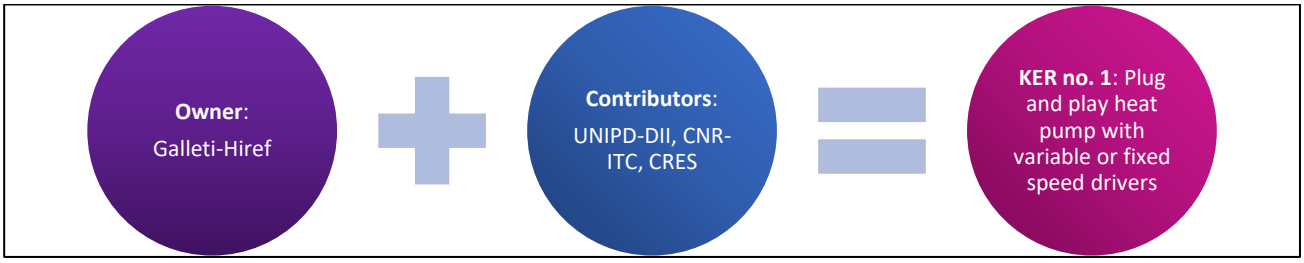

Figure 60 - KER no. 1

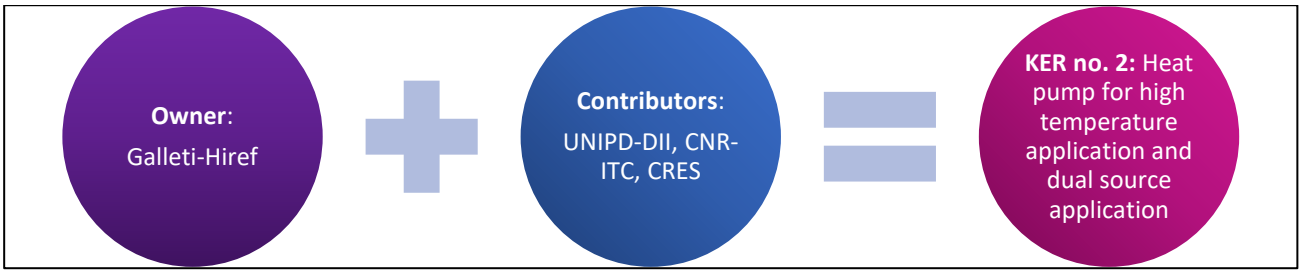

Figure 61 - KER no. 2

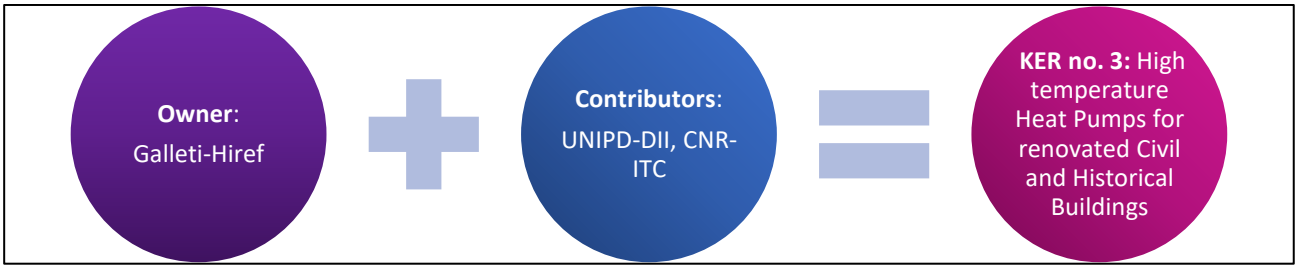

Figure 62 - KER no. 3

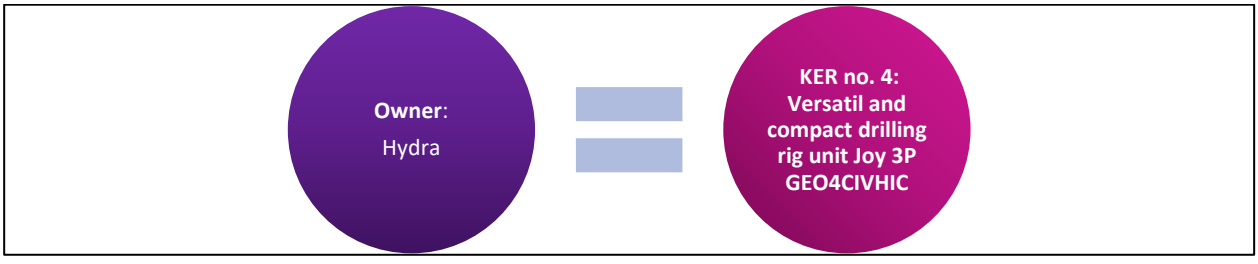

Figure 63 - KER no. 4

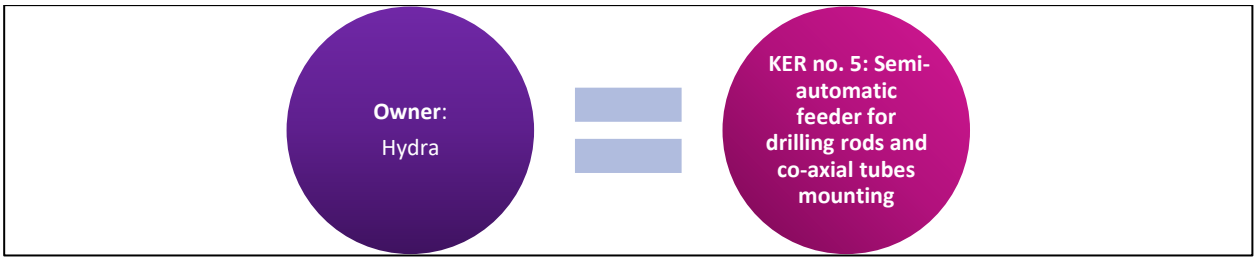

Figure 64 - KER no. 5

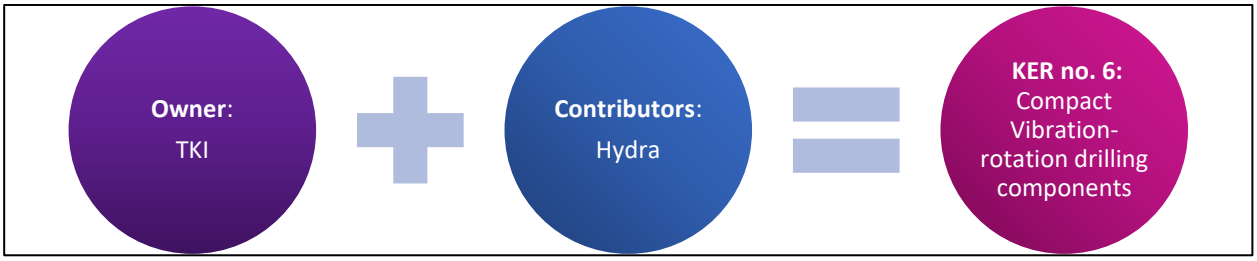

Figure 65 - KER no. 6

2) Fostering Innovative Action Plans and Business Models:

The project facilitated the development of innovative action plans, business models, and recommendations related to the financing and pricing of energy-efficient technologies, particularly in building refurbishment. All the partners participated in elaborating effective action plans and compressed financing and pricing of these technologies.

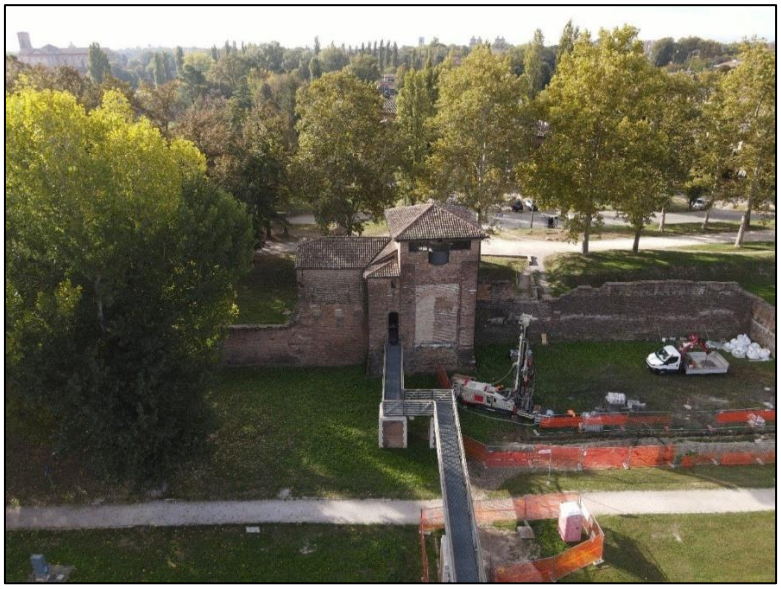

Figure 66 -Installation Example by GEO4CIVHIC
(Porta Degli Angeli Ferrara, Italy)

3) Promoting Standardization in Shallow Geothermal Systems: GEO4CIVHIC aims to encour-age the standard use of shallow geothermal systems through a comprehensive knowledge ex-change platform and the promotion of best practices.

This initiative is intended to ensure the continued success of the project even after its conclu-sion. The partners intend to continue the exchange of knowledge and to present their results after the project in order to maximize its outcomes.

Figure 67 - October, 25th 2021 Virtual session congress

6.1.2 IPR Strategies

In the dynamic landscape of innovation, securing and leveraging Intellectual Property Rights (IPR) has become a pivotal aspect of establishing competitive advantages, safeguarding innovations, and driving economic growth. IPR strategies encompass a multifaceted approach that gathers patents, trademarks, copyrights, and trade secrets, among others.

Crafting effective IPR strategies requires a delicate balance between innovation, legal protection, and commercialization, fostering a conducive environment for creators, entrepreneurs, and in-dustries to flourish.

First of all, **patents** play a central role in IPR strategies by offering legal protection to novel inven-tions. A well-constructed patent strategy involves identifying patentable aspects of innovations, conducting comprehensive patent searches, and navigating the patent application process. Pa-tents grant creators exclusive rights to their inventions, encouraging further research and devel-opment while fostering a culture of innovation. In the GEO4CIVHIC project, KER no. 1 (Plug and play heat pump with variable or fixed speed drivers), no. 2 (Heat pump for high temperature application and dual source application), no. 5 (Semi-automatic feeder for drilling rods and co-axial tubes mounting) and no. 7 (Efficient co-axial heat exchangers for piling with vibration-rota-tion drilling head - HYDRA-RED METHOD) established patents as their IPR strategies; moreover, KER no. 14 was already granted the patent on 9/11/20.

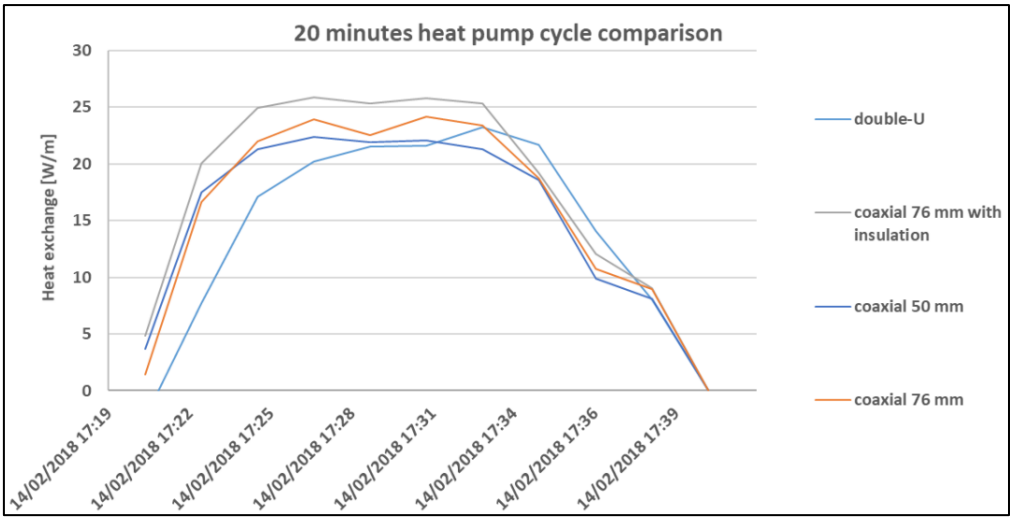

Figure 68 - Performances measured at a demonstration site in Belgium
(for the Cheap-GSHP Project)

As it was suggested in the figure above, the new co-axials (76mm with insulation) produced visible results, being more efficient than the older ones; the energy extraction rate on their behalf was at least 20 % higher than for double U's during heat pump cycles of 20 minutes[23].

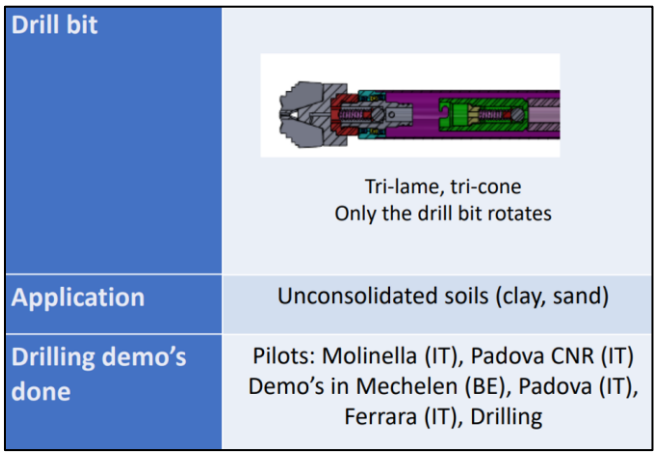

Figure 69 - Pilot sites used for testing the co-axial heat exchangers
(Source: Presentation by Mr. Luc Pockele from RED)

Copyrights safeguard original creative works, ranging from literary compositions to artistic creations. Crafting a **copyright** strategy involves understanding the scope of copyright protection, registration considerations, and enforcing copyright claims against infringements. Copyrights encourage creators to produce valuable cultural and artistic content while ensuring due recognition and compensation. In our project, copyrights are an IPR strategy for KER no. 7 and 8. All the materials in this project will contain the copyright sign, ensuring that these documents are fully protected.

Trade secrets encompass confidential information critical to a business's success, such as processes, formulas, and proprietary techniques. IPR strategies related to trade secrets involve instituting robust confidentiality measures, employee agreements, and legal actions against misappropriation. Effective trade secret management safeguards valuable intellectual assets while

[23] Luc Pockele from RED, *Presentation*

preserving a competitive edge. In GEO4CIVHIC, trade secrets are used for KER no. 3 (High temperature Heat Pumps for renovated Civil and Historical Buildings), no. 6 (Compact Vibration-rotation drilling components).

A **utility model** is a form of intellectual property protection that serves as a valuable strategy for safeguarding inventions and innovations. It offers a statutory right, akin to a patent, but with a shorter protection period, typically ranging from 6 to 15 years. Utility models are designed to cover new and industrially applicable inventions, making them a cost-effective option for inventors and businesses seeking IP protection, especially in countries that recognize and grant utility model rights. This shorter duration can be advantageous in rapidly evolving industries or for innovations with a shorter commercial lifespan, providing a quicker path to exclusive rights and potential market advantages. For our project, we have established as a form of protection the utility model for KER no. 3 (High temperature Heat Pumps for renovated Civil and Historical Buildings) and no. 5 (Semi-automatic feeder for drilling rods and co-axial tubes mounting) as well.

In a globalized world, considering international IPR protection is paramount. Evaluating where to seek protection, understanding regional nuances, and adhering to deadlines ensure that innovations are safeguarded across multiple jurisdictions.

Effective IPR strategies established and used in the GEO4CIVHIC project are aligned with commercialization goals. IPR protection can enhance marketability, secure licensing opportunities, and attract investors, ultimately translating innovative concepts into profitable ventures. The IPR strategies will also be used after the end of the project in order to ensure a proper flow to its outcomes in a safe environment.

6.2 GEO4CIVHIC Business model creation

To gain a significant competitive edge, a company's business model must effectively cater to the specific needs of its customers. According to studies, a business model entails defining how a company provides value to customers, attracts them to pay for that value, and converts these payments into profits.

Numerous studies have identified four fundamental components constituting a business model, including the value proposition, customer interface, infrastructure, and revenue model[24].

The term "value proposition," as defined by Osterwalder, represents an overall perspective on a company's package of products and services that hold value for customers. Infrastructure refers to the capabilities required to deliver value propositions and maintain the customer interface and the revenue model outlines how a company generates income[25].

In our project, the business model creation is a center piece, gathering the aspects that were the main focuses of our consortium, which include: the commercially exploitable main project results, the potential retrofit market, an analysis of barriers for exploitation on the retrofit market, exploitation scenarios and client-based commercialization strategies to bench market launch steps, the methodology and strategy for management of knowledge generated and, also, innovations and marketing interests in order to develop a mature project commercialization plan.

[24] Osterwalder & Pigneur 2009; Ballon 2007; Richter 2012; Richter 2013

[25] Eetu Virtanen - *Business models for construction companies in promoting ground source heat pump systems,* by Professor Ari Ahonen

6.2.1 Commercially exploitable main project results

The project's KERS have been projected with the scope of having a commercial dimension, in order to create proper, efficient products and apps for the implementation on the retrofit market. The characteristics of the buildings were taken into consideration so that the outcomes blend with the technological, financial and environmental issues and trends.

In the GEO4CIVHIC project, we have reached to the conclusion that the European heating and cooling industry currently faces several challenges that require the development of **new business models**. The consortium took into account that all the products, apps, methodologies included in the new business model must face competition in an attractive way. The commercial involvement implies that not only using the results independently, but also incorporating them into the entire heating and cooling sector.

The data analyzed revealed that the exploiting results ensure cost savings and significant reductions in CO2 emissions. Regarding the challenges identified in this field in the project, the consortium observed the following:

- the tendency of European heating and cooling companies to view heat pumps as competitors to be avoided,
- low level of maturity in terms of service provision,
- limited engagement with customers,
- difficulties in realizing the value of adopting green technology.

During different stages of the project, the consortium decided on the list of stakeholders to be approached, in order to create a path for commercializing the outputs.

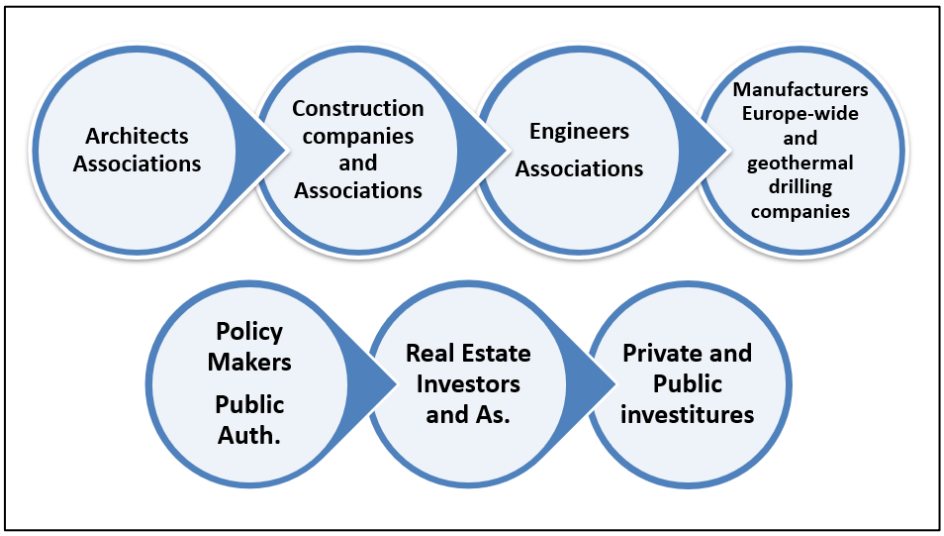

Figure 70 - Stakeholders identified for commercialization

In this project, we have identified a high impact on these categories of stakeholders at European level for:

1) Knowing the product, the advantages in terms of costs of investment/exploitation versus future and exploitation benefits,
2) Transfering the information between involved parts and tertiary partners,

3) Using a strategy to engage other stakeholders by: newsletters, social media campaigns targeted on the identified stakeholders, involvement in webinars, presentations, once the definitives KERs have been defined.

Table 8 - Stakeholders at European level identified in the GEO4CIVHIC project

STAKEHOLDER (name)	COUNTRY	LEVEL (local/national/European)
ASSOCIATIONS OF ARCHITECTS OR ARCHITECTS WITH INTEREST IN THE SECTOR		
Architects' Council of Europe	Belgium – Brussels	European
European Association for Architectural Education (EAAE)	Belgium – Brussels	European
European Network for Architectural competent Authorities (ENACA)	Slovakia – Bratislava	European
International Union of Architects	France – Paris	European
ASSOCIATIONS OF CONSTRUCTORS, ENGINEERS OR INDIVIDUAL CONSTRUCTORS OR COMPANIES WITH INTEREST IN THE SECTOR		
The New European Bauhaus Collective (NEBC) - several pan-European organisations representing architects, engineers, designers, educators	Belgium – Brussels	European
FIEC - European Construction Industry Federation	Belgium – Brussels	European
European Builders Confederation (EBC)	Belgium – Brussels	European
REAL ESTATE ASSOCIATIONS OR INVESTORS IN THE SECTOR		
European Associations of Real Estate Professions CEPI	Belgium – Brussels	European

In addition, we choose to group these stakeholders into main associations, because they are better exposed on the specific market and the information regarding our project results can have a better accessibility at local, national and European level.

All the KERs exploited by owners have selected the identified channels for addressing to stakeholders and all these actions are specific for commercialization of our products, apps, methodologies etc.

Table 9 - Commercialization actions and results

KER	Exploited by	Channels/Identified stakeholders	Targeted actions for commercialization
1, 2, 3	Galletti-Hiref	Architects, Engineers, Constructors, Historical buildings owners (private and public), people working in cultural world, R.E Investors	Manufacturing, Sales and distribution after the end of the project Workshops with specialists and non-specialists and Communication campaign

			Further research
4, 5	Hydra	Drillers involved in shallow geothermal installations	Manufacturing, Sales, Consultancy, Training Distribution, Further research 1 fair, 5 demonstration activities
6	TKI	Geothermal drilling business up to 120m depth Europe-wide and geothermal drilling companies	Manufacturing VibroDrills, further research is going on even without Geo4Civhic money, sales and marketing is going on worldwide, training of customers, servicing the VibroDrills, sold 5 units of new VibroDrills VD80 and 3 units of VD105. The machines are running all over Europe Technical appointments with civil and industrial engineers of drill rig manufacturers (OEM business) and with drilling companies in the geothermal drilling business
7	RED-HYDRA	Architects, Engineers, Constructors, Historical buildings owners (private and public) , people working in cultural world, R.E Investors	Manufacturing, Sales and distribution after the end of the project Workshops with specialists and non-specialists and Communication campaign Further research
8	Individual KER owners	All categories of stakeholders	Implementing GEO4CIVHIC integrated solutions

Our activities and outcomes show that the entire project is sustainable and has great applicability and opportunities to develop. Moreover, the products have already been commercialized on the market; for instance, TKI has already sold 5 units of VibroDrills VD80 and 3 units of VD105, proving a great job in the field.

Regarding the results that were obtained also in the project, there are several apps which can be used by different target groups. These apps are at free usage and have been developed in order to create a better connection with the market and final clients. The most **important results** in apps in GEO4CIVHIC project are:

- ✓ Application for easy management of energy – developed by RED (owner) and contributors: UNIPD-DII, UPV, TECNALIA.
- ✓ Decision support system – developed by Tecnalia (owner) and contributors: Tecnalia,UNIPD, PIETRE, FAU, RED, UPV, GALLETTI, CNR, CRES, UBeG.

6.2.2 Retrofit market – benefits and challenges

Fifty percent of the total energy consumption in the European Union is attributed to heating and cooling. Presently, district heating accounts for only 9% of heat supply in the EU, but there exists significant potential for its growth to facilitate Europe's decarbonization efforts. The industry primarily relies on residual materials from forestry for heat production, partly due to oil crises and varying taxation systems[26].

Despite the fact that it is an established industry, there are still significant challenges facing district heating and there's a big competition on the market from heat pumps. The energy market increased due to low electricity prices in the early 1980s and many installations of classic oil were replaced by electric ones.

However, nowadays, a recent trend is converting classic electric energy to heat pumps. There are studies that show that the heat pumps will continue to be successful in the retrofit market and to gain market share in a short and medium-term.

Some of the buildings that use heat pumps systems also use classic energy systems, this is why the heat pumps can be adapted as well in a complementary use. So, a lot of individuals utilize both systems in order to be certain that they ensure a good and comfortable climate in their houses. Integrating heat pumps in the energy system is a must nowadays. These innovative solutions generate advantages, competition, opportunities and solutions to overcoming barriers.

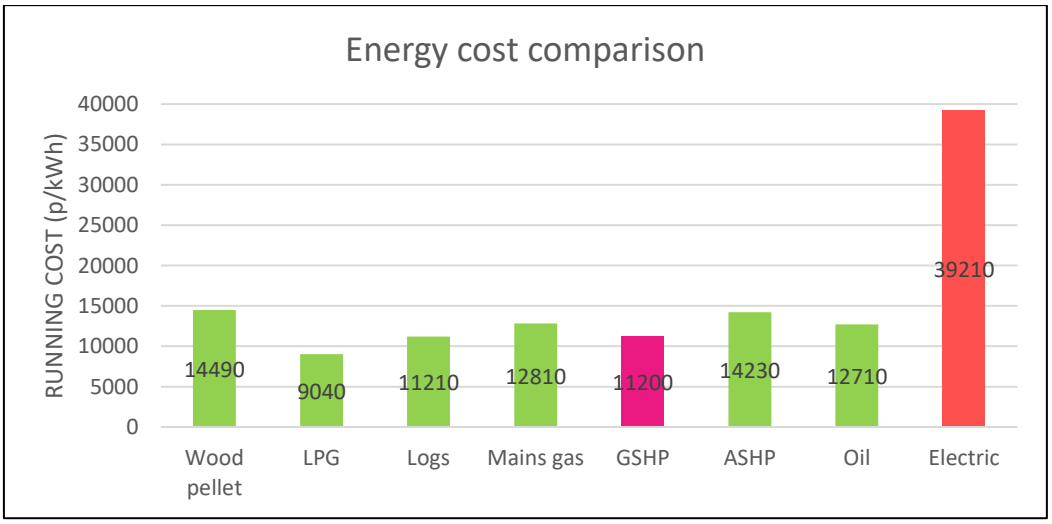

Figure 71 - Energy cost comparison between GSHP and electric systems (2022
(Source: Nu-Heat)

In the GEO4CIVHIC project, information about cost on the retrofit market has been analyzed and the following aspects have been taken into consideration:

- The mean and scope of expenses associated with retrofit interventions carried out by project teams
- The elements contributing to fluctuations in costs and strategies to mitigate these variances
- Recommended practices to promote in retrofit projects (and those to steer clear of)
- Guidance on approaching cost planning and data management in retrofit projects.

[26] *Low-carbon district heating - examining a successful energy transition*, by L. Di Lucia, K. Ericsson

Table 10 - Average cost for retrofit works in buildings
(Source: Ian Meikle, Report on average cost in Europe)

Component	Specification	Average cost
Windows	Double – triple	€ 300 – 650
Internal wall insulation	Rigid – natural – high-tech	€ 140 – 430
External wall insulation	Rigid – natural – high-tech	€ 180
Floor insulation	Rigid – natural – high-tech	€ 75 – 150
Roof insulation	Rigid – natural – loose-fill	€ 15 – 100
Mechanical Ventilation with Heat Recovery	System + ancillary works	€ 7000 per system
Low / Zero Carbon technologies	Air Source Heat Pump (ASHP)	€ 1500 per Kw
	Biomass	€ 2000 per Kw
	Ground Source Heat Pump (GSHP)	€ 3300 per kW
	PV	€ 6500 per kW
	Solar thermal	€ 2000 per Kw

This cost was estimated by analyzing more than 100 houses that needed and wanted to implement different works for reducing energy consumption. Due to this study, in the project, we have grouped the cost variations and opportunities to several factors as follows:

Table 11 - Factors of cost variation and opportunities in the GEO4CIVHIC project

Factors causing a cost variation	Opportunities to reduce cost
○ Non-standard or custom-made items ○ Lack of training for specialized workers ○ Not focusing on distribution channel ○ Not offering enough specifications of the products/apps ○ Bad design of system/product ○ Bad installation of system/product	• Products and app for GEO4CIVHIC offer specialized training • Distribution channels in our project are well-organized and uniformly placed • The products created have detailed specifications • Our partners have invested adequate time in the design and installation of the products and systems

Starting from this analysis of our products, we have reached some conclusions and, in the following, we present this analysis focused on the coaxial heat exchanger, which belongs to KER no. 7, developed with the RED-HYDRA method. The most important progress was achieved through:

1) The geometry and composition of the coaxial heat exchanger improved the thermal exchange yields in transitory conditions. This is elementary for the well function of the system.
2) The reduction of installation times were in the order of 30 – 50 % in unconsolidated soil when support casing is needed unless an expensive double headed drill rig is used.
3) Regarding the cost, its reduction potential of 20-30 % was the result of less meters to install (higher yields), the use of smaller machines and reduced installation times provided material costs are reduced further.
4) The compactness of the drilling machine made this technology particularly interesting for applications in built environment and for historical buildings.

As solutions for diminishing cost variations and use of opportunities in the GEO4CIVHIC, the partners have reached the following outputs:

Table 12 - GEO4CIVHIC Innovations

Rotary, vibration piling of steel co-axial GSHEs at depths between 50 – 80 m and up to 100 m
Improve the Co-axial heat exchangers efficiencies (steel) and test plastic (GEOCOND)
Dual source (air/water) heat pumps
Two stage heat pump for high temperature terminals
Low Global Warming Potential refrigerant heat pump working at low temperature
European drilling maps
Application (APP) for on-site drillability assessment
Decision support system (DSS) for preliminary feasibility assessment and analysis of different solutions
Application (APP) to guide user towards energy savings actions

To sum up, in order to help deal with cost variations and to bring innovation on the retrofit market, the project focused on this analysis and brought up solutions, from technical and technological advancements in the sector to applications for easy management of energy.

6.2.3 Exploitation scenarios for advancing commercialization

The GEO4CIVHIC partners took their time to design efficient and working technologies and to test their productivity in different European environments. This subchapter highlights the case study site locations, the products tested and the results they achieved throughout these demonstrations.

As an essential starting point, 2 field test sites in Alsfeld, Germany, and Molinella, Italy, were established in order to validate and improve the drilling methodology and machine components.

After that, 3 pilot case studies were conducted in existing infrastructure, to check and validate the adapted well point technology, to check and validate two types of innovative co-axial heat exchangers, two very shallow heat exchanger solutions, a new plug-and-play heat pump with optimized controls.

Figure 72 - 3 pilot case studies in Italy and Spain

In addition, 4 real demonstration case studies, from which one is civil and three are historical, were made in different built environments, undergrounds and climatic conditions. These were utilized with the scope of testing the shallow geothermal system with the innovative drilling machine, the improved GSHE's and, also, the novel heat pumps[27].

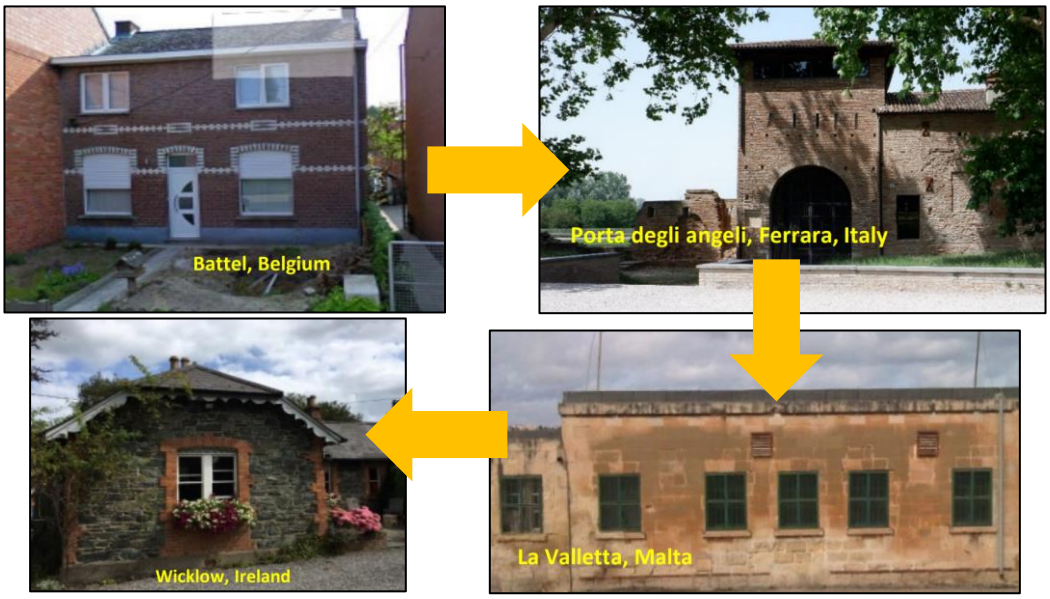

Figure 73 - 4 real demonstration case studies in Belgium, Italy, Ireland and Malta

Furthermore, 12 virtual "demonstration case studies" accompany the real demonstration sites, so that the DSS and design tools are applied.

[27] Luc Pockele in RED documents and reports

Figure 74 - 12 virtual demonstration sites

		Real demo sites				Virtual demo sites											
Location		Malta ❶	Italy ❷	Belgium ❸	Ireland ❹	Greece ❶	Spain ❷	Romania ❸	Romania ❹	Italy ❺	Croatia ❻	Germany ❼	Belgium ❽	Ireland ❾	Switzerland ❿	Spain ⓫	Holland ⓬
Age	Existing			X		X		X	X						X	X	X
	Historic	X	X		X		X			X	X	X	X	X			
Climate	Warm	X				X	X									X	
	Mild Warm		X					X	X	X	X						
	Mild Cold			X								X	X				X
	Cold				X									X	X		
Type	Residential			X	X			X	X							X	X
	Non-resid	X	X			X	X			X	X	X	X	X	X		

Figure 75 - Overview of demo sites in GEO4CIVHIC
(Source: GEO4CIVHIC brochure)

Furthermore, GEO4CIVHIC's goal was to build innovative geothermal and hybrid heat pumps for building retrofits and this result was achieved by developing some heat pump solutions, that are essential for several compelling reasons:

1) **Energy Efficiency**: Geothermal heat pumps are highly efficient, utilizing the Earth's stable temperature to efficiently heat or cool buildings. When combined with innovative hybrid systems, they can further optimize energy consumption, reducing overall energy bills and carbon emissions.
2) **Carbon Reduction**: Retrofitting existing buildings with innovative heat pump systems significantly reduces carbon emissions compared to traditional heating and cooling methods, contributing to climate change mitigation and environmental sustainability.
3) **Energy Independence**: Geothermal and hybrid heat pump systems reduce reliance on fossil fuels, enhancing energy security and reducing vulnerability to energy price fluctuations and supply disruptions.
4) **Improved Comfort**: These systems provide consistent and comfortable indoor temperatures throughout the year, enhancing the occupants' comfort and well-being.
5) **Long-Term Cost Savings**: While the initial investment in innovative heat pump systems may be higher, they often lead to substantial long-term cost savings through reduced energy bills, lower maintenance costs, and longer equipment lifespans.
6) **Market Competitiveness**: The development and deployment of innovative heat pump technologies position countries and companies as leaders in the growing market for energy-efficient building solutions, driving economic growth and job creation.
7) **Resilience**: Heat pumps can operate independently of external fuel sources, making buildings more resilient during power outages or fuel shortages.
8) **Regulatory Compliance**: Many regions are implementing stricter building codes and emissions regulations. Innovative heat pump systems can help building owners meet these requirements and avoid penalties.
9) **Technological Advancement**: Investing in research and development for innovative heat pump technologies fosters technological advancement and innovation in the broader heating and cooling industry.

10) **Sustainable Development Goals**: Promoting the use of geothermal and hybrid heat pumps aligns with global sustainability goals, such as those outlined in the United Nations' Sustainable Development Goals, by reducing energy consumption (SDG7) and mitigating climate change impacts (SDG13)[28].

Type	Specifics	Applications	Demo
Geothermal, plug and play	Small, versatile, 5kW, H&C, HSW, solar	Renovated, single flats in multi-flat buildings	Padova (IT) with and without inverter
Geothermal, high temperature	Two stages of which one with CO2	(Historic) Buildings with radiators or high temperature terminals	Zagreb (HR), Greystones (IR)
Hybrid, high temperature	Dual source: air and geothermal, CO2 driven	Building with high temperature terminals	Ferrara (IT)
Hybrid, low temperature	Dual source: air and geothermal	Reduces length of geothermal heat exchangers	La Valletta (MALTA)
Geothermal, high and low temperature	CO2 driven, delta T of 30°C	Buildings with high and low temperature terminals	Mechelen (BE)

Figure 76 - Exploitation demos in the GEO4CIVHIC project
(Source: Report by Luc Pockele from RED partner)

In summary, building innovative geothermal and hybrid heat pump systems for building retrofit projects is essential for achieving a sustainable, energy-efficient, and environmentally friendly built environment, benefiting both individual building owners and society at large. In order to achieve this goal, many case studies and demonstrations were conducted in different European areas and specific conditions.

Client Based Strategies

Developing client-based commercialization strategies and implementing a successful bench market launch for GSHP involved several key steps in this prokect. These strategies aimed to tailor the launch to meet the specific needs and preferences of our partners' target clients.

1. Client Segmentation: segmenting potential clients based on their characteristics, needs, and preferences. Identifying key client groups such as residential homeowners, commercial property managers, or industrial facility operators, historical buildings.

2. Market Research: conducting thorough market research to understand clients' pain points, preferences, and buying behaviors. Gathering data on the local energy market, incentives for renewable energy, and competitors in the area for tailoring the commercialization strategy.

3. Value Proposition: crafting a compelling value proposition that highlights the benefits of GSHP systems for each client segment. Focus on energy savings, environmental impact, comfort, and long-term cost-effectiveness.

4. Product Development and Testing: ensuring GSHP systems are ready for market launch. Conducting rigorous testing and quality assurance to guarantee reliability and efficiency.

[28] https://sdgs.un.org/goals

5. Pricing Strategy: setting competitive and flexible pricing models that cater to different client budgets. Considering offering financing options or subsidies to make GSHP systems more accessible.

6. Marketing and Promotion: creating marketing campaigns specifically designed for each client segment. Utilizing digital marketing, social media, and traditional advertising to reach target audience. Highlighting case studies, testimonials, and success stories to build trust.

7. Sales Training: training sales teams to understand the unique needs of each client group. Equipping them with the knowledge and tools to communicate the value of GSHP systems effectively.

8. Partnerships and Alliances: forming partnerships with relevant industry stakeholders, such as HVAC contractors, energy consultants, and local utilities. Collaborative efforts to help streamline installations and provide access to a broader client base.

9. Incentives and Rebates: leveraging government incentives and rebates available for renewable energy installations. Educating clients about these financial benefits to encourage adoption.

10. Pilot Programs: before a full-scale launch, considering running pilot programs in specific regions or with select clients. Gathering feedback, identifying potential issues, and fine-tuning

offerings based on real-world experiences.

11. Performance Monitoring: implementing systems to monitor the performance of GSHP systems post-installation. Ensuring that clients are satisfied and that the systems meet their expectations.

12. Scaling Up: after a successful bench market launch, gradually expanding the reach to additional regions and client segments. Using the lessons learned during the bench market phase to refine strategies.

13. Continuous Improvement: regularly assessing commercialization strategies and adapting them based on market feedback, changing client needs, and technological advancements.

By following these client-based commercialization strategies and taking a step-by-step approach, GEO4CIVHIC project KERs launch their systems into the market, catering to the specific needs and preferences of targeted clients while driving sustainable adoption.

6.3 Exploitation plan

The exploitation plan, formulated in Work Package 7 (WP7), was guided by a systematic methodology for creating a business model. This methodology encompassed the following steps:

1) **Detailed Definition of Commercially Exploitable Results**: This initial step involved a thorough definition of the primary project outcomes that held commercial potential, and it was conducted at the project's outset.

2) **Market Analysis and Potential Assessment**: A detailed analysis of the potential market was carried out, including preliminary cost assessments and business implications for various levels of renovation.

3) **Barrier Identification**: Barriers to the exploitation of geothermal applications in building renovation, encompassing technical, social, cultural, economic, and legislative aspects, were reviewed and identified.

4) **Exploitation Scenarios and Commercialization Strategies**: This stage involved the creation of exploitation scenarios and strategies tailored to clients, focusing on the steps required for market entry.

5) **Knowledge Management and IP Protection**: Strategies for managing generated knowledge and protecting intellectual property rights (IPR) was defined, including the establishment of a common patent filing strategy through a Consortium Agreement.

6) **Integration of Innovations and Marketing Interests**: The final step incorporated innovations and marketing considerations from all partners to formulate a mature project commercialization plan, including post-project plans.

In this subchapter, every KER is analyzed following all the steps presented above, with the accent falling on the results' strategies, with routes of exploitation, target users, markets, competitors, investors, and innovations and marketing interests in order to develop a mature project commercialization plan.

6.3.1 Individual EP for each KER

The deep retrofitting market for existing buildings is anticipated to grow over the next 5 to 10 years, driven by upcoming changes in EU Directives related to the Energy Transition. The innovations and advancements achieved through GEO4CIVHIC ensure that shallow geothermal heating and cooling systems play a significant role in this expanding market.

Initial assessments of their impact are conducted in the project and are refined further into business and exploitation plans throughout the project. The suite of tools designed for engineering the entire system add an extra layer of reliability and simplifies the implementation process. Collectively, these measures undoubtedly enhance the adoption of this renewable energy source. The active involvement of industries and small to medium-sized enterprises (SMEs) stimulates increased turnover and job creation.

Concurrently, ongoing standardization efforts by CEN promote GEO4CIVHIC technologies. Furthermore, the comprehensive training and education program initiated by our scientific and industrial partners was focused on early engagement, fostering confidence, and raising awareness among stakeholders.

Relevant project results were obtained, taking into consideration the KERs for each project partner.

Table 13 - KER no. 1, compressed exploitation plan

EXPLOITED RESULT N°1	Plug-and-play heat pump with variable or fixed speed drivers
Relation to other tasks and WP	WP2 DELIVERABLE D 2.6 Adapted well point technique and subsequent field evaluation for the installation
Key activities	Installation of the heat pump and monitoring of the same

Target	Civil society
Stakeholder	Associations of architects, engineers, constructors, private companies, civil society, local authorities
Area of impact	Civil and historical buildings
Specific objective	Use of heat pump
European dimension	Applicable to all European member states
Scaling up	Commercialization to reach as many users as possible
Owners	Galleti-Hiref
Contributors	UNIPD-DII, CNR-ITC
Method of protection	Patent
Owners' role	• Resource allocation to support the development, manufacturing, marketing and distribution of the heat pump • Quality assurance that the manufacturing and distribution of the heat pump meet high-quality standards • User support, to ensure that the users can easily adopt and use the plug-and-play heat pump effectively
Roles	• Galletti-Hiref (Owners) - responsible for overseeing the project's objectives and ensuring that the plug-and-play heat pump aligns with their business strategies. • UNIPD-DII and CNR-ITC (Contributors) - actively involved in research, development, and testing of the heat pump technology. • Associations of Architects, Engineers, Constructors - as stakeholders, these associations can advocate for the adoption of GSHP systems and promote the plug-and-play heat pump among their members. • Private Companies - potential partners for manufacturing, distribution, and sales of the heat pump. • Local Authorities - regulating and promoting energy-efficient solutions in historical buildings. • Civil Society - the end users who will benefit from the technology.
Benefits for users/ Value proposition	• Easy installation process, reducing installation time and costs; • Energy Savings – lower utility bills for buildings owners and occupants; • Environmental Impact - reducing the carbon footprint through the use of renewable energy sources. • The plug-and-play design ensures compatibility with various building types, making it suitable for a wide range of users.
Strategy	• Workshops with specialists and non-specialists (Architects, Engineers) • Communication campaign - focused on the market (newsletter, press, info days, technical meetings, participation in conferences, demonstration activities, webpage, etc.)
Method of exploitation	• Manufacturing, Further research, Sales, Distribution • Using the results in standardization activities

How the result contributes to the expected impact (after the end of the project)	• The plug-and-play heat pump contributes to improved energy efficiency in civil and historical buildings across Europe, leading to reduced energy consumption and lower carbon emissions; • By enabling the use of GSHP systems in historical buildings, the result helps preserve Europe's cultural heritage by providing sustainable heating and cooling solutions without compromising the structures; • The widespread adoption of these heat pumps can foster the growth of the GSHP industry in Europe, creating economic opportunities and supporting green innovation.

Table 14 - KER no. 2, compressed exploitation plan

EXPLOITED RESULT N°2	Heat pump for the high-temperature application and dual source application
Relation to other tasks and WP	WP5 DELIVERABLE D5.5 Evaluation of performance in a real demonstration
Key activities	Application of the heat pump
Target	Civil society
Stakeholder	Associations of architects, engineers, constructors, private companies, civil society, local authorities
Area of impact	Civil and historical buildings
Specific objective	Application of the heat pump
European dimension	Applicable to all member states
Scaling up	Commercialization to reach as many users as possible
Owners	Galleti-Hiref
Contributors	UNIPD-DII, CNR-ITC
Method of protection	Patent
Owners' role	• Galletti-Hiref should provide clear strategic direction for the KER's development and exploitation • Resource allocation to support the entire lifecycle of the heat pump, from research and development to manufacturing and marketing • Feedback integration from users, stakeholders and partners, ensuring the technology's continuous improvement
Roles	• Owners (Galletti-Hiref): Responsible for strategic direction, resource allocation, and overall project oversight. • Contributors (UNIPD-DII, CNR-ITC): Involved in research, development, and technical aspects of the heat pump. • Architects, Engineers, Constructors: Stakeholders and advocates for technology adoption. • Private Companies: Collaborators in manufacturing, sales, distribution, and potential support. • Civil Society: End-users, providing feedback and driving adoption. • Local Authorities: Regulators and promoters of energy-efficient solutions.

Benefits for users/ Value proposition	• High-Temperature Applications - providing efficient heating even in high-temperature requirements • Dual-Source Flexibility - increasing versatility and reliability. • Energy Savings - leading to reduced heating and cooling costs for building owners and occupants. • Environmental Impact - reducing their carbon footprint through the use of renewable energy sources. • The heat pump's adaptability makes it suitable for a wide range of building types, including civil and historical structures.
Strategy	• Workshops with specialists and non-specialists (Architects, Engineers) • Communication campaign - focused on the market (newsletter, press, info days, technical meetings, participation in conferences, demonstration activities, webpage, etc.)
Method of exploitation	• Manufacturing, Further research, Sales, Distribution • Using the results in standardization activities
How the Result Contributes to Expected Impact (after the end of the project)	• The heat pump's high-temperature and dual-source capabilities contribute to improved energy efficiency in civil and historical buildings across Europe, to significant reductions in energy consumption and carbon emissions. • By offering a sustainable heating and cooling solution suitable for historical buildings, the result supports the preservation of Europe's cultural heritage. • Market Growth and Job Creation – stimulating the growth of the GSHP industry in Europe, creating economic opportunities and supporting green innovation.

Table 15 - KER no. 3, compressed exploitation plan

EXPLOITED RESULT N°3	High-temperature Heat Pumps for renovated Civil and Historical Buildings
Relation to other tasks and WP	WP2 DELIVERABLE D5.5 Evaluation of performance in a real demonstration facility
Key activities	Installation of the pump for civil and historical buildings
Target	Civil society
Stakeholder	Associations of architects, engineers, constructors, private companies, civil society, local authorities
Area of impact	Civil and historical buildings
Specific objective	Patent
European dimension	Applicable to all member states
Scaling up	Commercialization to reach as many users as possible
Owners	Galleti-Hiref
Contributors	UNIPD-DII, CNR-ITC
Method of protection	Utility model / Trade secret

Owners' role	• Strategic leadership to define the long-term vision • Resource allocation to support all phases of the projects • Partnerships and colaborations with private companies, research institutions and industry associations to facilitate retrofit market entry
Roles	• Contributors (UNIPD-DII, CNR-ITC) - Engage in research, development, and technical aspects of the heat pumps. • Associations (Architects, Engineers, Constructors) - Advocate for technology adoption, facilitate awareness, and provide support for its application in civil and historical buildings. • Private Companies - Collaborate in manufacturing, sales, distribution, and technical support. • Civil Society - End-users who provide feedback and drive technology adoption. • Local Authorities - Regulators and promoters of energy-efficient solutions.
Benefits for users/ Value proposition	• Users benefit from efficient heating in renovated civil and historical buildings, improving comfort and reducing energy costs. • Preservation of Heritage - the technology allows for sustainable heating without compromising the structural integrity of historical buildings. • Energy Savings - reducing energy consumption and carbon emissions.
Strategy	• Workshops with specialists and non-specialists (Architects, Engineers) • Communication campaign - focused on the market (newsletter, press, info days, technical meetings, participation in conferences, demonstration activities, webpage, etc.)
Method of exploitation	• Manufacturing, Further research, Sales, Distribution • Using the results in standardization activities
How the Result Contributes to the Expected Impact (after the end of the project)	• Reducing energy consumption and environmental impact. • Providing sustainable heating solutions compatible with historical structures, preserving Europe's cultural heritage. • Stimulating growth in the GSHP industry, creating economic opportunities and supporting innovation in Europe.

Table 16 - KER no. 4, compressed exploitation plan

EXPLOITED RESULT N°4	Versatil and compact drilling rig unit Joy 3P GEO4CIVHIC
Relation to other tasks and WP	DELIVERABLE D2.1 - Overview of vertical geothermal heat exchangers and corresponding drilling machine techniques
Key activities	Promotion of semi-automatic feeder
Target	Drillers involved in shallow geothermal installations
Stakeholder	Associations of architects, engineers, constructors, private companies, civil society, local authorities
Area of impact	Industry
Specific objective	Commercialization of semi-automatic feeder
European dimension	Applicable to all member states
Scaling up	European commercialization

Owners	Hydra
Contributors	NA
Method of protection	Patent / Utility model
Owners' role	• Resource allocation to support the development, manufacturing, marketing, and distribution of the semi-automatic feeder. • Partnerships and collaboration to facilitate manufacturing, distribution, and market penetration. • Standardization to ensure compliance with industry standards and regulations
Roles	• Drillers Involved in Shallow Geothermal Installations - primary users and beneficiaries of the semi-automatic feeder technology. • Architects, Engineers, Constructors - advocate for technology adoption and provide support and education to their members. • Private Companies - potential collaborators in manufacturing, sales, distribution, and technical support. • Civil Society - may benefit indirectly through more efficient and cost-effective geothermal installations. • Local Authorities - regulators who may influence the adoption of innovative technologies in geothermal drilling.
Benefits for users/ Value proposition	• Efficiency - the semi-automatic feeder streamlines the drilling rod and coaxial tube mounting process, saving time and labor for drillers. • Users can reduce labor costs and increase project efficiency, leading to cost savings. • Safety during drilling operations due to automation and reduced manual handling. • Enhanced Productivity - drillers can complete more installations in less time, increasing their project capacity.
Strategy	• Participating at 1 (fairs), 5 (demonstration activities)
Method of exploitation	• Manufacturing, Sales, Consultancy, Training, Distribution • Further research
How the Result Contributes to the Expected Impact (after the end of the project)	• The semi-automatic feeder improves the efficiency of drilling operations, reducing project time and costs for drillers and making geothermal installations more attractive. • Widespread adoption of this technology can lead to increased adoption of shallow geothermal installations, contributing to energy efficiency and sustainability goals. • By streamlining drilling processes, the technology can stimulate growth in the shallow geothermal industry and create economic opportunities.

Table 17 - KER no. 5, compressed exploitation plan

EXPLOITED RESULT N°5	Semi-automatic feeder for drilling rods and co-axial tube mounting
Relation to other tasks and WP	DELIVERABLE D2.3 - Development of a versatile, compact, compact drilling machine to operate in urban areas
Key activities	Promotion of semi-automatic feeder
Target	Drillers involved in shallow geothermal installations
Stakeholder	Associations of architects, engineers, constructors, private companies, civil society, local authorities
Area of impact	Industry
Specific objective	Commercialization of semi-automatic feeder
European dimension	Applicable to all member states
Scaling up	European commercialization
Owners	Hydra
Contributors	NA
Method of protection	Patent / Utility model
Owners' role	• Resource allocation to support the development, manufacturing, marketing, and distribution of the semi-automatic feeder. • Partnerships and collaboration to facilitate manufacturing, distribution, and market penetration. • Standardization to ensure compliance with industry standards and regulations
Roles	• Drillers Involved in Shallow Geothermal Installations - primary users and beneficiaries of the semi-automatic feeder technology. • Architects, Engineers, Constructors - advocate for technology adoption and provide support and education to their members. • Private Companies - potential collaborators in manufacturing, sales, distribution, and technical support. • Civil Society - may benefit indirectly through more efficient and cost-effective geothermal installations. • Local Authorities - regulators who may influence the adoption of innovative technologies in geothermal drilling.
Benefits for users/ Value proposition	• Efficiency - the semi-automatic feeder streamlines the drilling rod and co-axial tube mounting process, saving time and labor for drillers. • Users can reduce labor costs and increase project efficiency, leading to cost savings. • Safety during drilling operations due to automation and reduced manual handling. • Enhanced Productivity - drillers can complete more installations in less time, increasing their project capacity.
Strategy	• Participating at 1 (fairs), 5 (demonstration activities)
Method of exploitation	• Manufacturing, Sales, Consultancy, Training, Distribution • Further research

How the Result Contributes to the Expected Impact (after the end of the project)	• The semi-automatic feeder improves the efficiency of drilling operations, reducing project time and costs for drillers and making geothermal installations more attractive. • Widespread adoption of this technology can lead to increased adoption of shallow geothermal installations, contributing to energy efficiency and sustainability goals. • By streamlining drilling processes, the technology can stimulate growth in the shallow geothermal industry and create economic opportunities.

Table 18 - KER no. 6, compressed exploitation plan

EXPLOITED RESULT N°6	Compact Vibration-rotation drilling components
Relation to other tasks and WP	WP2 DELIVERABLE 2.2 - Development of a compact, rotation vibration drilling head for urban areas
Key activities	Promotion of compact vibration-rotation drilling
Target	Acquiring company
Stakeholder	Associations of architects, engineers, constructors, private companies, civil society, local authorities
Area of impact	Industry
Specific objective	Commercialization
European dimension	Applicable to all member states
Scaling up	European commercialization
Owners	TKI
Contributors	Hydra
Method of protection	Trade secret
Owners' role	• Resource allocation to support the development, manufacturing, marketing and distribution of the drilling technology • High-quality standards in manufacturing and performance • Feedback from stakeholders to drive continuous improvement • Ensuring the long-term viability of the drilling technology
Roles	• Acquiring Company - acquisition and deployment of the drilling technology. • Architects, Engineers, Constructors - advocate for technology adoption and provide support and education to their members. • Private Companies - potential collaborators in manufacturing, sales, distribution, and technical support. • Civil Society - may benefit indirectly through more efficient and cost-effective geothermal installations. • Local Authorities - regulators who may influence the adoption of innovative drilling technologies in geothermal drilling.

Benefits for users/ Value proposition	• The compact vibration-rotation drilling technology streamlines drilling operations, reducing project time and costs for drilling companies. • Users can lower drilling costs, increase productivity, and improve overall project efficiency. • Enhanced safety during drilling operations due to automation and reduced manual handling. • Making drilling companies more competitive in the market.
Strategy	• Technical appointments with civil and industrial engineers of drill rig manufacturers (OEM business) and with drilling companies in the geothermal drilling business
Method of exploitation	• Manufacturing VibroDrills, further research is going on even without Geo4Civhic money, sales and marketing is going on worldwide, training of customers, servicing the VibroDrills
How the Result Contributes to the Expected Impact (after the end of the project)	• Enhanced Geothermal Drilling Efficiency - the compact vibration-rotation drilling technology improves drilling efficiency, reducing project costs and making geothermal installations more attractive. • Widespread adoption of this technology can lead to increased use of geothermal energy, contributing to energy efficiency and sustainability goals. • By streamlining drilling processes, the technology can stimulate growth in the geothermal drilling industry, create economic opportunities, and support innovation.

Table 19 - KER no. 7, compressed exploitation plan

EXPLOITED RESULT N°7	Efficient co-axial heat exchangers for piling with vibration-rotation drilling head (HYDRA-RED METHOD)
Relation to other tasks and WP	WP2 DELIVERABLE 4.3 Guide for the use of the Application for friendly and easy management of the energy systems
Key activities	Improving the efficiency of co-axial heat
Target	Civil society
Stakeholder	Research institutions, Associations of architects, engineers, constructors, private companies, civil society, local authorities
Area of impact	Research
Specific objective	Implementation of existing pipe
European dimension	European most advanced countries
Scaling up	Further research
Owners	RED-HYDRA
Contributors	-
Method of protection	Patent granted
Owners' role	• Resource allocation to support the improvement of co-axial heat exhangers

	• Ensuring that the heat exchanger design meets high-quality standards, in manufacturing and performance • Feedback from stakeholder for the continuous improvement • Partnerships and collaborations with research institutions, drill rig manufacturers (OEM business), drilling companies and industry associations to facilitate development and retrofit market penetration
Roles	• Research Institutions - collaborate on research and development to improve the efficiency of co-axial heat exchangers. • Architects, Engineers, Constructors - advocate for technology adoption and provide support and education to their members. • Private Companies - potential collaborators in manufacturing, sales, distribution, and technical support. • Civil Society - potential end-users who may benefit from improved geothermal systems. • Local Authorities - regulators who may influence the adoption of innovative geothermal technologies.
Benefits for users/ Value proposition	• Efficient co-axial heat exchangers improve the overall energy efficiency of geothermal systems, reducing energy consumption and costs for users. • Users can benefit from lower operating costs and reduced energy bills. • Increased efficiency reduces the environmental impact of geothermal heating and cooling systems. • Adopting this technology can make geothermal systems more competitive and attractive for both residential and commercial applications.
Strategy	• Technical appointments with civil and industrial engineers of drill rig manufacturers (OEM business) and with drilling companies in the geothermal drilling business
Method of exploitation	• Manufacturing, Sales, Consultancy, Training, Distribution, Further research
How the Result Contributes to the Expected Impact (after the end of the project)	• Efficient co-axial heat exchangers contribute to improved overall geothermal system efficiency, making geothermal systems more cost-effective and environmentally friendly. • Widespread adoption of this technology can lead to increased use of geothermal energy, contributing to energy efficiency and sustainability goals. • By enhancing the performance of geothermal systems, the technology can stimulate growth in the geothermal heating and cooling industry, create economic opportunities, and support the broader adoption of sustainable energy solutions.

Table 20 - KER no. 8, compressed exploitation plan

EXPLOITED RESULT N°8	GEO4CIVHIC integrated solution
Relation to other tasks and WP	WP2 DELIVERABLE 4.3 Guide for the use of the Application for friendly and easy management of the energy systems
Key activities	Implementation activities

Target	Civil and academic society
Stakeholder	Research institutions and companies involved
Area of impact	Research and industry
Specific objective	Implementation of existing pipe
European dimension	Applicable to all member states
Scaling up	Further research and commercialization
Owners	Individual KER owners
Contributors	Individual KER contributors
Further exploitation	Partners interested in further exploitation: Solintel, Supsi, DLH, CRES, Pietre Edil Method of exploitation: Further research
Method of protection	Non-equity strategic alliance
Owners' role	• Each individual KER owner takes responsibility for the strategic direction of their specific component within the integrated solution, ensuring alignment with project objectives and market needs. • Allocating necessary resources, including financial, technical, and human resources, to support the implementation and development of their respective KER. • Ensuring that their KER component meets high-quality standards, both in implementation and performance. • Gathering feedback from stakeholders, including research institutions and companies, into their KER's development roadmap to drive continuous improvement.
Roles	• Research Institutions - collaborate on research and development activities to implement and enhance the GEO4CIVHIC integrated solution. • Companies Involved - actively contribute to the commercialization and implementation of the integrated solution. • Civil and Academic Society - end-users and beneficiaries of the integrated solution, who may benefit from improved geothermal systems and research outcomes.
Benefits for users/ Value proposition	• GEO4CIVHIC integrated solution offers a comprehensive and efficient approach to geothermal systems, providing benefits in terms of energy efficiency, cost savings, and environmental impact. • Academic and research institutions can benefit from access to advanced geothermal technologies and research outcomes, contributing to the advancement of knowledge in the field. • Companies involved in geothermal systems can enhance their product offerings and competitiveness in the retrofit market.
Strategy	• Many publications during and after the project
Method of exploitation	• Further research • Commercialization • Implementation of the integrated solution in real-world applications (geothermal heating and cooling systems)

How the Result Contributes to the Expected Impact (after the end of the project)	• The integrated solution represents a significant advancement in geothermal technology, making geothermal systems more attractive, efficient, and environmentally friendly. • Through publications and further research, the project contributes to the dissemination of knowledge and best practices in the geothermal sector. • By enhancing the performance of geothermal systems and promoting research, the technology can stimulate growth in the geothermal heating and cooling industry, create economic opportunities, and support the broader adoption of sustainable energy solutions.

Through the exploitation plans, the GEO4CIVHIC partners seeked to increase commercialization and penetration on the market, but also to continue the research, especially in the shallow geothermal sector. The main results obtained showed that the products developed in the GEO4CIVHIC project are safer, faster, that the drilling can be performed by a lower amount of workers and ensuring lower costs; the products developed by TKI are 50% cheaper than the competitors'; for instance, it's also important to highlight the fact that TKI has double the experience the other competitors on the market have. The products developed by Galletti generate the possibility to match high temperature water – with multi sources units.

The actions that are included in the exploitation plans are continuously reviewed and updated for assuring the future activity for this project, minimum 4 years after ending it.

6.3.2 Routes for exploitation

The identified exploitable results follow various main routes:

- **Commercial Exploitation**: Depending on the nature of the product (technologies, software as a service, product sale, etc.), different commercialization methods were pursued.

- **Consultancy Services**: The knowledge generated during the project was employed to offer consultancy services, including new business models and certification services.

- **Product Visibility**: Solution vendors use the project's repository to enhance the visibility of their products and strategies.

- **New Training Programs**: Stakeholders, particularly building owners and municipalities with significant refurbishment needs, as well as practitioners seeking to implement methodologies, guidelines, and support tools, benefit from new training programs.

- **Free or Time-Limited End-User Applications**: Tools, methodologies, and other project outcomes may be made available for free or on a time-limited basis to facilitate their adoption by end users.

- **Application in Other Projects**: The project's know-how and findings are applied in other educational, research, and innovation initiatives.

Figure 77 - GEO4CIVHIC Commercial exploitation

The partners involved in the project offer their knowledge regarding:

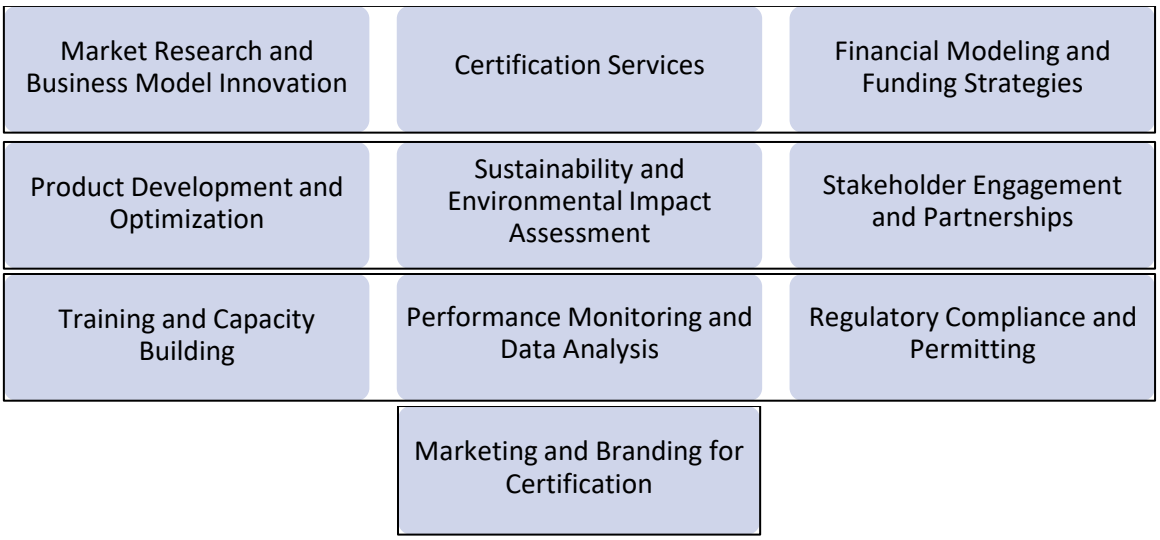

Figure 78 - Consultancy services aspects in GEO4CIVHIC

In order to enhance product visibility in the shallow geothermal sector, our project's partners have gathered effective exploitation strategies that showcase our developed products in a repository of strategies and technologies.

Table 21 - Exploitation strategies for GEO4CIVHIC's products' visibility

Optimize Online Presence (using SEO strategy)
Leverage Social Media
Participating in Industry Events
Collaborating with Industry Associations
Customer Testimonials and Case Studies
Online Directories and Repositories
Content Marketing (distributed on the app, social media, publications)
Investing in Paid Advertising
Continuous Innovation to maintain a competitive edge
Feedback and Reviews
Networking and Partnerships
Educational Workshops and Webinars

Regarding new training programmes for the app and products, the consortium decided to create special training according to the stakeholders' needs and level of comprehension.

Figure 79 - Proposal for new training programmes

To facilitate the adoption of tools, methodologies, and other resources related to the GEO4CIVHIC project as part of our commercialization project, our partners have planned to implement an exploitation strategy that involves offering these resources to end users. This approach can help generate interest, encourage adoption, and build trust among potential customers and stakeholders. Here's a strategy framework:

Figure 80 - Exploitation strategies

By providing end users with the opportunity to explore our tools and methodologies at very few constraints, we can significantly reduce barriers to adoption and drive interest in the shallow geothermal sector and in GEO4CIVHIC as well. This approach can help build a loyal user base and position our project as a valuable resource in the GSHP industry.

Leveraging the know-how generated from our project to benefit education, research, and innovation initiatives can have a substantial impact on the broader adoption of GSHP systems. Here are some exploitation strategies found by our partners in order to achieve this:

Figure 81 - Exploitation strategies know-how

In summary, the outlined exploitation strategies are indispensable components of the GEO4CIVHIC project. They serve as a multifaceted approach to maximize the project's impact and reach. Commercial exploitation ensures sustainability and revenue generation, consultancy services leverage project knowledge to support industry growth, and product visibility enhances market presence.

Meanwhile, new training programs empower stakeholders, end-user application fosters tool adoption, and knowledge-sharing fuels education and innovation. Collectively, these strategies not only advance the commercialization of our products and services, but also position our project as a valuable resource for promoting sustainability and renewable energy solutions in the broader context.

6.3.3 Analysis of target users, markets, competitors, investors

In the GEO4CIVHIC project, there have been extracted the main categories of target users, markets, competitors and, also, investors for the shallow geothermal sector.
First of all, the targeted audiences for the project's outcomes include:

Table 22 - Target groups in GEO4CIVHIC

Key Target Groups	Specialists in the GSHP industry (e.g., HVAC engineers, installers, drillers, designers, architects)
	SMEs in the construction sector
	Associations within the European built sector, particularly Architect and Engineering and related Technology Platforms
Secondary Target Groups	Policy bodies at local, regional, and national levels (e.g., municipal planners, energy managers in public authorities)
	Standard bodies
Tertiary Target Groups	The scientific community
	Educational institutions (universities, etc.)
	Public entities, chambers of commerce and industry
	Development agencies, energy agencies, centers of environmental expertise, professional associations,
	Journalists, media
	The general public

The target market is the retrofit one, applied at shallow geothermal sector, in particular for the retrofit of commercial and residential buildings.

Secondly, our competitors are mostly manufacturers of drilling equipment in general, but, in the retrofit market, no specific competition was identified. Our partners pointed out some companies that are top tiers on the market, including Honeywell, Johnson Controls, ABB, Schneider. One of our partners, TKI, stated that, in the drilling business, there are some important competitors to bring into view: EuroDrill, Boart Longyear and Sonic Drilling.

Attracting investors is essential for financial backing for growth. Investors interested in sustainable technologies and energy efficiency can be attracted by showcasing the growth potential of GSHP systems in a transitioning energy landscape. Demonstrating clear market demand, cost savings, and environmental benefits can position GSHP systems as viable investment options.

Building a team with technical expertise in GSHP systems is crucial. This team drives innovation, system design, and continuous improvement, ensuring the technology's competitiveness in the market.

Table 23 - Business model applied to investors, competitors, target users on the retrofit market

Key partnerships - Companies and experts in the field	**Key resources** - Products, app, methodologies developed in the project	**Customer value** - Low cost - Flexibility - Green energy use
Customer segment - Associations of architects, engineers, drilling companies, SMEs, Civil society	**Key activities** - Commercialization of products - Integrative services	**Customer channel** - Direct and indirect, using other interfaces

Customer relationship	Cost structure	Revenue stream
- Strong collaborations and partnerships	- Small direct complementary costs	- Small and direct increases

In the GEO4CIVHIC project, the partners understood that, by collaborating with construction companies, energy consultants, architects, and contractors, seamless integration of GSHP systems into building projects is ensured. Partnerships enhance the accessibility of GSHP technology and provide a broader market reach.

6.3.4 Innovation and marketing interests in order to develop a mature project commercialization plan

In numerous European countries, heat pumps are regarded as a crucial catalyst in the process of decarbonizing residential heating systems. The support from evolving building regulations is increasingly aiding the penetration of heat pumps into the new construction market.

The primary obstacle persists in economics, primarily concerning the initial costs and, in some instances, ongoing expenses. This issue becomes more pronounced when comparing the relatively low prices of gas and oil to electricity in certain regions. Consequently, heat pumps are primarily being adopted in existing buildings who are inclined toward technology, with some exceptions in more established markets such as the North Europe.

The second major hurdle is raising awareness among end-customers regarding the feasibility of installing a heat pump in their homes, as opposed to simply calling a familiar installer to replace their current boiler.

Figure 82 - Survey of private homeowner gas boiler users
(Source: SSE Energy Solutions)

Customers typically rely on installers for guidance. In recent research regarding market entry strategies, we delved into several pivotal relationships that installers maintain with other stakeholders in the value chain. Expanding the market for highly efficient heating technologies, such as heat pumps, may necessitate improved customer engagement by installers or other stakeholders.

Nevertheless, installers are often resistant to change. Convincing them to shift from years of boiler installations to adopting heat pumps can be challenging. Investing time and resources in training for new technologies presents risks, particularly when they already have a steady demand for the technologies they are accustomed to. This is especially true for heating systems

that demand higher skill levels, increased customer education, and a perceived risk of more service callbacks compared to their usual installations. Most installers tend to follow market trends rather than pioneering new ones.

Increasing heat pump sales in the retrofit market can be accomplished in two main ways: either by educating end-customers about their options and securing the sale or by entrusting the sales process to a third party, with the installer acting as a subcontractor. The latter approach is likely to be the most effective way to achieve a significant increase in sales.

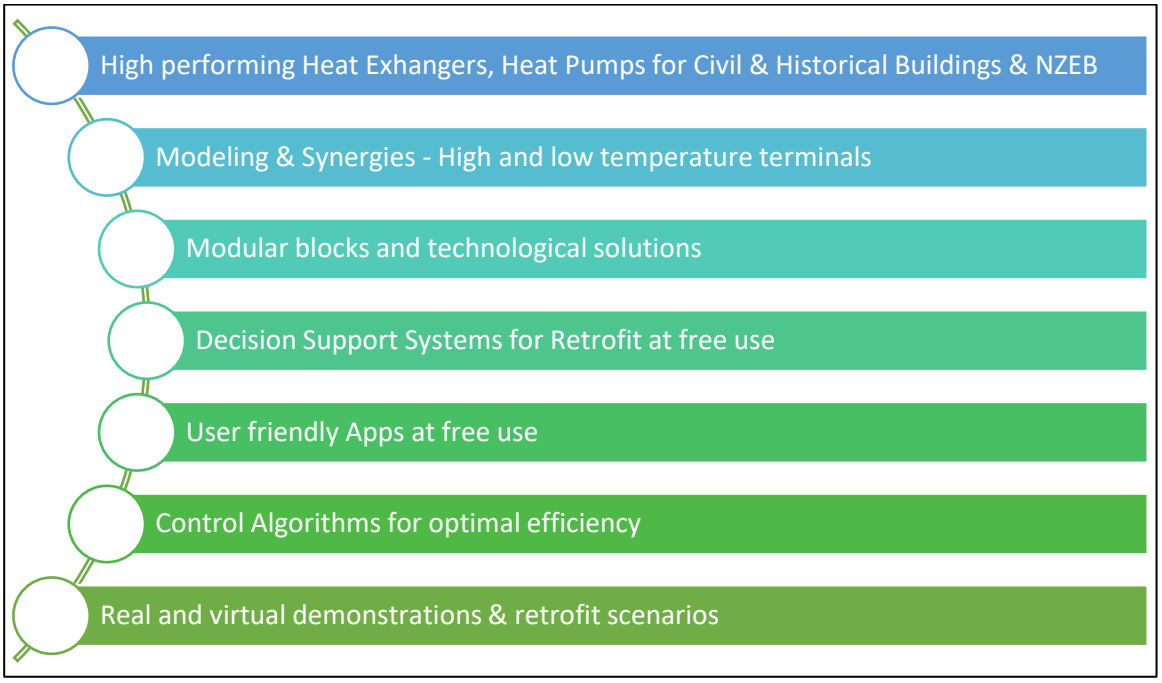

Figure 83 - Innovations in the GEO4CIVHIC project

The innovations developed in the GEO4CIVHIC project contribute to creating a good environment in this field, offering solutions to overcoming the already existing barriers. These innovations demonstrate as well the environment impact, risk assessment, cost effectiveness and efficiency for the system.

In addition, from the practical field, we know that installers should not be burdened with explaining to customers what a heat pump is. As an industry, providers of heat pumps must continue to invest in marketing and raising general awareness, with electricity suppliers being well-positioned to contribute to this effort. Over time, online marketplaces and sales channels for heating systems could also play a substantial role, as will service-based offerings.

The shortage of installer skills remains a significant impediment to the growth of heat pumps in most markets. However, as awareness and demand continue to rise, installers are incentivized to overcome this challenge. Industry associations and manufacturers are already subsidizing training programs and marketing efforts aimed at installers, although there is room for improvement in many markets. In the GEO4CIVHIC project's planning, there is also a special attention for implementing new training programs for installers regarding our products, as we have mentioned earlier in our exploitation plan.

Regardless of the approach taken to reach end-users, active engagement with installers across the value chain is essential to build their competence and confidence in the technical and economic aspects of heat pumps[29].

Furthermore, our project's partners established criteria for a risk assessment of each KER, rating them between low, medium or high risk. Below, this is the criteria that helped providing a holistic view of the risks associated with the commercialization of our products:

Table 24 - Risk assessment criteria for our products/services/app

Technical Feasibility	✓ Assessing the overall technical feasibility of the GSHP system commercialization project. ✓ Evaluating the readiness of the technology and its components for market deployment. ✓ Considering the potential technical challenges and risks.
Market Viability	✓ Analyzing the market demand for GSHP systems and related technologies. ✓ Assessing the size, growth potential, and competition within the target market. ✓ Identifying potential barriers to market entry.
Regulatory and Compliance	✓ Ensuring compliance with relevant regulations, standards, and industry guidelines. ✓ Assessing potential legal and regulatory risks associated with the project. ✓ Considering any permitting or certification requirements.
Resource Availability	✓ Evaluating the availability of resources, including funding, materials, and skilled labor. ✓ Considering the capacity to scale production or deployment as needed. ✓ Identifying potential resource constraints and dependencies.
Safety and Environmental Impact	✓ Assessing safety risks associated with the technology, its installation, and operation. ✓ Considering the environmental impact, including any potential risks or mitigation measures. ✓ Ensuring alignment with environmental regulations and sustainability goals.
Cost Efficiency and Cost-Benefit Analysis:	✓ Analyzing the cost-effectiveness of the GSHP systems and associated components. ✓ Conducting a cost-benefit analysis to determine the project's economic viability. ✓ Identifying areas where cost optimization or cost reduction is possible.
Technological Innovation and Competitive Advantage	✓ Evaluating the level of technological innovation offered by the GSHP systems. ✓ Identifying potential competitive advantages over existing solutions. ✓ Considering intellectual property protection if applicable.

[29] Article by Felicity Tolley MAPM

Market Entry Strategy	✓ Defining a clear market entry strategy and assess its effectiveness. ✓ Evaluating the risks and benefits of different market penetration approaches. ✓ Considering partnerships, alliances, or distribution channels for market access.
Customer Awareness and Education	✓ Assessing strategies for raising customer awareness about GSHP systems. ✓ Considering the need for customer education and information dissemination. ✓ Evaluating potential challenges in convincing customers to adopt the technology.
Project Management and Implementation	✓ Evaluating the project's management structure and leadership. ✓ Assessing the project timeline, milestones, and critical path. ✓ Considering risk mitigation strategies and contingency plans.

Table 25 - Risk assessment of the GEO4CIVHIC KERs

		RISK ASSESSMENT		
KER No.	**Key Exploited Result**	**LOW**	**MEDIUM**	**HIGH**
1	Plug-and-play heat pump with variable or fixed speed drivers		☑	
2	Heat pump for the high-temperature application and dual source application		☑	
3	High-temperature Heat Pumps for renovated Civil and Historical Buildings		☑	
4	Versatil and compact drilling rig unit Joy 3P GEO4CIVHIC		☑	
5	Semi-automatic feeder for drilling rods and co-axial tube mounting		☑	
6	Compact Vibration-rotation drilling components		☑	
7	Efficient co-axial heat exchangers for piling with vibration-rotation drilling head (HYDRA-RED METHOD)	☑		
8	GEO4CIVHIC integrated solution	☑		

In conclusion, our comprehensive risk assessment for GSHP systems in the GEO4CIVHIC project underscores the importance of diligent planning, monitoring, and mitigation strategies to ensure the successful and sustainable implementation of geothermal technologies within our civil and infrastructure projects.

7 Conclusion

In conclusion, the GEO4CIVHIC project has meticulously crafted business models fitted for 8 different KERs, but also applicable to the exploitable results of this project, conducting extensive market analyses, and examined the barriers and challenges facing the geothermal heat pump (GSHP) systems sector.

In doing so, GEO4CIVHIC has laid the essential foundation for the widespread commercialization and adoption of GSHP systems.

The journey embarked upon within this project has been nothing short of remarkable, encompassing a diverse range of endeavors. From the design of heat pumps suited for high-temperature applications to the development of semi-automatic drilling methods, each facet of this project represents not only technological advancement, but also the strategic planning necessary for the seamless integration of these innovations into the market.

It is undeniable that the GSHP industry faces substantial challenges, but the GEO4CIVHIC project offers a ray of hope by presenting innovative solutions and a well-defined path forward. This endeavor is not merely confined to Europe; it has the potential to become a global model for sustainable energy initiatives, showcasing the transformative power of forward-thinking strategies.

The Exploitation plan applied for each KER developed in the GEO4CIVHIC project shows that the strategic roadmap paves the way for commercial success, outlining the pathways to harness the full potential of GSHP systems. It is now incumbent upon stakeholders, visionary entrepreneurs, discerning investors, and forward-looking policymakers to unite in realizing the boundless potential of GSHP systems, as illuminated by the GEO4CIVHIC project, taking into consideration the potential for commercialization.

As we transition from the project phase to the implementation phase, we must acknowledge that our journey is far from over. The exploitation plan meticulously outlined in this project serves as a roadmap to commercial success. However, it is now incumbent upon stakeholders, visionary entrepreneurs, discerning investors, and forward-looking policymakers to unite in realizing the boundless potential of GSHP systems, as illuminated by the GEO4CIVHIC project.

Together with our project partners, we have the power to create a future where sustainable geothermal-based heating and cooling solutions are not a luxury, but a fundamental part of our lives. Let us collectively work towards a more sustainable and eco-friendly tomorrow, where GSHP systems contribute significantly to a cleaner, more energy-efficient world. The legacy of GEO4CIVHIC is one of innovation, sustainability, and the unwavering belief that a better future is within our reach.

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9 Annex 1

STAKEHOLDERS DATABASE

Below, we have part of the stakeholders' database identified at national level by all the partners involved, in the participating countries. Besides the retrofit buildings, we have also created a special section for historical buildings, in order to have a better overview of the main categories.

STAKEHOLDER (Name)	COUNTRY	Level (local/national/european)
Associations of Architects or architects with interest in the sector		
Romanian Order of Architects (OAR)	ROMANIA	national
Consiglio Nazionale degli Architetti, Pianificatori, Paesaggisti e Conservatori (CNAPPC)	ITALY	national
CONSEJO SUPERIOR DE LOS COLEGIOS DE ARQUITECTOS DE ESPAÑA (CSCAE)	SPAIN	national
Royal Institute of the Architects of Ireland (RIAI)	IRELAND	national
Conseil National de l'Ordre des Architectes (CNOA)	BELGIUM	national
Bundesarchitektenkammer (BAK)	GERMANY	national
Technical Chamber of Greece (TEE-TCG)	GREECE	national
Kamra tal-Periti (KTP)	MALTA	national
Conférence Suisse des Architectes (CSA)	SWITZERLAND	national

Associations of Architects with interest in the sector at national level

Associations of Constructors or individual constructors or companies		
FPSC	ROMANIA	national
ASSOCIAZIONE NAZIONALE COSTRUTTORI EDILI (ANCE)	ITALY	national
CONFEDERACIÓN NACIONAL DE LA CONSTRUCCIÓN (CNC)	SPAIN	national
CONSTRUCTION INDUSTRY FEDERATION (CIF)	IRELAND	national
EMBUILD - THE BELGIAN CONSTRUCTION ASSOCIATION	BELGIUM	national
HAUPTVERBAND DER DEUTSCHEN BAUINDUSTRIE (HDB)	GERMANY	national
PANHELLENIC ASSOCIATION OF ENGINEERS CONTRACTORS OF PUBLIC WORKS (PEDMEDE)	GREECE	national
MALTA CHAMBER OF CONSTRUCTION MANAGEMENT	MALTA	national
SCHWEIZERISCHER BAUMEISTERVERBAND (SBV-SSE-SSIC)	SWITZERLAND	national

Associations of Constructors/individual constructors/companies with interest in the sector

Real Estate Associations or Investors in the sector		
Romanian Association of Building Owners	ROMANIA	national
Merope Asset Management Srl	ITALY	national
Meridia Capital	SPAIN	national
Property Industry Ireland	IRELAND	national
Nextensa	BELGIUM	national
ADLER Real Estate AG	GERMANY	national
PRODEA Investments	GREECE	national
Malta Real Estate Investment Trust (REIT)	MALTA	national
Swiss Aim	SWITZERLAND	national

Real Estate Associations or Investors in the sector

Associations of Engineers or individual engineers or companies		
The General Association of Engineers in Romania	ROMANIA	national
Consiglio Nazionale degli Ingegneri	ITALY	national
Comite Nacional Espanol de la ENGINEERS EUROPE	SPAIN	national
Engineers Ireland	IRELAND	national
Fédération Royale des Associations Belges d'Ingénieurs civils, d'ingénieurs agronomes et bioingénieurs (FABI)	BELGIUM	national
Deutsches Nationalkomitee der ENGINEERS EUROPE	GERMANY	national
Association of Civil Engineers of Greece	GREECE	national
Chamber of Engineers and Kamra tal – Periti	MALTA	national
Swiss society of Engineers and Architects - SIA	SWITZERLAND	national

Associations of Engineers or individual engineers or companies with interest in the sector

Historical Monuments Associations		
National Union of Restorers of	ROMANIA	national
Associazione Dimore Storiche Italiane	ITALY	national
Asociación de Propietarios de Casas	SPAIN	national
Historic Houses of Ireland	IRELAND	national
Association Royale des Demeures	BELGIUM	national
Observer Member: Schlösser und	GERMANY	national
Elliniki Etairia – Society for the	GREECE	national
Heritage Malta	MALTA	national
Domus Antiqua Helvetica (DAH)	SWITZERLAND	national

Historical Monuments Associations

Policy makers and Public Authorities		
AMR (ASSOCIATION OF MUNICIPALITIES IN ROMANIA)	ROMANIA	national
National Association of Italian	ITALY	national
Federación Española de Municipios y Provincias (FEMP)	SPAIN	national
The County and City Management	IRELAND	national
The Association of Flemish Cities and	BELGIUM	national
The German Association of Towns and Municipalities (Deutscher Städte- und Gemeindebund, DStGB)	GERMANY	national
Central Union of Municipalities of	GREECE	national
Local Councils' Association	MALTA	national
Swiss Association of Cities	SWITZERLAND	national
Private and Public Stakeholders which have interest in the sector		
Magurele Science Park	ROMANIA	national
Unione Geotermica Italiana (UGI)	ITALY	national
La Asociación de Empresas de Energías Renovables (APPA)	SPAIN	national
The Geothermal Association of Ireland (GAI)	IRELAND	national
IDEA	BELGIUM	national
GeoEnergy Celle e.V.	GERMANY	national
EARG DEVELOPERS GREECE	GREECE	national
MIDI plc	MALTA	national
Geothermie.ch / SVG	SWITZERLAND	national

Policy makers and Public Authorities, Private and Public Stakeholders, which have interest in the sector