

User-tailored catalogue of good practice business models to implement geothermal heat pumps systems at different scales

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Abbreviations

ASHP – air source heat pump

ATES – aquifer thermal energy storage

BREEAM - Building Research Establishment Environmental Assessment Method

BTES – borehole thermal energy storage

BHE – borehole heat exchanger

CAGR – compound annual growth rate

CAPEX – capital expenditure

CBI - Climate Bonds Initiative

CEC - Citizen Energy Communities

COP - Coefficient of Performance

DHW – domestic hot water

EaaS – Energy as a Service

EIB – European Investment Bank

EPREL - European Registry for Energy Labelling

ESG - Environmental, Social, Governance

EHPA - European Heat Pump Association

EPBD – Energy Performance of Building Directive

ESCO – Energy Service Company

ETS – Emission Trading System

EU - European Union

GeoBOOST – project that promotes geothermal heating and cooling

GHG - greenhouse gas

GHP – geothermal heat pump

GHE - ground heat exchangers

GSHP – ground source heat pump

GBP - Green Bond Principles

HaaS – Heat as a Service

HVAC – heating, ventilation, air-conditioning

ICMA - International Capital Market Association

IoT – internet of things

IP – intellectual property

KfW - Kreditanstalt für Wiederaufbau

MRV - monitoring, reporting, and verification

NGO – non-governmental organisation

NPV – net present value

LEED - Leadership in Energy and Environmental Design

OPEX – operational expenditure

PV – photovoltaic

Prosumer – Combination of words "producer" and "consumer" and signifies individuals actively involved in the creation or customization of what they use.

ROI - return on investment

SME – small and medium enterprises

TRT – thermal response test

UTES – underground thermal energy storage

VPP - Virtual Power Plant

1. Introduction

As countries worldwide strive to meet ambitious climate and energy goals, the decarbonization of heating and cooling has emerged as a critical challenge. Geothermal heat pump (GHP) systems offer a clean, efficient, and scalable solution, capable of significantly reducing greenhouse gas emissions and energy consumption in buildings and industrial applications. However, despite their technical and environmental advantages, widespread deployment of GHPs remains constrained by high upfront costs, complex stakeholder involvement, and diverse market conditions.

European countries have emerged as leaders in the utilization of renewable energy, playing a crucial role in mitigating CO₂ emissions and combating the greenhouse gas effect. Over the past two decades, the adoption of renewable energy sources has experienced exponential growth, with geothermal energy being a significant contributor. Heating and cooling account for nearly half of global final energy use, with the vast majority (about 90%) still reliant on fossil fuels or the inefficient, unsustainable uses of biomass (acc. to IRENA — World Energy Transitions Outlook 2022). Geothermal heat pumps, which utilize the earth's stable subsurface temperatures in the first few hundred meters to provide heating and cooling (shallow geothermal energy), represent a mature and efficient renewable energy solution.

In particular, the market for GHPs has witnessed significant growth, driven by factors such as phasing-out natural gas and other fossil fuels (see Deliverable D2.1.). While some countries are actively providing financial support for the establishment of new geothermal installations, others have been slower to do so. The Russian invasion of Ukraine prompted European nations to seek for even greater independence from Russian gas supplies, leading to increased private investments in geothermal infrastructure in EU member states.

One of the main challenges to be addressed by GeoBOOST is the limited diversity and application of business models, as well as insufficient financing. Access to finance and/or financial products such as risk insurance is an issue for project developer. New and innovative business models help to reduce total project costs which further increase the benefits of GHPs. The Green Bond market is expected to be a major source of growth for clean technology. GHPs are recognized in the EU's Sustainable Finance Taxonomy and therefore should benefit from this new source of finance. Designing green bonds and financing for project developers is addressed in Tasks 5.3 and in the report D4.1., which provides "A life-cycle-cost analysis tool for different heating and cooling technologies". There is also a need for an interface to bring together potential consumers and lenders of private capital, which is addressed in Task 4.2. (see Deliverable D4.2).

Unlike other renewables, such as solar thermal or biomass, GHPs offer the opportunity of being cost efficient and economically stable in the long term. However, GHPs are affected by high upfront costs. Standard economic evaluation schemes, such as net present value (NPV)

methods, do not have the capacity to outline the long-term benefits of GHPs. GeoBOOST will tailor integrative economic analyses based on real option values towards the life cycle profiles of GHPs (D4.1.). GeoBOOST also aims at connecting the outcomes of the adapted analyses to business models suitable for mass deployment of GHPs in Europe.

Due to a changing heating and cooling market with, on the one hand, the challenges of a more decentralized volatile and flexible market including many renewable resources and, on the other hand, a decreasing heating demand (e.g. caused by refurbishments) and increasing cooling demand (caused by climate change and urban heat island effects), new concepts for the actors in the market are necessary. Despite the high potential of GHPs as a renewable energy resource in various cases for building and quarters, shallow geothermal is often not focused because the flexibility, advantages and integration opportunities of GHP are not well known by the market actors. Existing good practice of successfully implemented business models showing the economic and ecological advantages of GHP utilization and how they are implemented can be used as a role model for other stakeholders in the energy market. The changing market includes also various actors like energy suppliers (producers) but also the private sector and Citizen Energy Communities (CEC) as prosumers, addressing also different scales of energy supply like district heating and cooling grids, low temperature grids for quarters and the single households.

Task 5.3 aims to identify good practice examples for business models integrating GHPs addressing the different market actors (e.g. CEC, Energy Suppliers, utilities, project developers). The task concentrated new business models that differ from the most common and traditional model, where a designer offers to design the system and connects to drillers and heat pump installers. The intention was to showcase alternative business approaches and highlight how diversifying such models can help expand the sales and market penetration of GHPs. All GeoBOOST project partners looked for companies representing different business models and collected details about it using a standardized questionnaire, which was based on the business model canvas framework.

The collected business models were analyzed and prepared for the different stakeholders in terms of different requirements (e.g. sector coupling opportunities, Prosumer Roles). Task 5.3 developed a user-tailored business models catalogue, which will be used to close the knowledge gaps by dissemination activities (publishing it at web-portals, conferences, trade fairs, etc.).

This catalogue provides a comprehensive and user-tailored overview of good practice business models for the successful implementation of GHP systems across various scales - residential, commercial, institutional and industrial. By applying the business model canvas framework, this report maps out practical pathways for different stakeholders to participate in and benefit from GHP adoption.

The catalogue aims to support policymakers in understanding and enabling viable business models, and to assist developers, utilities, technology providers, and financial institutions in identifying and applying models that can be adapted locally. It also helps end-users to better understand the available offer types and solutions that derive from these business models.

1.1 Purpose and scope of the catalogue

Purpose

The user-tailored catalogue of good practice business models aims to provide a structured and practical guide for stakeholders interested in deploying GHP systems across different scales. The document serves as a reference tool to help decision-makers - such as homeowners, businesses, policymakers, and investors - identify and implement effective business models that align with their specific needs, financial constraints, and market conditions.

This catalogue will:

- Showcase successful business models that have been implemented worldwide for different scales of GHP systems.
- Guide stakeholders on how to structure financing, partnerships, and operations to maximize the benefits of GHPs.
- Facilitate informed decision-making by presenting case studies, challenges, and innovative approaches to GHP adoption.
- Encourage wider adoption of GHP technology by addressing economic, regulatory, and technical barriers.

Scope

This catalogue covers a wide range of GHP applications, categorized by scale developed in the GeoBOOST project:

- Small-Scale (< 20 kW): Residential homes, small businesses and decentralized installations.
- Medium-Scale (20 kW – 150 kW): Multi-family housing, commercial buildings, educational institutions and public facilities.
- Large-Scale (150 kW – multi MW): District heating and cooling networks, industrial applications and utility-owned GHP systems.

The examples of the categories here are typical cases. Many factors can influence the specific capacity required in a certain project.

For each scale, the catalogue will examine:

- Business models suited to different financial, technical, and market conditions.
- Key stakeholders involved in financing, installation, and operation.
- Revenue generation mechanisms, including energy savings, leasing options, and service-based models.
- Policy and incentive frameworks that support market growth.
- Best practices and case studies that illustrate successful implementation.

By providing tailored solutions and scalable business models, this catalogue will help accelerate the transition to sustainable, energy-efficient heating and cooling systems powered by shallow geothermal technology.

1.2 Benefits of geothermal heat pump systems in the energy transition

The transition to a low-carbon, sustainable energy system is a global priority, driven by the need to reduce greenhouse gas (GHG) emissions, improve energy efficiency, and enhance energy security. GHPs play a crucial role in this transition by offering a clean, reliable, and energy-efficient solution for heating and cooling buildings across residential, commercial, and industrial sectors. Figure 1. contains the main benefits of GHPs in the energy transition.

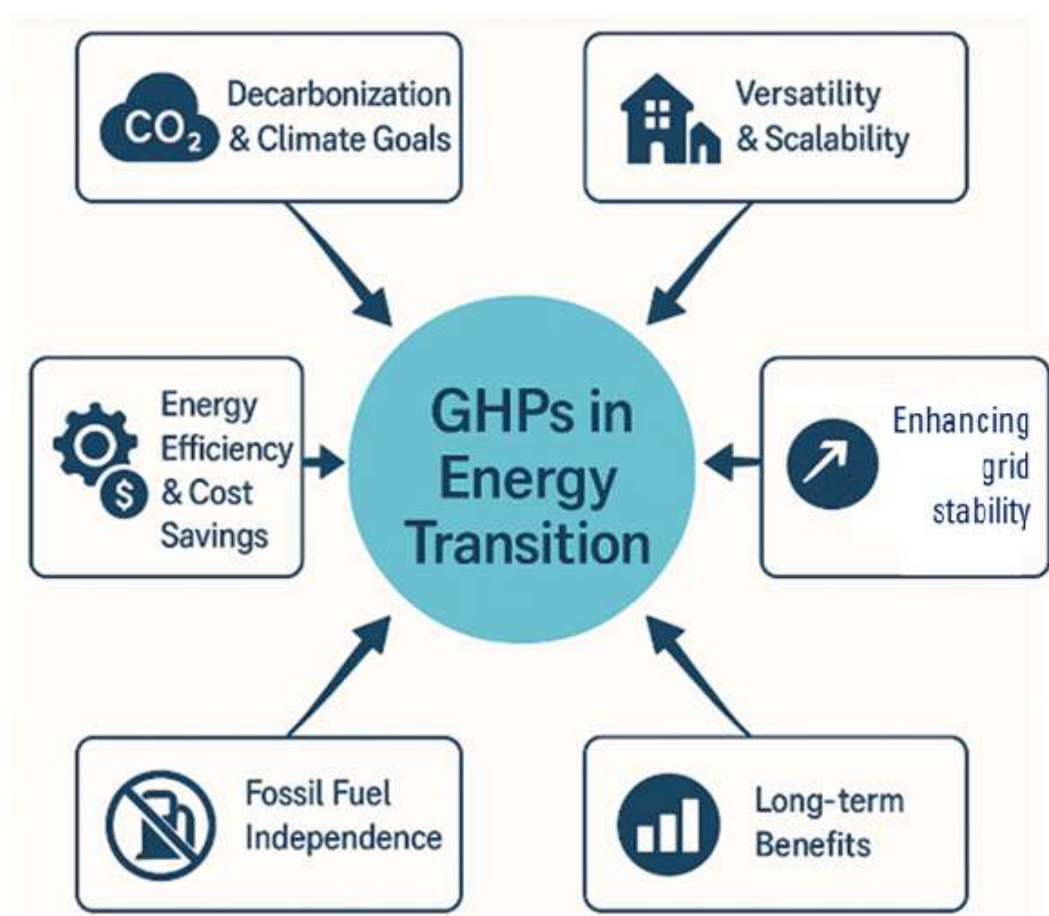


Fig. 1. Main benefits of GHPs in energy transition

1. Contribution to decarbonization & climate goals

- GHPs significantly reduce carbon emissions by replacing fossil fuel-based heating systems (e.g., gas boilers, oil heaters).
- They support net-zero energy targets by integrating with renewable energy sources such as solar PV and wind power.
- Many governments recognize GHPs as a key technology in achieving their climate action plans and national energy efficiency goals.
- Widespread adoption of GHPs supports job creation in engineering, installation, and maintenance sectors, contributing to the green economy.

2. Energy efficiency and cost savings

- GHPs use the stable underground temperature to provide high-efficiency heating and cooling, with energy savings of 30–70% compared to conventional HVAC systems.
- They operate at COP (Coefficient of Performance) values of 4 to 6, meaning they provide four to six times more energy than they consume.
- Reduced operational costs make GHPs financially attractive in the long run, especially in regions with high gas prices.

3. Reducing dependence on fossil fuels

- Unlike traditional heating systems that rely on natural gas, coal, or oil, GHPs harness renewable geothermal energy, reducing exposure to volatile fuel prices.
- They contribute to energy independence by reducing reliance on imported fuels, especially in regions with limited fossil fuel resources.
- GHPs work well with electrification strategies, aligning with the shift toward clean energy grids powered by renewables.

4. Enhancing grid stability and energy integration

- GHPs reduce peak electricity demand by providing highly efficient heating and cooling, thereby lessening the strain on power grids.
- When combined with thermal energy storage and smart grid integration, GHPs contribute to grid flexibility and demand response programs.
- Large-scale GHP systems can support district energy networks, improving overall energy efficiency at the community level.

5. Versatility and scalability

- GHPs can be deployed across various scales, from single-family homes to district heating systems for entire cities.
- They are suitable for retrofits and new developments, making them a viable option for both urban and rural settings.
- Advances in drilling technologies and hybrid systems (e.g., combining GHPs with solar thermal energy) are expanding the feasibility of GHPs in diverse climates and geographies.

6. Long-term economic and environmental benefits

- While initial installation costs can be higher than traditional systems, GHPs offer low operating and maintenance costs, leading to long-term financial benefits.
- They enhance building value and marketability, particularly in regions with green building certifications and energy performance regulations.
- Widespread adoption of GHPs supports job creation in engineering, installation, and maintenance sectors, contributing to the green economy.

GHP systems are a critical enabler of the energy transition, offering low-carbon, cost-effective, and resilient heating and cooling solutions. Their integration into business models, policy

frameworks, and energy systems can drive widespread adoption, accelerating the shift toward sustainable and energy-efficient built environments worldwide.

1.3 Key stakeholders in GHP implementation

This report is designed to support a diverse group of stakeholders involved in the development, financing, installation and operation of geothermal heat pump (GHP) systems. By understanding their unique roles, challenges and interests, this chapter aims to provide relevant insights.

Utilities & Energy Service Companies (ESCOs)

Forward-thinking utilities are playing a crucial role in advancing the GHP market. Some utilities have proactively implemented programs aimed at encouraging the adoption of GHP systems, with a particular focus on residential customers. These initiatives not only promote energy efficiency but also position utilities as leaders in the transition towards sustainable heating practices.

Energy service companies are actively investing in and promoting GHP technologies as part of their comprehensive energy efficiency solutions. By incorporating GHPs into their portfolios, ESCOs are not only meeting the demand for sustainable energy solutions, but they also profit from long-term extremely high-savings contracts for the end user. There are many technical issues in maintenance and operation which can make the heating/cooling network uneconomical.

- Role: Providing financing, infrastructure, and maintenance services for GHP systems.
- Interest: Expanding renewable heating solutions, offering new customer services, and meeting energy efficiency targets.
- Challenges: Regulatory approvals, upfront infrastructure costs, and customer adoption rates.

Financial institutions & investors

Financial institutions and investors play a crucial role in scaling up GHP adoption by providing the necessary capital, risk-sharing mechanisms, and investment structures. Their involvement helps bridge the high upfront cost barrier, making GHP systems more financially viable for homeowners, businesses, and large-scale facilities.

- Role: Providing capital for GHP projects through loans, green bonds, and climate funds.
- Interest: Investing in sustainable energy projects with stable returns.
- Challenges: Long payback periods, perceived risks in emerging markets.

Policy-makers & regulatory bodies

Policy-makers and regulatory bodies play a crucial role in shaping the legal, financial, and market conditions for the adoption of GHP systems. By implementing incentives, regulatory frameworks, and climate policies, they can help reduce market barriers, encourage investment, and accelerate the transition to sustainable heating and cooling solutions using GHP.

- Role: Developing policies, incentives, and regulatory frameworks that support GHP adoption.
- Interest: Achieving climate goals, reducing fossil fuel dependence, and promoting energy efficiency.
- Challenges: Balancing market incentives with energy affordability and infrastructure needs.

Drilling companies and geologists

Drilling companies and geologists play essential roles in the successful implementation of GHP systems. They are primarily responsible for assessing, drilling, and ensuring the installation of ground loop systems, which are fundamental for heat exchange with the earth.

- Role: Borehole Drilling and System Installation, Site Evaluation and Geothermal Feasibility Assessment, Risk Mitigation:
- Interest: Expanding the market for GHP solutions, long-term business sustainability, proper geological assessments to ensure that drilling does not cause harmful disturbances
- Challenges: Training workforce, geological uncertainty, overcoming drilling barriers and permitting procedures, ensuring system reliability. balancing sustainability with feasibility

Technology providers, sanitary designers & installers

Technology providers, sanitary designers and installers are essential stakeholders in the deployment of GHP systems. They are responsible for developing, manufacturing, supplying, designing and installing the necessary hardware and technology to make GHP systems operational. Their role extends to ensuring that the systems are efficient, reliable, and customized to the specific needs of each user, whether residential, commercial, or industrial.

- Role: Supplying GHP equipment, designing systems, and handling installation.
- Interest: Expanding the market for GHP solutions and improving technological performance.
- Challenges: Training workforce, overcoming installation barriers, ensuring system reliability.

By addressing the needs of homeowners, businesses, municipalities, utilities, investors, and policymakers, this catalogue ensures that each stakeholder group has access to tailored business models that make GHP adoption financially viable, scalable and sustainable.

1.4 Market trends and emerging opportunities

The GHP industry is evolving rapidly, driven by technological advancements, growing policy support, and increasing awareness of the benefits of renewable energy solutions. This section highlights the key market trends and emerging opportunities that are shaping the adoption and expansion of GHP systems at different scales. The market trends of GHPs have been presented and discussed in detail in the GeoBOOST deliverable D2.1. Below, the main key points are summarized.

Market Trends



Fig. 2. Market trends of geothermal heat pumps in Europe

1. Rising demand for renewable heating and cooling solutions

- Decarbonization goals: Many countries are implementing policies to achieve net-zero emissions, driving the adoption of renewable heating and cooling technologies, including GHP systems in accordance with EU Climate Law (Regulation EU 2021/1119)
- Electrification of heating and cooling: As the energy sector shifts towards electrification, GHP systems are gaining traction as they integrate seamlessly with low-carbon electricity grids.
- Energy efficiency prioritization: GHP systems are highly efficient compared to traditional HVAC systems, offering significant energy savings for residential, commercial, and industrial users.

2. Growth in district heating and cooling

- Urbanization and smart cities: Growing urbanization and the rise of smart city projects are creating demand for sustainable district heating and cooling networks, where GHP systems are a key component.
- Integration with renewable grids: District systems incorporating geothermal energy are becoming more common, especially in areas with favorable geological conditions.

3. Technological advancements

- Smart geothermal systems: Innovations in smart controls, remote monitoring, and AI-powered optimization are enhancing the performance of GHP systems, making them more user-friendly and efficient.
- Improved drilling techniques: Advances in drilling technologies are reducing installation costs, making GHP systems more accessible to a broader range of customers.
- Hybrid systems: Combining GHPs with other renewable energy technologies (e.g., solar PV, wind energy) is emerging as a popular trend to maximize energy efficiency and reduce overall carbon footprints.

4. Government policies and incentives

- Subsidies and tax credits: Increasing availability of government subsidies, tax incentives, and grants for renewable energy solutions is accelerating the adoption of GHP systems. Due to much higher efficiency of GHPs they should be eligible for higher subsidy levels in comparison to other heating systems (e.g. Clean Air Scheme or My Heat Scheme in PL)
- Carbon pricing: The introduction of carbon pricing and emissions trading systems (ETS2 on fossil fuels in the building sector in 2027) incentivizes businesses to switch to low-carbon technologies like GHPs (ETS Directive).
- Building codes and standards: Stricter energy efficiency requirements in building codes are encouraging the use of GHPs for heating and cooling (see EPBD regulations).

5. Expanding market segments

- Retrofit opportunities: Retrofitting existing buildings with GHP systems is becoming a growing market, especially in urban areas with aging infrastructure.

- Industrial applications: Industrial facilities are increasingly adopting GHPs for process heating and cooling, leveraging the consistent and reliable thermal energy provided by geothermal systems.
- 5th generation heating and cooling grids: Heating and cooling grids that run on low temperatures are implemented more often. Here, GHPs play an important role, especially in their application of seasonal heat storage.

Emerging opportunities



Fig. 3. Emerging opportunities for geothermal heat pumps in Europe

1. Residential market growth

- Energy cost savings: Rising energy prices are making GHP systems more attractive to residential customers seeking long-term savings on heating and cooling costs.
- Green building certifications: Developers are installing GHPs to qualify for green building certifications such as LEED, enhancing property values and appeal.
- Value increase: There are many examples in Europe stating that GHP systems increase the value of the building (even by 12% as reported in Sweden).

2. Commercial and industrial applications

- Sustainable corporate initiatives: Businesses are adopting GHP systems as part of their corporate sustainability strategies, driven by customer demand, shareholder pressure or legal requirements to reduce carbon emissions.
- Process heating and cooling: Industries such as food processing, pharmaceuticals, and manufacturing are increasingly adopting GHPs for specialized thermal applications, creating a new revenue stream for technology providers and installers.

3. District-scale applications

- Public infrastructure projects: Local governments and municipalities are exploring GHP systems for low temperature district heating and cooling projects, especially in urban centers and campuses (5th generation district heating and cooling grids).
- Energy sharing networks: Emerging concepts like geothermal energy sharing grids enable multiple users to share thermal energy from a centralized geothermal source, maximizing system efficiency and reducing costs (Kensa Group in UK showcasing first examples).

5. Financial innovation

- As GHP systems face very often a challenge with CAPEX, there is high need for exploration of new and promising business models, which could be utilized in the implementation and wider adoption of GHP systems.
- They will be thoroughly analyzed in this report.

5. Integration with smart grids

- Demand response opportunities: GHP systems can be integrated into smart grid platforms, allowing them to participate in demand response programs and contributing to grid stability by shifting heating/cooling loads.
- Energy storage potential: The thermal mass of the ground can be used for seasonal energy storage, enabling innovative business models that combine GHPs with thermal energy storage solutions (UTES, ATES, BTES).

6. Expanding global markets

- Emerging economies: Developing countries with growing energy demand are beginning to explore GHP systems as a way to achieve sustainable energy access.
- International collaboration: Multilateral organizations, such as the International Renewable Energy Agency (IRENA), are promoting GHP adoption in regions with

significant geothermal potential, such as East Africa, Southeast Asia, and South America.

7. R&D and innovation

- Low-cost drilling technologies: Ongoing research into cost-effective drilling techniques, such as coiled tubing drilling and horizontal directional drilling, is reducing the upfront costs of GHP installations (more on that see in the deliverable 5.1 Catalogue of existing and promising technical solutions).
- Geothermal for net-zero buildings: Innovations in GHP design are driving the development of net-zero energy buildings, where geothermal systems work seamlessly with renewable electricity and smart energy management systems.

8. Circular economy approaches

- Recycling and reuse: Opportunities exist to incorporate recycled materials into GHP systems, such as using reclaimed piping or components, aligning with the principles of the circular economy.
- Waste heat recovery: Combining GHP systems with waste heat recovery technologies (like waste water, data centers, production processes) can further improve efficiency and open new markets.

The GHP market is positioned for significant growth, with trends like urbanization, electrification, and policy support acting as major drivers. Emerging opportunities, including innovations in financing models, smart technology integration, and district-scale solutions, are expanding the scope of GHP adoption. By capitalizing these trends and addressing challenges, stakeholders can unlock the full potential of geothermal systems as a cornerstone of the global energy transition.

2. Business models for GHP system implementation

2.1 Overview of business models for GHP implementation

The successful deployment of GHP systems depends not only on technological advancements but also on well-structured business models that address financial, operational, and market challenges. Different business models can be applied depending on scale (residential, commercial, or district-level), financing options, and ownership structures.

This section provides an overview of the most common business models used for GHP implementation, focusing on ownership, financing, and revenue generation mechanisms.

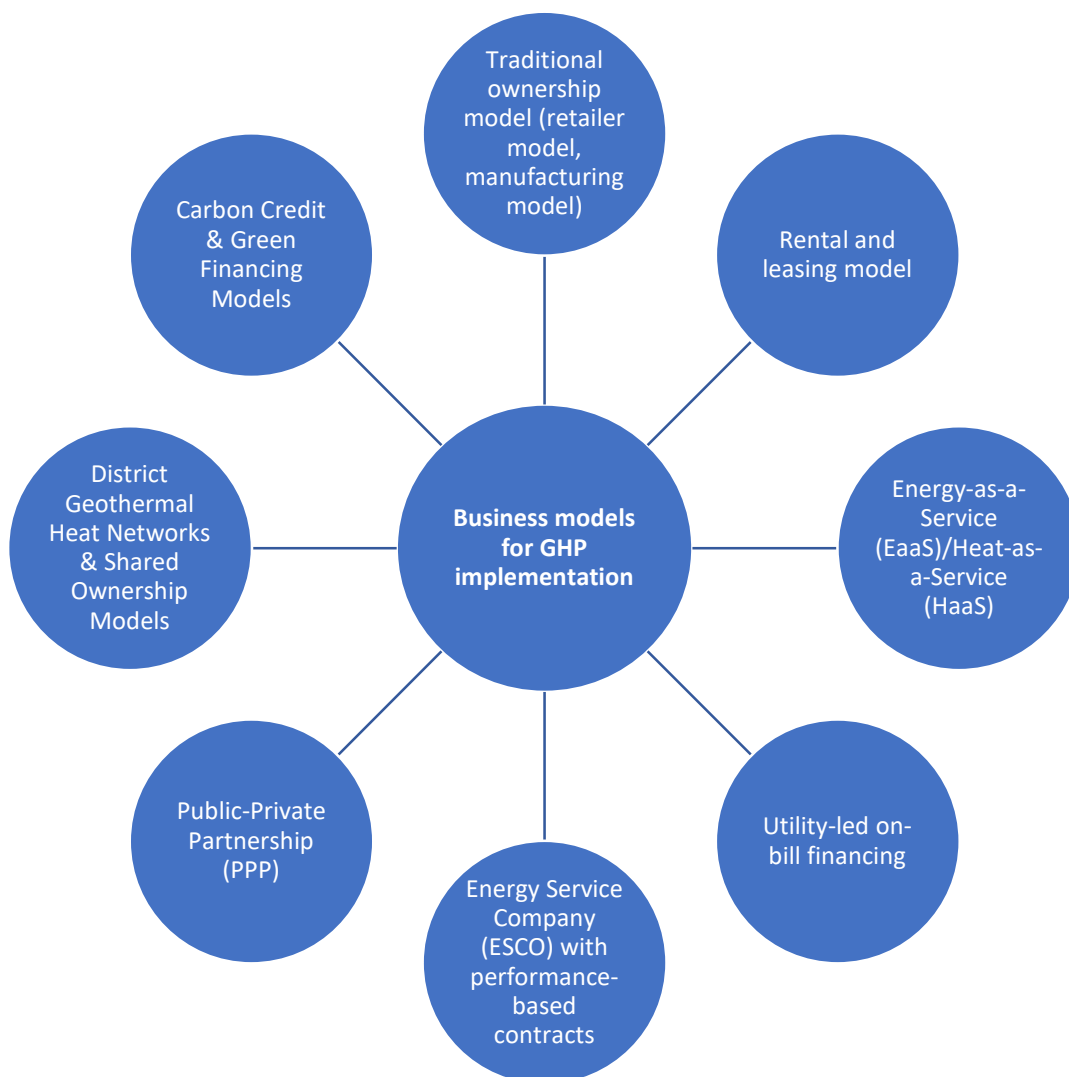


Fig. 4 Overview of business models for geothermal heat pump implementation

1. Traditional ownership model (retailer model, manufacturing model)

- The end-user (homeowner, business, or institution) purchases and owns the GHP system outright.
- Installation costs are covered by the owner, potentially with the help of incentives, grants, or tax credits.
- Long-term savings come from reduced energy bills and maintenance costs.
- Best suited for: Homeowners, businesses with capital investment capacity, and organizations with access to subsidies.
- Challenges: High upfront capital costs, need for technical expertise in system selection and installation.

2. Rental and leasing model

- The customer leases the GHP system from a third-party provider rather than purchasing it.
- Monthly lease payments cover installation, maintenance, and operational costs.
- Some models offer a buyout option after a certain period.
- Best suited for: Small businesses, homeowners, and institutions seeking to reduce upfront investment.
- Challenges: Long-term contract commitments, potential higher costs over time, hard to combine with subsidies (as they are mainly based on traditional ownership model).

3. Energy-as-a-Service (EaaS)/Heat-as-a-Service (HaaS)

- Instead of purchasing a GHP system, customers pay for the heating and cooling as a service.
- A third-party company installs, owns, and operates the system, and users pay based on energy consumption.
- This model removes technology risk and maintenance responsibility from the customer.
- Best suited for: Multi-family buildings, commercial facilities, municipalities.
- Challenges: Contract complexities, reliance on the service provider.

4. Utility-led on-bill financing

- Utility companies finance and own the GHP system while customers repay through their monthly utility bills.
- This lowers the barrier to entry for customers by removing the need for upfront capital.
- Can be structured as a fixed monthly payment or pay-as-you-save model.
- Best suited for: Homeowners and businesses in partnership with utilities.
- Challenges: Requires regulatory approval, potential concerns about long-term cost commitments.

5. Energy Service Company (ESCO) with performance-based contracts

- An Energy Service Company (ESCO) installs and manages the GHP system.
- The ESCO guarantees energy savings, and customers repay costs based on achieved savings (Performance-Based Contracting).

- Reduces customer risk while ensuring ongoing optimization and efficiency.
- Best suited for: Large commercial buildings, institutions, and industrial facilities.
- Challenges: Contract complexity, reliance on accurate savings measurement.

6. Public-Private Partnership (PPP)

- A collaboration between government entities and private investors to finance, install, and operate large-scale GHP systems.
- Often used in district heating projects, public housing, and municipal buildings.
- Governments may provide grants, tax incentives, or low-interest loans to reduce investment risks.
- Best suited for: Large-scale public projects, city-wide or district heating networks.
- Challenges: Long project timelines, regulatory barriers, need for strong public-private collaboration.

7. District Geothermal Heat Networks & Shared Ownership Models

- A centralized GHP system serves multiple buildings or users within a district.
- Customers pay a connection fee and usage-based rates for heating/cooling.
- The system may be owned by utilities, cooperatives or municipalities.
- Best suited for: Urban developments, industrial parks, and community energy projects.
- Challenges: High initial infrastructure costs, long payback periods, and regulatory approvals.

8. Carbon Credit & Green Financing Models

- GHP systems contribute to carbon emission reductions, allowing owners to earn carbon credits or participate in green financing programs.
- Projects may receive funding through sustainability-linked loans, green bonds, or international climate finance initiatives.
- Best suited for: Large-scale industrial and institutional projects with measurable carbon reductions.
- Challenges: Complex market mechanisms, verification requirements for carbon savings.

The choice of business model for GHP implementation depends on project scale, available financing mechanisms, policy environment, and risk appetite of the stakeholders involved. Innovative financing strategies such as leasing, energy-as-a-service, and public-private partnerships help overcome financial barriers and encourage widespread adoption of GHP technology in both small-scale and large-scale applications. The current financial framework for GHPs of the GeoBOOST countries was analyzed in deliverable D4.2. This report also includes recommendations for improved financial mechanisms.

2.2 Key characteristics of successful business model

Successful business models for implementing GHP systems are defined by their ability to balance technical feasibility, financial viability, environmental sustainability, and stakeholder collaboration. These models not only maximize the benefits of GHP systems but also address the specific challenges of their deployment, such as high upfront costs, long payback periods, and the need for effective policy support. Below are the key characteristics of business models that drive success in GHP system implementation:

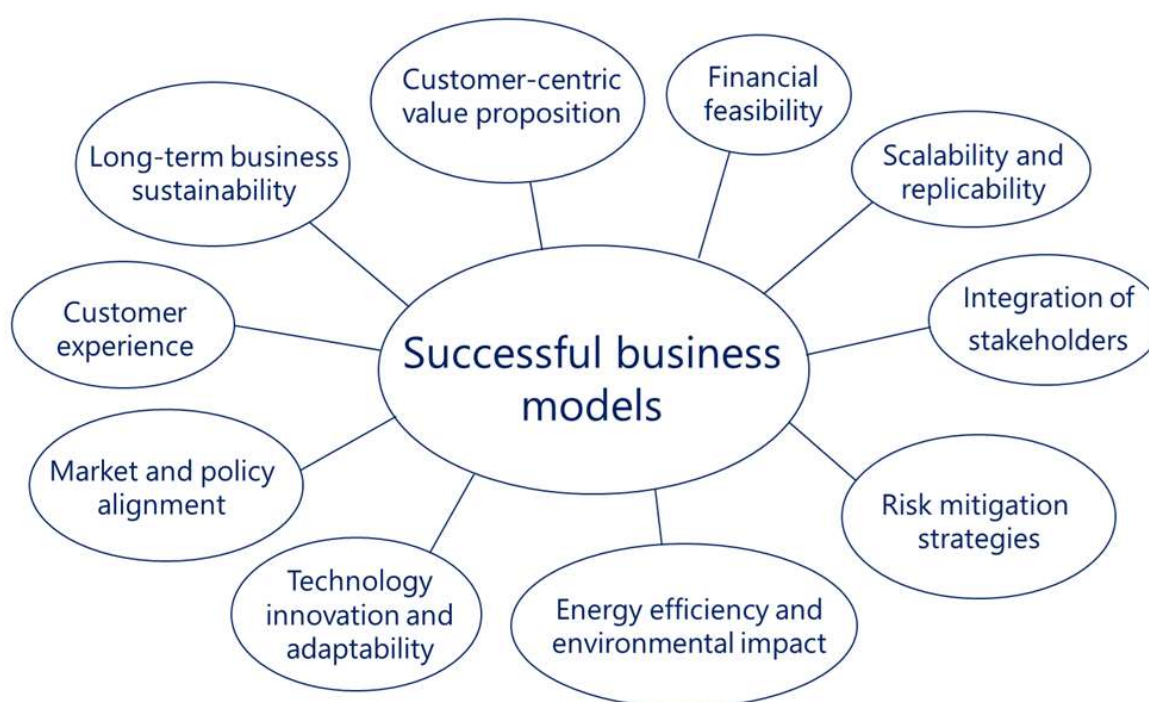


Fig. 5. Key characteristics of successful business model

1. Customer-centric value proposition

- Addressing specific needs: A successful business model begins with a clear value proposition that aligns with the needs of the target customer segments (e.g., residential users, commercial building owners, municipalities, or industrial facilities).
 - Example: For residential customers, the model might emphasize energy cost savings and comfort, while for municipalities, it might focus on decarbonization and long-term energy planning.
- Customized solutions: Business models should offer tailored solutions based on the scale and application of the GHP system (e.g., individual homes, district heating, or industrial cooling systems).

2. Financial feasibility

- Affordability and financing options: Successful business models mitigate the high upfront cost of GHP systems through innovative financing mechanisms, such as:
 - Third-party ownership (e.g., ESCOs).

- Leasing models.
- Green loans or on-bill financing.
- Incentive-based structures (e.g., tax credits, subsidies, and grants).
- Predictable Return on Investment (ROI): Models should provide transparent and quantifiable projections of energy savings, payback periods, and lifecycle cost benefits, enabling stakeholders to make informed decisions.

3. Scalability and replicability

- Standardized processes: Successful business models feature standardized and streamlined processes that make GHP system installation and operation easier to replicate across different sites and scales.
- Modular solutions: Models that allow for scalable modular systems can adapt to customer needs and geographical constraints, making them suitable for both small-scale residential projects and large-scale commercial or district heating networks.

4. Integration of stakeholders

- Collaborative partnerships: The most effective models foster partnerships among key stakeholders, including:
 - Drilling companies for site-specific installation.
 - Technology providers for high-quality heat pump equipment.
 - Policy-makers to ensure supportive regulations and incentives.
 - Financial institutions to provide financing or loans.
- Clear roles and responsibilities: Successful models clearly define the roles of each stakeholder to ensure seamless collaboration and execution.

5. Risk mitigation strategies

- Technical risk management: Models must account for site-specific challenges, such as geological variability, by incorporating thorough feasibility studies and risk assessments.
- Financial risk sharing: Risk-sharing mechanisms (e.g., performance-based contracts or guarantees) reduce financial risk for customers and investors, making projects more attractive.
- Policy and regulatory compliance: Ensuring compliance with environmental regulations and leveraging government support (e.g., subsidies, permitting assistance) reduces risks associated with legal and regulatory barriers.

6. Focus on energy efficiency and environmental impact

- Energy performance guarantees: Business models that provide performance-based guarantees ensure that GHP systems deliver expected energy savings and operational efficiency.
- Carbon reduction goals: Successful models align with broader sustainability and carbon neutrality objectives, emphasizing the role of GHPs in reducing greenhouse gas emissions and reliance on fossil fuels.

- Lifecycle sustainability: By incorporating durable, low-maintenance equipment, successful models ensure long-term environmental benefits and cost efficiency.

7. Technology innovation and adaptability

- Incorporating smart technologies: The use of smart controls, sensors, and monitoring systems enhances GHP performance and user experience, improving energy management and reducing operational costs.
- Integration with renewable energy sources: Successful models often combine GHP systems with other renewable energy solutions, such as solar PV or wind power, for a hybrid approach to sustainable energy use.

8. Market and policy alignment

- Leveraging incentives: Business models that take full advantage of government subsidies, tax incentives, and grants make GHP systems more financially viable for customers.
- Adapting to market conditions: Flexible business models that adapt to local energy prices, climate conditions, and regulatory frameworks are better suited to succeed across diverse regions.
- Creating awareness: Investing in market education and customer awareness campaigns ensures that potential customers understand the benefits of GHP systems, increasing adoption rates.

9. Emphasis on customer experience

- Hassle-free installation: Simplifying the installation process through turnkey solutions enhances customer satisfaction.
- Long-term support: Successful business models include provisions for ongoing support, such as maintenance services, warranty programs, and performance monitoring.
- Transparent communication: Clear and transparent communication regarding costs, benefits, and expected outcomes builds trust and confidence with customers.

10. Long-term business sustainability

- Revenue diversification: Business models that diversify revenue streams (e.g., through maintenance contracts, system upgrades, or equipment leasing) ensure financial sustainability for service providers.
- Circular economy approaches: Models incorporating recycling of components, reuse of materials, or sustainable disposal practices align with long-term environmental and economic goals.

The key characteristics of successful business models for GHP systems focus on addressing stakeholder needs, reducing risks, and ensuring financial and environmental sustainability. By integrating innovative financing mechanisms, stakeholder collaboration, and technology advancements, these business models facilitate the adoption of GHP systems across various scales, from residential to large industrial and district heating applications. They provide a

framework for achieving energy efficiency, cost savings, and decarbonization in the global energy transition.

2.3 Factors influencing business model selection

Selecting an appropriate approach for implementing GHP systems depends on a combination of technical, financial, market, and stakeholder considerations. The choice of a specific product, service, or contractual model, which reflects different underlying business models, should take into account the unique characteristics of the project, the needs of the involved stakeholders, and external factors such as regulations and economic conditions. Figure 6 provides an overview of the main factors influencing these decisions.

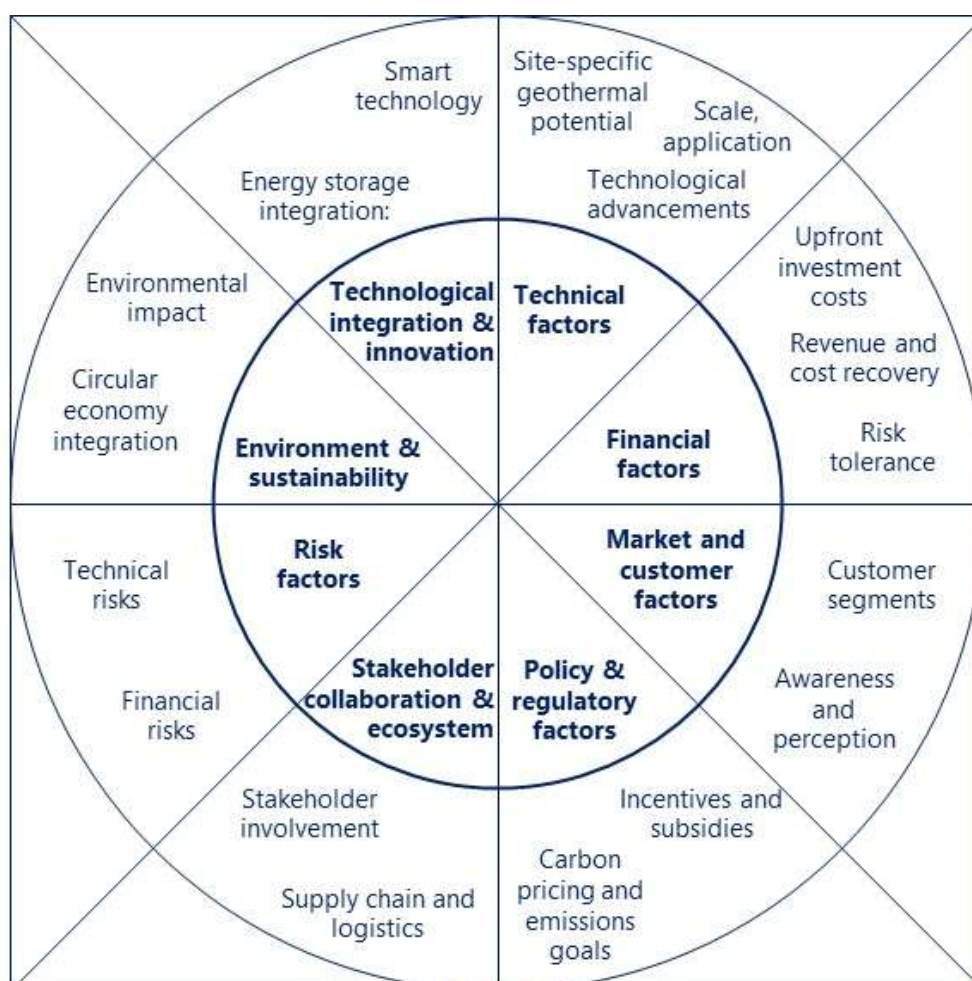


Fig. 6. Main factors influencing business model selection

1. Technical factors

1.1 Site-specific geothermal potential

- Geological conditions: The availability and quality of geothermal resources, such as soil type, ground temperature, and water table levels, significantly influence the technical feasibility of GHP systems.
- Drilling complexity: The ease or difficulty of drilling and installing geothermal wells impacts costs and affects the choice of business model (e.g., high drilling costs may necessitate third-party financing or shared ownership models).

1.2 Scale and application

- Residential vs. commercial: The scale of the project - whether it is a single-family home, a commercial building, or a district heating network - determines the complexity and financing needs of the business model.
- Integration with existing systems: The extent to which GHP systems can be integrated with existing heating/cooling infrastructure impacts costs and business model design.

1.3 Technological advancements

- Efficiency enhancements: Business models may vary based on the use of advanced technologies, such as smart controls or hybrid systems combining geothermal with solar or wind energy.
- Customization: Projects requiring bespoke solutions for specific applications (e.g., industrial cooling) may favor specialized service models or turnkey solutions.

2. Financial factors

2.1 Upfront investment costs

- Capital intensity: High initial costs for drilling, equipment, and installation can deter customers without access to financing. Business models like leasing, Energy Service Company (ESCO) models or performance-based contracts may be more suitable in such cases.
- Subsidies and incentives: Availability of government subsidies, tax credits, or grants can lower upfront costs and make certain business models more viable.

2.2 Revenue and cost recovery

- Payback period: Business models must align with customer expectations for payback periods and return on investment (ROI). Shorter payback periods may require innovative financing options or performance guarantees.
- Operational and maintenance costs: Models with long-term service agreements or warranties can help customers manage ongoing costs and improve system reliability.

2.3 Risk tolerance

- Financial risk sharing: Risk-sharing mechanisms (e.g., co-investment or guaranteed savings models) may appeal to customers or investors who are wary of the financial risks associated with GHP systems.
- Investor confidence: Transparent financial projections and proven business models can attract investment from financial institutions or private equity.

3. Market and customer factors

3.1 Customer segments

- Residential customers: Often prefer simple, low-cost models such as on-bill financing or leasing due to budget constraints and lack of technical expertise.
- Commercial and industrial customers: Typically prioritize energy cost savings, reliability, and environmental impact, favoring models with clear ROI and performance guarantees.
- Municipalities and district heating projects: Require scalable, community-oriented models, such as shared ownership or public-private partnerships (PPPs).

3.2 Awareness and perception

- Customer education: Awareness of GHP benefits influences business model selection. Customers unfamiliar with the technology may prefer models with lower risk and minimal upfront investment.
- Market maturity: In mature markets, customers may seek advanced financing and ownership models, while emerging markets may require more basic approaches, such as grants or turnkey solutions.

4. Policy and regulatory factors

4.1 Incentives and subsidies

- Policy Support: The availability of government incentives, such as tax credits, grants, and subsidies, can determine the financial feasibility of certain business models.
- Regulatory Compliance: Business models must ensure compliance with local building codes, environmental regulations, and renewable energy mandates.

4.2 Carbon pricing and emissions goals

- Carbon offset opportunities: Models that monetize carbon reductions (e.g., through carbon credits or emissions trading) may be more attractive in regions with strict emissions regulations.
- Decarbonization policies: Policies promoting renewable energy and energy efficiency create a favorable environment for GHP adoption.

5. Stakeholder collaboration and ecosystem factors

5.1 Stakeholder involvement

- Partnership models: Collaboration with key stakeholders, such as drilling companies, technology providers, and financial institutions, influences the design of business models.
- Public-Private Partnerships (PPPs): For large-scale projects, PPPs can distribute costs and risks between public and private entities, making GHP systems more feasible.

5.2 Supply chain and logistics

- Availability of expertise: Access to skilled professionals for drilling, installation, and maintenance impacts the feasibility of different models.
- Local supply chains: The availability of locally sourced materials and equipment can reduce costs and influence the choice of business models.

6. Risk factors

6.1 Technical risks

- Site uncertainty: Geological variability or unexpected site challenges can impact project costs and timelines, requiring models with built-in contingencies.
- System performance risks: Performance-based business models must account for the risk of underperformance or equipment failure.

6.2 Financial risks

- Market fluctuations: Changes in energy prices or interest rates can affect project economics and the attractiveness of certain financing models.
- Customer payment risks: For models relying on long-term payments (e.g., ESCO or leasing), the risk of customer default must be mitigated.

7. Environmental and sustainability factors

7.1 Environmental impact

- Sustainability goals: Models that emphasize lifecycle sustainability and reduced carbon footprints are attractive to environmentally conscious customers.
- Resource use efficiency: Efficient use of geothermal resources, such as minimal water consumption and waste heat recovery, influences model design.

7.2 Circular economy integration

- Recycling and reuse: Models incorporating recycled materials or equipment reuse align with sustainability goals and may attract eco-conscious customers.
- End-of-life considerations: Business models that account for the responsible decommissioning and recycling of system components enhance long-term viability.

8. Technological integration and innovation

8.1 Smart technology

- Smart monitoring and controls: Models that incorporate advanced monitoring systems or IoT-enabled devices provide added value through optimized performance and reduced operational costs.
- Energy storage integration: Models that combine GHPs with energy storage systems or renewable energy sources (e.g., solar PV, wind power) can enhance customer appeal and expand market opportunities.

The selection of a business model for GHP systems is influenced by a variety of factors, including technical feasibility, financial considerations, market conditions, policy support, stakeholder collaboration, and environmental goals. A well-chosen business model not only maximizes the potential benefits of GHP systems but also addresses the unique challenges and opportunities of each project. By carefully evaluating these factors, stakeholders can design business models that are both sustainable and profitable, driving the broader adoption of GHP technology.

2.4 Methodology of Business Model Canvas by Alexander Osterwalder

Collection of the data regarding business models existing in the Partners' countries was done via a questionnaire among Partners (appendix 1.). The goal of the questionnaire was to identify and assess good practice examples of business models integrating GHPs addressing different market actors in the project Partner countries.

In order to provide a comprehensive and structured approach in the analysis of business models, the Business Model Canvas by Alexander Osterwalder (Osterwalder, A. & Pigneur, Y., 2010) was selected to give a certain framework.

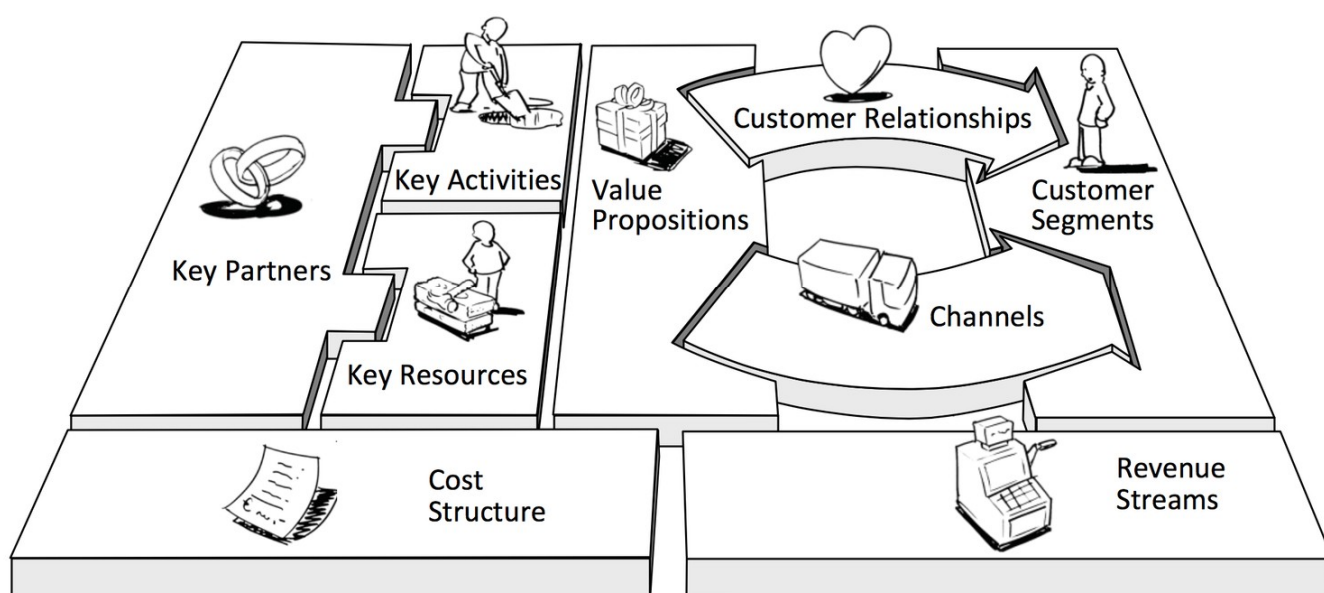


Fig. 7. Business Model Canvas by Alexander Osterwalder (Pereira, 2024)

1. Customer Segment

This block describes the buyer persona (customer segmentation). The description includes the following:

- Demographics (age, gender, etc.)
- Professional status
- Motivation and goals
- Shopping preferences

There are different customer segments a business model can target and they are;

- **Mass market:** A business model that focuses on mass markets doesn't group its customers into segments. Instead, it focuses on the general population or a large group of people with similar needs. For example, a product like a phone.
- **Niche market:** Here the focus is centered on a specific group of people with unique needs and traits. Here the value propositions, distribution channels, and customer relationships should be customized to meet their specific requirements. An example would be buyers of sports shoes.
- **Segmented:** Based on slightly different needs, there could be different groups within the main customer segment. Accordingly, you can create different value propositions, distribution channels, etc. to meet the different needs of these segments.
- **Diversified:** A diversified market segment includes customers with very different needs.
- **Multi-sided markets:** this includes interdependent customer segments. For example, a credit card company caters to both their credit card holders as well as merchants who accept those cards.

2. Value Proposition

A value proposition is a brief description of the product and its ultimate value for a client. In other words, write down in a Business Model Canvas why consumers should buy the goods or services. Ideally, it solves a problem or drives additional value for an end-client. A value proposition should be unique or should be different from that of other market players. Value propositions can be either quantitative (price and speed of service) or qualitative (customer experience or design).

3. Distribution Channels

Channels are the different structures and methods that are used to deliver one's company's product and value proposition to its customers. Channels are the touchpoints that let the customers connect with the company.

Osterwalder, together with Pigneur (Osterwalder, A. & Pigneur, Y., 2010), described five phases of channel development.

- **Awareness** includes channels that establish initial contact with the target audience and develop the connection. It usually involves marketing channels.
- **Evaluation** implies allowing potential buyers to try your goods and see the value. Popular channels are free samples, reviews, and case studies.
- **Purchase** is about when and by what means customers can buy your product. The channels vary significantly depending on the prevalence of online or offline communication.

- Delivery describes how an end consumer receives a product.
- After-sales is usually limited to customer support that provides after-sales service and resolves problems.

There are basically two types of channels:

- Owned channels: company website, social media sites, in-house sales, etc.
- Partner channels: partner-owned websites, wholesale distribution, retail, etc.

4. Customer Relationship

A customer relationship strategy determines how the target audience interacts with the company. In this section, you need to establish the type of relationship the company will have with each of the customer segments or how the company will interact with them throughout their journey with the company. You can choose from five types of customer relationships in terms of the Business Model Canvas:

- Personal assistance is a traditional approach where a customer interacts with a personal assistant when contacting your brand. It implies a high level of personal care and deep, meaningful relationships.
- Self-service is the opposite of personal assistance: a brand doesn't directly communicate with a consumer – instead, the consumer can understand the product via guides and FAQs.
- Automated service involves AI-based suggestions and bots that can provide basic assistance. This type is more engaging than self-service.
- Communities are spaces developed by a brand itself to help the audience understand the product better. A good example is Oracle, which practices the approach.
- Co-creation implies educating customers via user-generated content.

5. Revenue Streams

The next block of the Business Model Canvas is about determining where the revenue comes from. Here, the buyer's persona has to be considered to identify what the target audience is ready to pay for.

There are several ways to generate revenue from:

- Asset sales: by selling the rights of ownership for a product to a buyer
- Usage fee: by charging the customer for the use of its product or service

- Subscription fee: by charging the customer for using its product regularly and consistently
- Lending/leasing/renting: the customer pays to get exclusive rights to use an asset for a fixed period of time
- Licensing: customer pays to get permission to use the company's intellectual property
- Brokerage fees: revenue generated by acting as an intermediary between two or more parties
- Advertising: by charging the customer to advertise a product, service or brand using company platforms

6. Key Resources

This includes a list of key resources or the main inputs one needs to carry out the key activities in order to create the value proposition. In the Business Model Canvas, key resources are divided into four categories. Here are they explained:

- Human (employees)
- Financial (cash, lines of credit, etc.)
- Intellectual (brand, patents, IP, copyright)
- Physical (equipment, inventory, buildings)

7. Key Activities

Key activities are specific activities or tasks that are fundamental to the operation of the business. What are the activities/tasks that need to be completed to fulfill the business purpose? This section includes all the key activities the company needs to do to make the business model work.

These key activities should focus on fulfilling its value proposition, reaching customer segments and maintaining customer relationships, and generating revenue.

Here are a few things to consider about key activities:

- What key activities are necessary to deliver value proposition?
- What activities set the company apart from others?
- How do the revenue streams, distribution channels, and customer relationships differ from competitors? How do your key activities affect these?
- Do you need to procure specific niche resources?
- Do you need to streamline to keep costs and prices low?

8. Key Partners

Key partners are parties like suppliers who are vital to flawless business operations. In other words, a company can't survive without them. There are four categories to include in the Business Model Canvas:

- Supplier – A partner who supplies you with raw materials or finished goods
- Non-competitors – Companies you team up with to leverage their resources: for example, you can source goods from several suppliers
- Joint ventures – Partners who help you fill the gap: enter a new market or reach a new niche. The result of a joint venture is enhanced mutual profitability.
- Coopetition – Partnership between two competitors, which may take place as a merger to market a new product

9. Cost Structure

The cost structure lists all costs associated with the operation of the business model. This includes the costs of creating and delivering value propositions, creating revenue streams, and maintaining customer relationships. This will be easier to do, once key resources, activities, and partners have been identified.

Businesses can either be cost-driven (focuses on minimizing costs whenever possible) and value-driven (focuses on providing maximum value to the customer).

3. Small-scale GHP systems (< 20 kW): residential and small commercial applications

This chapter focuses on the deployment of GHP systems for small-scale applications, including single-family homes and small commercial establishments. It highlights the **retailer model**, **manufacturing model (one-stop shop)** and **rental/leasing model** using Business Model Canvas and showcases examples of good practices, challenges faced in these settings, along with potential solutions.

3.1 Retailer business model with GHP systems

Below is a detailed business model canvas for a retailer implementing a business strategy based on GHP systems. This model is the most traditional one in the small-scale segment and can apply to a retailer in the renewable energy or HVAC business. To distinguish this better from the one-stop shop, the crucial parts of the implementation process are separated, and the customer itself has to bring the parties together and is responsible for himself for getting the permitting, organizing the installation company and drilling company, applying for appropriate financial support etc.

1. Customer Segments

- Residential customers: Single-family homeowners and multi-family property developers seeking efficient and eco-friendly heating/cooling solutions.
- Small and medium enterprises (SMEs): Retail stores, offices, and small commercial spaces aiming to lower operational energy costs.
- Real estate developers: Builders incorporating GHP systems into new developments to attract eco-conscious buyers and tenants.
- Educational and public institutions: Schools, libraries, and community centers adopting GHP technology for long-term savings and environmental stewardship.
- Environmentally conscious consumers: Customers motivated by sustainability and renewable energy adoption.

2. Value Propositions

- Energy efficiency and cost savings: Significant reduction in heating and cooling costs over time, with up to 50-70% energy savings.
- Environmental sustainability: Carbon footprint reduction by using renewable geothermal energy.

- Customizable solutions: Tailored systems for specific customer needs and heat/cool demand of the building, ensuring compatibility with property constraints.
- Turnkey service: A seamless experience from system design to installation and maintenance.
- Long-term durability: Reliable and durable systems with life spans of 25+ years (for GHP) and 50+ years (for borehole heat exchangers), supported by performance warranties.
- Convenient financing options: Making high-quality GHP systems accessible with flexible payment terms, leasing, and financing partnerships.
- Techno-economic assessment: To maximize system efficiency and value proposition to the client (lowest embodied carbon/CO2 emissions).
- Energy performance certifications (according to EPBD): Helping customers achieve sustainability goals and certifications for their homes or businesses.

3. Channels

- Manufacturers / installers showrooms: Physical venues where customers can explore GHP products, consult with experts, and book installations.
- 2-tier channel: manufacturer – installer – investor
- 3-tier channel: manufacturer – wholesale - installer – investor
- Online sales platforms: E-commerce channels offering GHP systems and related products, along with virtual consultations.
- Partnership networks: Collaborating with contractors, real estate developers, and architects to promote GHP adoption.
- Marketing campaigns: Leveraging digital marketing, social media, and traditional advertising to reach target segments, often including “word-of-mouth” recommendation.
- Exhibitions and trade shows: Demonstrating GHP systems at energy and HVAC industry events.

4. Customer Relationships

- Consultative sales process: Providing personalized advice and system design to address customer needs and constraints.
- Loyalty programs: Incentivizing repeat purchases and referrals through discounts on maintenance and upgrades for installers offered by wholesale / manufacturer.
- Dedicated support teams: Offering 24/7 customer support for technical issues and performance optimization.
- Educational engagement: Hosting events, webinars, and workshops to empower customers with knowledge about GHP systems and their benefits.

- Performance monitoring: Offering smart monitoring tools and apps to keep customers engaged and informed about system efficiency and savings.

5. Revenue Streams

- System sales: Direct revenue from selling GHP units and accessories.
- Installation and drilling services: Charges for drilling, installation, and setup of GHP systems.
- Maintenance contracts: Recurring revenue from long-term maintenance agreements.
- Leasing and financing plans: Revenue from leasing or offering installment payment options to customers.
- Smart technology integration: Revenue from selling IoT-enabled monitoring tools and smart controls.
- Training and consulting: Income from providing training sessions for installers and consultation services for developers.
- Referral programs: Incentives for existing customers bringing in new clients, increasing sales volume.

6. Key Resources

- Technical expertise: Skilled personnel for system design, installation, and maintenance.
- Inventory: Stock of GHP units, accessories, and spare parts to ensure timely availability.
- Partnership contracts: Agreements with drilling companies, manufacturers, and installers to deliver end-to-end solutions.
- Customer database: Robust CRM tools for managing customer relationships and tracking preferences.
- Showrooms and online platforms: Physical and digital spaces to showcase GHP products and services.
- Brand reputation: Building trust through positive customer reviews, certifications, reference projects and proven performance.
- Technology: Tools for smart system integration and performance monitoring. Calculation tools for designing GHP.

7. Key Activities

- Sales and distribution: Retail and online sales of GHP systems for residential, commercial, and small industrial customers.
- System design and customization: Creating customized GHP solutions based on customer property requirements (e.g., vertical vs. horizontal loops).

- Installation management: Coordinating with drilling partners and installation teams to ensure seamless setup.
- After-sales support: Providing ongoing maintenance, warranties, and troubleshooting services.
- Customer education: Raising awareness about GHP technology, benefits, and financial savings via workshops, webinars, and marketing campaigns.
- Securing incentives: Helping customers access government grants, rebates, and tax credits.
- Technology Integration: Incorporating IoT-enabled smart thermostats and monitoring systems into GHP setups to enhance efficiency.

8. Key Partners

- GHP manufacturers and suppliers: For sourcing high-quality GHP units, accessories, and components (e.g., heat exchangers, loops).
- Drilling companies: To handle site-specific geothermal well drilling requirements, usually as sub-contractors to HVAC installers or sometimes direct contract with investors.
- Installers and maintenance/service teams: Partnerships with certified professionals for installation and after-sales services.
- Consultancy and designing companies (mostly geologists): Help to design the GHP system and prepare needed permitting documentation.
- Government agencies: For access to renewable energy incentives, rebates, and regulatory compliance.
- Energy efficiency certification bodies: To certify the retailer's systems as meeting sustainability or energy efficiency standards (e.g., LEED, ENERGY STAR).
- Marketing and advertising agencies: To promote GHP systems and educate customers about their benefits.

9. Cost Structure

- Product procurement: Cost of purchasing GHP units, components, and accessories from manufacturers.
- Drilling and installation costs: Payments to drilling contractors and installation teams.
- Marketing and advertising: Budget for campaigns, content creation, and educational initiatives.
- Customer support: Expenses for dedicated support teams and service infrastructure.
- Maintenance and warranty fulfillment: Ongoing costs for after-sales services and warranty claims.
- Technology investments: Development and integration of smart systems for performance monitoring.

- Overhead costs: Retail store operations, utilities, and employee salaries.

This business model canvas outlines how a retailer can successfully implement and scale a business centered on GHP systems. By leveraging key partnerships, offering flexible financing models, and addressing customer needs with tailored solutions, this model provides a pathway to expand GHP adoption in residential and small commercial markets while promoting sustainability and energy efficiency.

Examples of Good Practices

This model has become, throughout the last decades, the main and traditional business models in the HVAC business, covering about 80% of cases. There are plenty of examples across Europe, starting from manufacturers of GHP and accessories, drilling companies, installation companies and wholesalers.

Just to name few of the examples from different Partners' countries:

Manufacturers

- Bosch (Germany),
- Vaillant Group (Germany),
- NIBE Group (Sweden)
- Daikin Europe (Belgium)
- Mitsubishi Electric Europe
- LG Electronics (Korea/Europe Division)
- Atlantic Group (France)
- Stiebel Eltron (Germany)
- Panasonic Heating & Cooling Solutions (Japan/Europe Division)
- Thermia Heat Pumps (Sweden)
- Alpha-InnoTec (Germany)
- Viessmann (Germany)
- iDM (Austria)
- Ariston Thermo Group (Italy)
- Glen Dimplex Group (Ireland)
- Galmet (Poland)
- Wolf Heiztechnik (Germany)
- Hitachi Cooling & Heating (Japan/Europe Division)

Drilling and consultancy companies

- Terra GeoServ Ltd (Ireland)
- Glenergy Ltd (Ireland)
- Daly Renewables (Ireland)
- Alternative Heating and Cooling (Ireland)
- Eurotech (Ireland)
- GeoEnergieKonzept (Germany)
- DPS sp z o.o. (Poland)
- RS Drill sp z o.o. (Poland)
- SATOR (Poland)
- Rototec (Finland, Sweden, Norway, Germany, Nort-Eastern USA)
- Finspångs brunnborrning AB (Sweden)
- Peek AB (Sweden)
- BPS Borroch Pump Service Aktiebolag (Sweden)
- PORR (Austria)

3.2. Manufacturing business model with GHP systems as a one-stop shop

This business model focuses on a manufacturing company that not only produces heat pumps but also provides end-to-end solutions (a "one-stop shop") for customers – encompassing:

- design/sizing of an appropriate heat pump system,
- preparation of all necessary documentation for drilling,
- production and distribution of a heat pump,
- installation and drilling of borehole heat exchanger,
- support in searching and achieving adequate subsidy or tax exemption,
- after-sales service.

1. Customer Segments

- Residential customers: Homeowners seeking efficient, eco-friendly heating and cooling systems.
- Commercial entities: Businesses like retail stores, offices, and hospitality establishments aiming to reduce energy costs and enhance green branding.
- Industrial clients: Factories and warehouses requiring scalable GHP systems for heating and cooling large spaces.
- Real estate developers: Builders integrating sustainable energy solutions into new projects for residential or mixed-use developments.

- Public sector: Schools, hospitals, and government facilities adopting renewable energy systems for cost savings and environmental compliance.

2. Value Propositions

- End-to-end solution: Customers receive a full package, from system design to installation and maintenance, minimizing hassle.
- High-quality products: Durable, energy-efficient, and smart GHP systems tailored for long-term performance.
- Cost-effective energy: Significant energy savings for customers, with an average 50-70% reduction in heating and cooling costs.
- Convenience: A single point of contact for all geothermal heating and cooling needs.
- Sustainability: Environmentally friendly solutions contributing to reduced carbon footprints and compliance with green building standards.
- Customizable systems: Solutions tailored to specific customer needs, property sizes, and geographic conditions.
- Access to financing: Flexible payment options, including leasing, on-bill financing, and partnerships with financial institutions.
- Smart integration: Systems equipped with IoT capabilities for monitoring, remote control, and optimization.

3. Channels

- Direct sales: Engaging customers through dedicated sales teams and online consultations.
- Online platforms: E-commerce for GHP systems and components, with virtual design consultations.
- Trade shows and events: Showcasing products and solutions at renewable energy and HVAC industry exhibitions.
- Collaboration with contractors: Partnerships with contractors for system installation and maintenance services, however only outsourcing the services.
- Marketing campaigns: Leveraging digital marketing, social media, and traditional advertising to reach target segments, often including "mouth" recommendation.
- Educational campaigns: Digital marketing, social media, and green energy forums to raise awareness of GHP benefits.

4. Customer Relationships

- Direct consultation: Personalized advice and design solutions for customers to ensure satisfaction.
- Turnkey solutions: Comprehensive offerings from system design to maintenance create long-term relationships.
- After-sales service: Regular system checks, warranties, and on-demand repairs.
- Educational engagement: Workshops, webinars, and online content to inform customers about GHP technology.
- Smart system monitoring: IoT-enabled tools that provide real-time feedback and alerts, ensuring continuous performance.
- Feedback mechanisms: Ongoing customer surveys and support channels to improve product and service quality.

5. Revenue Streams

- Product sales: Revenue from selling GHP systems, accessories, and components.
- Integrated solutions: Income from turnkey services that include design, manufacturing, drilling, installation, and after-sales support.
- Leasing programs: Recurring revenue from customers leasing GHP systems.
- Maintenance and monitoring services: Ongoing fees for routine maintenance and smart system monitoring tools.
- Partnerships and licensing: Income from licensing technology to other manufacturers or installers.
- Government subsidies: Revenue generated indirectly through incentives provided to customers for renewable energy adoption.

6. Key Resources

- Manufacturing facilities: State-of-the-art factories for producing high-quality GHP systems and components.
- Design and engineering Teams: Skilled personnel for product design, geology, customization, and innovation.
- Supply chain: Strong relationships with raw material and component suppliers to ensure reliability.
- Drilling resources: Own drilling equipment with dedicated team or outsourcing drilling works.
- Installation and maintenance teams: Professional and region or country covering network to secure fast and seamless installation at end user's site.

- Customer database: CRM systems to manage customer interactions, preferences, and history.
- Technology tools: IoT platforms and monitoring software for smart system integration. Calculation tools for designing GHP and for sizing the geothermal part (borehole heat exchangers)
- Distribution networks: Logistics systems to ensure timely delivery and seamless coordination with partners and investors.
- Brand reputation: Established trust through high-quality products, certifications, and satisfied customers.

7. Key Activities

- Design and manufacturing: Producing high-quality, energy-efficient GHP systems tailored for different scales (residential, commercial, industrial).
- Integrated solution offering: Acting as a single provider for system design, production, installation, and maintenance services.
- Customer education: Raising awareness of GHP benefits through workshops, webinars, and informational content.
- R&D innovation: Developing cutting-edge technology such as compact designs, hybrid systems, and smart thermostats.
- Logistics and distribution: Ensuring timely delivery to installation teams and end-users.
- Installation and deployment: Offering in-house or certified installation services to ensure seamless customer experiences.
- After-sales support: Providing warranties, routine maintenance and system optimization services.
- Certification and compliance: Ensuring that products meet or exceed industry standards for energy efficiency and sustainability (EPREL database).

8. Key Partners

- Suppliers of components: Reliable suppliers for compressors, heat exchangers, piping, control systems, and refrigerants to maintain high product quality.
- Drilling companies: To handle site-specific geothermal well drilling requirements, usually as sub-contractors.
- Installers and maintenance / service teams: Building own installation teams with certified professionals for installation and after-sales services.
- Consultancy and designing companies (mostly geologists): Help to design the GHP system and prepare needed permitting documentation.
- R&D institutions: Collaboration with research centers for innovations in energy efficiency, smart technology integration, and sustainable materials.

- Financial institutions: Partners to provide financing options for customers, such as loans or leasing programs.
- Government and regulatory bodies: Collaboration to align with renewable energy incentives, subsidies, and compliance standards (e.g., tax credits, environmental certifications).
- Technology providers: IoT and software partners to integrate smart monitoring and performance optimization tools.

9. Cost Structure

- R&D and innovation: Investment in developing cutting-edge technology and improving product efficiency.
- Manufacturing costs: Expenses related to raw materials, labor, and equipment.
- Logistics and distribution: Costs for shipping products to investors like end-users or small businesses.
- Marketing and sales: Budget for customer acquisition, advertisements, and promotional campaigns.
- Installation services: Costs associated with employing or partnering with certified installation teams.
- Drilling services: Costs associated with employing or partnering with certified drilling teams.
- After-sales support: Expenses for warranties, maintenance, and system monitoring services.
- Compliance and certifications: Fees for achieving energy efficiency certifications and regulatory compliance.

The one-stop-shop manufacturing business model for GHP systems streamlines the adoption of geothermal heating and cooling technology by offering end-to-end solutions. By integrating selection of a GHP, design, drilling, installation, financing and maintenance under a single umbrella, manufacturers can create value for customers, address their concerns about complexity and accelerate the deployment of sustainable energy solutions on a global scale.

Examples of Good Practices

The one-stop-shop manufacturer business model is an emerging model in the HVAC industry in the last couple of years. We can observe more and more companies operating in this way on the market integrating GHP production, drilling, installation, and maintenance under a single company.

To name a few of the examples:

- AIRA (Sweden)
- Octopus Energy (UK)
- 1Komma5 (Germany)
- Thermondo (Germany)
- ENERPLAN (Austria)

3.3 Rental and leasing model with GHP systems

Rental and leasing business model for GHP systems enables customers to access the benefits of GHP technology without ownership, reducing upfront costs and risk while encouraging wider adoption - especially in residential, SME or light commercial sectors. The customer rents or leases the GHP system from a third-party provider rather than purchasing it. Monthly rental/lease payments cover installation, maintenance and operational costs. Some models offer a buyout option after a certain period.

1. Customer Segments

- Homeowners: Especially those seeking energy efficiency without the burden of upfront investment.
- Landlords & property managers: Looking to upgrade HVAC systems and reduce tenant energy costs.
- Small and medium enterprises (SMEs): Interested in stable, low-carbon energy costs for their operations.

2. Value Propositions

- Low or no upfront cost: Customers can access GHP systems via monthly rental or lease payments.
- Predictable monthly fees: Long-term cost transparency for heating/cooling.
- Professional maintenance included: Leasing company maintains performance and reliability.
- Flexible terms: Leases typically span 10–20 years, often with buyout options.
- Transferable agreements: Lease can be passed to new homeowners or tenants upon property transfer.

3. Channels

- Dedicated sales teams (B2B/B2C outreach to homeowners, developers, commercial clients)
- Company website/online portal for lease quotes, applications, virtual configurators and contract management
- Mobile apps for tracking usage, payments and service requests
- HVAC installers & contractors - act as sales agents for the leasing provider
- Banks & green financing institutions - bundle leasing with green mortgages or energy loans
- Digital advertising (social media, Google Ads) targeted at homeowners & SMEs
- Content marketing (case studies, energy savings calculators)

4. Customer Relationships

- Service-oriented: Emphasis on seamless, hassle-free operation, maintenance, and billing.
- Long-term agreements: Strong ongoing relationship over the lease period (10–20 years).
- Support and monitoring: Real-time monitoring tools and responsive service if issues arise.
- Trust building: Education and assurance around contract terms and savings potential.

5. Revenue Streams

- Monthly lease or rental payments: Fixed or variable depending on usage and service level.
- Buyout option fees: Customers may purchase the system at the end of the lease term.
- Service & monitoring subscriptions: Optional added value features like advanced energy analytics.

6. Key Resources

- Capital for equipment: Funding to procure and install GHP systems upfront.
- Skilled drilling companies, installers & engineers: Teams to design and implement geothermal systems.
- Monitoring & management software: Tools to track performance and generate customer reports.
- Legal & financial infrastructure: Lease agreements, customer screening, and risk assessment tools.

- Maintenance staff: Technicians ensuring smooth system operation and customer satisfaction.

7. Key Activities

- Financing & structuring leases: Managing capital flow, credit checks, and lease documentation.
- Installation & commissioning: Coordinating GHP system deployment at customer sites.
- Operations & maintenance: Providing full lifecycle support and system optimization.
- Customer onboarding: Educating users about energy savings, system usage, and lease terms.
- Billing & CRM: Managing lease payments, support tickets, and account history.

8. Key Partners

- One-stop shops: GHP sizing, borehole drilling, GHP installation and rental/leasing offering to end-users.
- Manufacturers & suppliers: Reliable and cost-effective GHP equipment providers.
- Financial institutions: Banks or green investors supporting upfront capital through leasing programs.
- Utility companies: Co-marketing or on-bill integration for lease payments.
- Installers & contractors: Execution partners for local deployment and service.
- Government agencies: Access to incentives or subsidies for scaling.

9. Cost Structure

- System procurement & installation: Capital and labor for GHP deployment.
- Customer acquisition & onboarding: Marketing, education, and contract execution costs.
- Maintenance & operations: Ongoing service over the lease term.
- Performance incentives for customers: Optional shared savings or efficiency bonuses.
- Financing costs: Interest, investor returns, or capital leasing charges.
- Software & billing infrastructure: Platforms to manage customer accounts and system performance.

This rental/leasing model lowers adoption barriers, spreads GHP market penetration, and allows new actors like fin-techs, ESCOs and utilities to participate in a recurring revenue business. This business model offers ground source heat pump rentals, saving customers upfront costs and at the same time lowering energy bills. Revenue for GHP manufacturer

comes from monthly leases, maintenance and support. This rental and lease model makes ground source heat pumps accessible for homeowners and businesses that don't want to buy and own GHPs.

Examples of Good Practices

Nibe & Econic in Netherlands:

<https://aardgasvrij.nibenl.eu/kosten-en-subsidie/een-warmtepomp-leasen-kan-dat>

GreenComfort Leasing Co. in Scandinavian residential market:

- Terms: 15-year lease with €0 down, monthly payments equivalent to ~80% of former heating bill
- Inclusions: Installation, remote monitoring, annual maintenance, and option to buy-out at end of term
- Outcomes:
 - Average customer savings of 20–30% vs oil or electric resistance heat
 - High customer satisfaction due to system performance and ease of use
 - System ownership transferred in 30% of cases by year 10

3.4 Challenges and solutions at the small-scale

The main challenges of the GHP deployment at the small scale are following:

1. High upfront costs

- Challenge: The capital-intensive nature of GHP systems deters many homeowners and small business owners from adopting them.
- Solution: Offer flexible financing models, such as rental or leasing. Provide education on government incentives and potential long-term savings.

2. Limited awareness

- Challenge: Many potential customers are unaware of GHP technology and its benefits.
- Solution: Conduct targeted marketing campaigns, provide clear information on ROI, and share success stories through case studies.

3. Regulatory barriers

- Challenge: Many potential customers are afraid of GHP technology due to long and complicated permitting process
- Solution: Take care of the whole process for the customer (one-stop shop business model). Work with policymakers to streamline permitting processes and develop geothermal-specific incentives and end-user guidelines.

4. Installation complexity

- Challenge: The need for drilling and specialized installation can cause disruptions and raise concerns among customers.
- Solution: Develop standardized installation processes, offer turn-key solutions, and ensure professional expertise through training programs for installers. Drilling process conducted with minimum impact on end customers and always ending the projects with cleaning up and restoring as much as possible.

5. Space constraints

- Challenge: Small properties may lack sufficient space for horizontal loops. High effort and costs for drilling vertical wells in case of existing houses and surroundings (gardens, pavements, etc).
- Solution: Explore alternative solutions such as slinky loops, shared loop fields for multi-family housing, hybrid systems, vertical wells with inclination (one starting point).

6. Uncertainty in payback period

- Challenge: Customers are often unsure of the financial benefits of GHP systems due to variability in energy savings and maintenance costs.

- Solution: Provide detailed financial projections and offer performance guarantees or warranties to increase customer confidence.

Figure 8. presents an overview of main challenges and solutions at the small scale:



Fig. 8. Illustration of challenges and solutions at the small scale GHPs

Small-scale GHP systems present a promising opportunity to advance energy-efficient heating and cooling in residential and small commercial settings. By addressing challenges through innovative financing models, strong stakeholder collaboration, and targeted education, stakeholders can unlock the potential of GHP systems to contribute significantly to the energy transition at the local level.

4. Medium-scale GHP systems (20 kW – 150 kW): multi-family, commercial, and institutional applications

This chapter focuses on the deployment of GHP systems for medium-scale applications, including multi-family homes, commercial and institutional applications. It highlights the **shared ownership (community-based) model** and **Energy Service Companies (ESCOs)** as the most common business model in this scale using Business Model Canvas. Nonetheless some business models like Heat As a Service or utility on-bill can apply at medium scale but are more common at large scale - thus they are covered in Section 5. The analysis shows examples of good practices as well, challenges faced in these settings, along with potential solutions.

4.1 Shared ownership / community-based models with GHP systems

This canvas provides a framework for understanding how district geothermal heating/cooling networks, combined with shared ownership models, operate efficiently and deliver value to stakeholders (communities/cooperatives). A centralized (shared) GHP system serves multiple buildings or users within a district. Customers pay a connection fee and usage-based rates for heating/cooling. The system may be owned by utilities, cooperatives or municipalities.

1. Customer Segments

- Residential communities: Apartment complexes, housing cooperatives, and multi-family homes that benefit from shared geothermal heating/cooling networks.
- Commercial buildings: Office parks, retail complexes, and mixed-use developments seeking cost-effective and sustainable heating/cooling solutions.
- Public and institutional users: Schools, hospitals, universities, and municipal buildings requiring centralized and reliable heating/cooling systems.
- Utilities and energy cooperatives: Entities managing local energy systems, including shared geothermal infrastructure.

2. Value Propositions

- Cost efficiency: Shared ownership reduces upfront and operational costs through economies of scale.
- Sustainability: Geothermal heat networks lower carbon footprints and enhance energy efficiency.
- Energy security: Stable and reliable heating and cooling independent of fluctuating fossil fuel markets.
- Community benefits: Promotes collaboration among stakeholders, enabling equitable access to renewable energy.

- Customizability: Flexible design tailored to diverse user needs, from residential to large-scale institutional settings.

3. Channels

- Community engagement programs: Workshops, town halls, and online platforms to educate stakeholders on geothermal benefits.
- Partnerships with developers: Collaboration with real estate developers during project planning phases.
- Partnerships with local governments and energy suppliers.
- Direct marketing: Targeted outreach to residential cooperatives, commercial property managers, and municipalities.
- Digital platforms: Dedicated websites or apps for project management, stakeholder communication, and subscription services.

4. Customer Relationships

- Collaborative governance: Stakeholders share decision-making responsibilities through cooperative boards or advisory groups.
- Dedicated customer support: Professional maintenance, real-time monitoring, and issue resolution.
- Community partnerships: Regular engagement with stakeholders to ensure alignment with local needs and priorities.
- Education and awareness: Information campaigns to highlight long-term savings and environmental benefits.

5. Revenue Streams

- Connection fees: One-time charges for property owners joining the network.
- Subscription fees: Monthly or annual payments for access to the geothermal heating system.
- Energy usage charges: Pay-per-use model based on individual energy consumption.
- Incentives and subsidies: Revenue from government grants, renewable energy credits, or carbon offset programs.
- Surplus energy sales: Selling excess energy to nearby users or back to the grid.

6. Key Resources

- Geothermal infrastructure: Centralized drilling fields and heat pumps or centralized drilling fields and decentralized heat pumps, distribution pipelines, and control systems.
- Technical expertise: Skilled engineers, geologists, and maintenance teams for system design, installation, and support.
- Partnerships: Collaboration with local authorities, energy companies, district heating operators, financial institutions, and technology providers.
- Digital platforms: Software for real-time monitoring, billing, and stakeholder communication.

- Financial capital: Investment pools sourced from government subsidies, private investors, and community contributions.

7. Key Activities

- Network design and development: Engineering and constructing geothermal heat networks tailored to site-specific needs.
- Stakeholder coordination: Aligning interests and roles among residents, commercial users, municipalities, and investors.
- Maintenance and monitoring: Ensuring the system operates efficiently through regular checks and upgrades / optimization.
- Community education: Running outreach campaigns to build trust and encourage participation.
- Financing and fundraising: Securing funding through shared ownership agreements, grants, and institutional investors.

8. Key Partners

- Local authorities and municipalities: Support for permitting, zoning, risk mitigation and public infrastructure integration.
- Private investors looking for energy efficiency projects as part of larger developments.
- Energy cooperatives: Organizations facilitating shared ownership and community-based governance.
- Financial institutions: Banks and green investment funds providing loans or grants for upfront costs.
- Technology providers: Suppliers of geothermal drilling execution, heat pumps, and energy management systems.
- Real estate developers: Early-stage collaboration to include geothermal infrastructure in new housing or commercial projects.
- Policy makers: Advocates for renewable energy policies, tax credits, and incentives.

9. Cost Structure

- Upfront costs: Drilling, loop installation, heat pumps and network development (centralized and distributed components).
- Operational costs: Ongoing maintenance, repair, and system monitoring.
- Administrative costs: Governance, stakeholder management, and community outreach expenses.
- Technology costs: Digital platforms for energy monitoring, billing, and usage analytics.
- Financing costs: Interest payments for loans or shared ownership agreements.

Geothermal heating is an excellent option for energy communities, as it allows infrastructure to be shared among several households, which reduces costs and improves efficiency. However, the challenge lies in efficiently managing the infrastructure and ensuring that all members of the community are aligned in terms of system use and maintenance. Energy communities are starting to gain ground in Europe, especially in pilot projects in urban areas.

However, the complexity of coordination between different actors (local governments, communities and businesses) and the need for upfront financing may slow down large-scale adoption. Further incentives and government support are still needed for this model to expand.

Examples of Good Practices

Som Energia, a Spanish energy cooperative, facilitates sustainable energy transitions for individuals and communities by pooling resources to invest in renewable projects, including geothermal installations. Members collaboratively finance and benefit from these energy projects, promoting local energy resilience and lowering energy costs.

<https://www.somenergia.coop/es/welcome-to-som-energia/>

Germany strongly promotes energy communities where users come together to share the benefits of a centralized geothermal heating system. Mostly community-based companies with the city partnership like Stadtwerke Neuruppin, Geo Energie München Ost or Hamburger Energiewerke invest in large geothermal heating networks, especially in new residential areas. Cities such as Grevesmühlen with Novocarbo have implemented pilot projects to create shared geothermal heating networks, especially in new residential developments.

4.2 Energy Service Companies (ESCOs) with GHP systems

Energy Service Companies (ESCOs) implementing GHP systems offer comprehensive energy solutions - design, financing, installation, and maintenance - typically under performance-based contracts, making them ideal players in expanding GHP deployment. In this model, ESCOs guarantee energy savings or a certain efficiency, which motivates both parties (customer and supplier) to optimize the performance of GHP systems. The Governments are promoting these models to expand geothermal energy in district heating networks.

1. Customer Segments

- Commercial & industrial buildings: Offices, factories, warehouses with high heating/cooling demands.
- District heating and cooling providers: Seeking decarbonization of heating and cooling to meet CO2 emission targets.
- Public sector: Schools, hospitals, municipal buildings aiming to cut energy costs and emissions.
- Multi-family residences: Property managers and developers of apartment blocks or housing associations.
- Large single-family homes: High-end homeowners open to third-party financing and performance guarantees.

2. Value Propositions

- Turnkey energy solution: Design, install, finance, and maintain GHP systems from start to finish.
- No upfront costs: Customers pay through energy savings (shared-savings or guaranteed savings models).
- Guaranteed performance: ESCO assumes energy performance risk - customers only pay if savings are achieved.
- Lower operational costs: GHP systems significantly reduce energy bills and maintenance costs.
- Decarbonization support: Helps customers meet sustainability goals and comply with carbon reduction strategies.
- Transfer of ownership: Buy-back options after long term contract.

3. Channels

- Direct sales teams: Targeted outreach to commercial clients, developers, and municipalities.
- Energy audits & assessments: Initial site evaluations to scope feasibility and potential savings.
- Public tenders: Competitive bidding for institutional or municipal energy efficiency projects.
- Partnerships with utilities, installers and drilling companies: Leveraging existing relationships to scale deployment.

4. Customer Relationships

- Long-term contracts: Performance-based Energy Savings Performance Contracts (ESPCs), typically 10–20 years, personalized to the customers' needs.
- Ongoing maintenance & support: Full-service operation & maintenance included in the ESCO agreement.
- Transparent monitoring: Real-time dashboards and reporting to track energy savings and performance.
- Risk-sharing: Builds trust by aligning ESCO revenue with delivered savings.

5. Revenue Streams

- Shared energy savings: ESCO earns a portion of the customer's reduced energy bills.
- Guaranteed savings model: ESCO receives fixed payments tied to guaranteed performance levels.
- Pay-As-You-Save (PAYS): Payments are made by the client as savings are realized, ensuring no financial loss.
- Maintenance fees: Optional or bundled service fees for ongoing system optimization.
- Incentives/subsidies: ESCO may retain all or part of rebates, tax credits, or carbon savings.
- Transfer of ownership: Sale of asset if buy-back structure is agreed.

6. Key Resources

- Capital access: Either own capital or partnerships with green banks, investors, or funds.
- Technical expertise: Engineers, designers, and geothermal specialists.
- Monitoring & data systems: Tools to measure energy performance and ensure savings delivery.
- Contract templates & legal expertise: Performance-based agreements tailored to different clients.
- Professional network: Trusted drilling companies, heat pump suppliers, and installers.

7. Key Activities

- Energy auditing & feasibility studies: Evaluating thermal loads and site suitability for GHP.
- System design & engineering: Customizing GHP systems to each customer's building and needs.
- Finance structuring: Arranging capital through internal funds or external financiers.
- Installation & commissioning: Coordinating drilling, heat pump installation, equipment setup, integration and steering.
- Monitoring & optimization: Ensuring GHP systems operate at peak efficiency over time, including predictive maintenance services.

8. Key Partners

- Technology providers: Manufacturers of GHP equipment and monitoring systems.
- Drilling & installation contractors: Specialized partners for boreholes and system deployment.
- Financing institutions: Green funds, impact investors, or banks funding upfront costs.
- Government & incentive agencies: Access to subsidies, grants, and regulatory compliance support.
- Property developers & ESCO aggregators: For scaling bundled or district-level projects.

9. Cost Structure

- Capital investment: Upfront cost of GHP system design, drilling, installation, and equipment.
- Labor, operation & maintenance: Staff costs for engineering, monitoring, customer service, and maintenance.
- Financing costs: Interest rates or return requirements for capital deployed.
- Marketing & sales: Client acquisition, proposal development, and feasibility studies.
- Insurance & risk management: For long-term project guarantees and energy performance risk.

The ESCO business model with GHP systems is very powerful for decarbonizing heat at scale, particularly where capital constraints and technical complexity are barriers. Thanks to performance-based contracts it secures the customer's needs, minimizes the risk and prevails from failure via ongoing monitoring and optimization. The performance of GHP systems benefits greatly from this type of contract, as ESCOs are motivated to ensure highest energy

efficiency to maximize savings. This translates into a high level of optimization and fine-tuning of the geothermal system during the operational time, ensuring that energy savings targets are met.

Examples of Good Practices

Performance-based contracts and ESCO models have proven to be very effective in the German market, especially for large companies and commercial buildings. However, their implementation at residential level is more limited due to the complexity of the contracts and the requirement for constant monitoring. ESCOs in Germany, such as E.ON, Engie or EnBW, play a key role in promoting energy efficiency and renewable projects through energy performance contracts. Federal and state authorities in Germany are promoting this model with geothermal systems among district heating companies.

The ESCO model is efficient in Spain's energy market due to its alignment with energy reduction mandates. For example, Veolia operating in Spain, manages geothermal projects as part of their ESCO services, including projects focused on energy efficiency in urban environments. Edison Next also offers ESCO services with geothermal components as part of its portfolio in Spain.

<https://www.veolia.es/>

<https://edisonnext.es/>

In Netherlands Brontechnologie (Exploitatie WKO installaties) is a company active in the exploitation open well sources/ATES based on ESCO performance.

<https://www.brontechnologie.nl/wij-zijn-een-energy-service-company/>

4.3 Challenges and solutions at the medium-scale

The main challenges of the GHP deployment at the medium scale are following:

1. High upfront investment

- Challenge:
 - Drilling boreholes and system integration can cost significantly more than gas boilers or air-source heat pumps
 - Payback period (10–15 years) is often too long for commercial property owners
- Solutions:
 - ESCO model: Third-party owns and operates the GHP system, customer pays fixed fee and benefits from performance-based contracts.

- Shared ownership: Build a local community in order to raise common funding for investment and distribute financial burdens.

2. Technical integration into existing buildings

- Challenge:
 - Retrofitting older buildings is complex (radiator systems may require higher temperatures).
 - Limited outdoor space for boreholes.
- Solutions:
 - Hybrid systems (combine GHP with auxiliary boilers or air/water heat pumps for peak loads).
 - Shared borehole fields between buildings or incline drilling (even under the building) to reduce footprint.
 - Pre-installation feasibility and 3D ground surveys to optimize drilling layout.

3. Regulatory and permitting barriers

- Challenge:
 - Medium systems require permits for drilling and groundwater use, which vary by jurisdiction.
 - Bureaucratic delays increase project risk.
- Solutions:
 - Standardized approval pathways through early engagement with local authorities.
 - Use of certified installers and drilling companies with adequate expertise to streamline the process
 - Policy advocacy for simplified permitting for renewable heating.

4. Operational & maintenance complexity

- Challenge:
 - Multi-user systems need professional management, unlike small residential units.
 - Owners may lack technical capacity to operate effectively.
- Solutions:
 - ESCO operation contracts with performance guarantees.
 - IoT-enabled monitoring with predictive maintenance.
 - Training of local facility managers + remote support.

5. Risk of underperformance

- Challenge:
 - If heat demand is underestimated or ground conditions are miscalculated, it may result in system inefficiency.
 - Risk of thermal imbalance in the ground.
- Solutions:
 - High-quality feasibility studies (hydrogeology, load profiles).

- Seasonal thermal energy storage integration.
- Performance-based contracts (payment linked to delivered heat, not just installation).

6. Awareness and acceptance

- Challenge:
 - Building owners may not be familiar with geothermal, perceive it as “experimental.”
 - Investors may resist long-term contracts or worry about hidden costs.
- Solutions:
 - Showcase case studies of successful medium-scale projects.
 - Conduct targeted educational campaigns highlighting long-term cost savings.
 - Include comfort and climate benefits (stable indoor temperature, green credentials).

7. Scalability and replicability

- Challenge:
 - Each site is “custom” → drives up cost and slows replication.
- Solutions:
 - Standardize system design modules (e.g., 50 kW blocks).
 - Develop catalogues of proven configurations for schools, offices, apartment blocks.
 - Use digital twin models for quicker design validation.

Figure 9. presents an overview of main challenges and solutions at the medium scale:

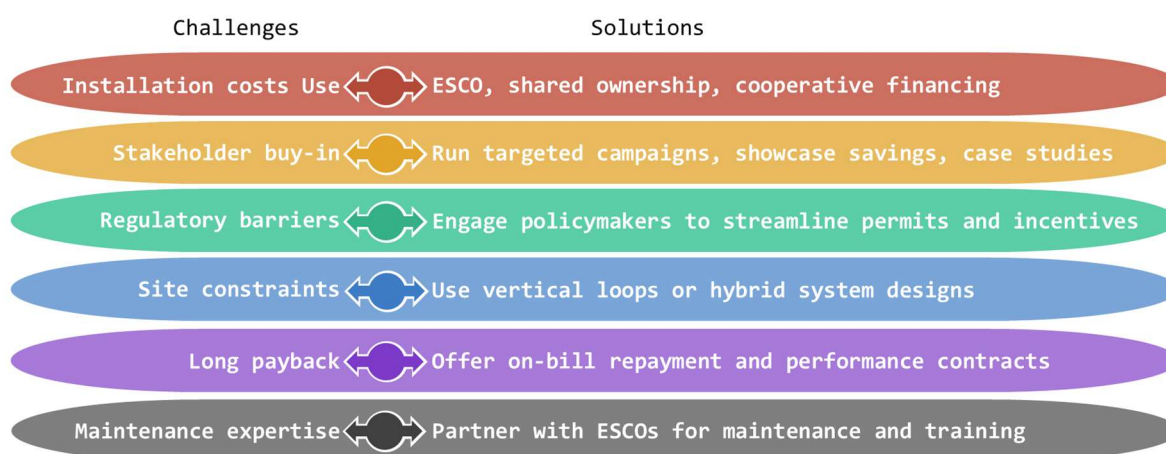


Fig. 9. Illustration of challenges and solutions at the medium scale GHPs

Medium-scale GHP systems offer significant potential to enhance energy efficiency in multi-family, commercial and institutional applications. By engaging key stakeholders, leveraging innovative financing models and learning from successful practices, stakeholders can

overcome challenges and maximize the benefits of geothermal technology. These systems contribute to sustainability goals while delivering tangible economic and environmental advantages.

5. Large-scale GHP systems (150 kW – multiple MW): district energy and industrial applications

Large-scale GHP systems serve expansive urban, industrial, and institutional infrastructures. Their success depends on alignment between multiple high-impact stakeholders:

- Utility companies: Often lead or co-invest in district systems; manage distribution, metering, and maintenance.
- Governments & municipalities: Set policy frameworks, provide public funding or land access, and often act as anchor customers.
- Large-scale property developers: Invest in sustainable infrastructure for new urban zones or retrofits.
- Industrial park operators: Benefit from predictable, low-cost heating/cooling to support energy-intensive processes.
- Engineering & technology firms: Deliver system design, modeling, and implementation services.
- Financial institutions & infrastructure funds: Provide long-term capital through climate bonds (Green Bonds) or climate financing.

The most common business models for large scale are **utility-led on-bill model, heat as a service model, public-private partnership** and **green bonds and climate financing**. However it may happen that shared ownership/community-based models or ESCO models may also serve as a good solution for large scale.

5.1 Utility-led on-bill model with GHP systems

This model enables utilities to offer customers financing for GHP installations with repayments made through the utility bill. It aligns repayment with energy savings over long periods (10–30 years). The customer still owns and maintains the equipment after repayment. Repayments are typically tied to the meter (not the customer), so they can transfer to a new occupant if the property changes hands. Suitable for new neighborhoods, commercial districts or campuses, where utilities act as infrastructure providers.

1. Customer Segments

- Residential homeowners: Seeking energy-efficient, low-carbon heating and cooling solutions without high upfront costs.

- Small and medium businesses (SMEs): Want to reduce operational energy expenses and environmental impact.
- Low-to-middle-income households: Especially benefit from accessible, inclusive financing options.
- Municipal and institutional customers: Schools, public buildings, and local governments looking to decarbonize heat.

2. Value Propositions

- No upfront costs: Customers can install GHP systems without major capital outlay.
- Affordable payments: Repayments are integrated into utility bills, typically offset by energy savings.
- Energy savings: GHP systems reduce heating/cooling costs significantly over time.
- Low-risk adoption: Utility involvement increases trust and reliability.
- Increased property value: Efficient HVAC systems enhance asset value and occupant comfort.

3. Channels

- Utility customer service portals: Direct communication through bills, emails, apps, and websites.
- In-Home energy audits: Utilities offer assessments identifying potential for GHP installations.
- Installer networks: Certified geothermal contractors partnering with utilities.
- Community outreach: Workshops, local campaigns, and info sessions in targeted neighborhoods.

4. Customer Relationships

- Long-term engagement: Customers remain tied to the utility for years via bill repayment.
- Personalized support: Energy audits, system recommendations, and ongoing performance monitoring.
- Trust-based: Utility reputation boosts credibility and adoption.
- Convenience focused: Seamless billing, automatic repayments, and low administrative burden for users.

5. Revenue Streams

- Repayment through utility bills: Customers repay the cost of GHP systems monthly with energy charges.
- Interest or admin fees: Utilities may earn modest revenue through financing charges.
- Energy sales: Reduced peak demand may optimize load balancing and improve margins.

- Incentives/subsidies: Utilities may receive government incentives for facilitating renewable technology deployment.

6. Key Resources

- Billing infrastructure: Systems capable of integrating loan repayments into energy bills.
- Capital access: Utility funds or third-party financing pools to pay for up-front installations.
- Workforce/installers: Trusted geothermal contractors to implement projects.
- Data and analytics: Tools to monitor energy savings and loan performance.
- Customer trust and brand: Existing relationships with large customer bases.

7. Key Activities

- Program design and administration: Managing customer qualification, program structure, and billing mechanisms.
- Customer outreach and marketing: Educating and enrolling customers.
- Partnerships with installers and drilling companies: Ensuring quality installation and service.
- Regulatory compliance: Meeting energy and finance regulations.
- Monitoring and maintenance: Tracking performance and ensuring customer satisfaction.

8. Key Partners

- Geothermal technology providers & installers: Certified companies that install and service systems.
- Financial institutions: Banks or green funds supplying capital for utility.
- Government agencies: Supporting with subsidies, tax credits, or guarantees.
- Regulators: Ensuring legal and consumer protections are maintained.
- Nonprofits & community groups: Assisting outreach to vulnerable or under-served populations.

9. Cost Structure

- Capital deployment: Initial investment in GHP systems covered by the utility.
- Administrative costs: Staffing, processing applications, and customer service.
- System integration: Updating billing systems and data platforms.
- Marketing and outreach: Education, promotions, and customer engagement.
- Maintenance support: Ensuring customer systems perform reliably over time.

This business model provides a powerful, scalable way to enable wider adoption of GHP systems - especially for customers who might otherwise be priced out - while aligning with utility goals for decarbonization and customer retention.

Examples of Good Practices

EVN Waerme GmbH (Austria): By law, service contracts from public energy providers are limited to below 20 years (at average to 15 years). Investing into the subsurface infrastructure (BHEs, connecting pipeline) leads to high heat prices for the consumers and might therefore not be paid off in the lifetime of the contract. For that reason, the current business model of EVNW foresees two possibilities: (i) at least co-funding of the client to establish the subsurface infrastructure (share >75%) or (ii) that the client executes the full investment into the subsurface infrastructure and is the owner of it; EVNW rents the subsurface infrastructure to operate the system.

Geothermal district heating and cooling network – Copenhagen, Denmark:

- Scope: Entire urban district of 25,000 residents served by a low-temperature GHP-based system.
- Model: Utility-led investment combined with green municipal bonds and EU subsidies.
- Outcomes: 80% reduction in CO₂ emissions, 35% lower annual heating costs, smart metering integration.

5.2 Heat as a Service (HaaS) business model with GHP systems – service provider (energy provider, utility, district heating operator)

This model shifts the focus from system ownership to the provision of thermal comfort, where customers pay for delivered heating/cooling instead of the equipment or energy source. The customer pays for a *service* (e.g., a warm home or specific number of heating hours), not for fuel or equipment. The service provider (often an energy company or utility) retains ownership and is responsible for the operation and maintenance of the heating system. Payments are subscription-based or service-based, not tied directly to energy consumption. On the other hand, provider is motivated to make the system efficient and reliable, since their profit is linked to performance rather than energy volume.

1. Customer Segments

- Homeowners & tenants: Interested in low-carbon, worry-free comfort without system ownership.
- Commercial buildings: Offices, retail, hotels – seeking predictable thermal costs.
- Public institutions: Schools, hospitals, and municipalities looking to outsource energy management.
- Property managers & housing associations: Large-scale residential blocks seeking integrated energy services.

2. Value Propositions

- Comfort, not equipment: Customers pay for a level of heating/cooling, not for technology or fuel.
- No upfront costs: All system design, installation, and maintenance included in a service contract.
- Performance guarantee: Provider ensures reliability, comfort levels, and efficiency.
- Transparent, predictable pricing: Flat monthly fee and/or usage-based pricing model.
- Free cooling with GHP: Free cooling is included for free (as it is used to recharge the BHE field), an additional benefit that the building contractors can offer to their customers. A sustainable and long living heating source with free cooling on top increases the value of the building. In addition, the cooling aspect can be associated with "sustainability" or alternatively, a new value "comfort" can be proposed.

3. Distribution Channels

- Direct sales: Through ESCOs or dedicated HaaS providers with energy performance contracting.
- Real estate & construction companies: Bundled into development of new buildings or major retrofits.
- Utility partnerships: Integration with electricity or district energy providers.
- Online platforms: Customer portals for selecting service levels, monitoring energy usage, and billing.

4. Customer Relationships

- Subscription-based: Long-term contracts (10–30 years), service-oriented relationship.
- Responsive support & maintenance: 24/7 technical assistance and fault resolution.
- Performance-based trust: Regular reporting on indoor comfort and energy savings.
- Customization: Tailored service levels (e.g., basic heating vs premium comfort with real-time control).

5. Revenue Streams

- Monthly subscription fees: Based on floor area, performance level, and/or actual kWh of heat delivered.
- Optional add-ons: Smart home integration, advanced air quality monitoring, cooling upgrades.
- Carbon credits / ESG value: Monetization through green certification or offset markets.

6. Key Resources

- Capital for equipment & installation: GHP infrastructure.
- Technical teams: Engineers, HVAC technicians, installers, drilling companies and data analysts.
- Monitoring & control systems: IoT platforms, smart thermostats, performance dashboards, billing system.
- Legal & contractual frameworks: For service-level agreements and regulatory compliance.
- Brand trust: Especially important for public and institutional clients.

7. Key Activities

- System design, installation, and commissioning: Customized for each property.
- Operations & maintenance: Ensuring reliability, performance, and compliance with agreed comfort levels.
- Energy monitoring & optimization: AI-based control systems to improve efficiency and reduce costs.
- Customer engagement: Education, feedback loops, and user-friendly interfaces.
- Risk management: Managing performance risks, energy market exposure, and customer churn.

8. Key Partners

- Designers for BHE: For more complex systems including groundwater models, EED simulations and to handle the application for a water right.
- Technology providers: GHP manufacturers and smart control system suppliers.
- Installation, drilling & maintenance subcontractors: Local delivery of physical works.
- Financial partners: Green banks, infrastructure investors, or ESCOs for upfront capital.
- Utilities or aggregators: Demand response opportunities and energy market integration.
- Government programs: Incentives for renewable heating services or low-carbon infrastructure.

9. Cost Structure

- Capital expenditure (CAPEX): GHP system installation, ground drilling, and smart controls.
- Operational costs: Staff, remote monitoring, customer service, repairs.
- Financing costs: Leasing, loan repayments, or investor returns.
- Customer acquisition & retention: Marketing, sales, and contract management.
- Insurance & risk contingency: To mitigate comfort or performance shortfalls.

The HaaS model decouples heat from hardware, making geothermal energy accessible, affordable, and scalable - especially when bundled with performance contracting, digital control, and smart financing. This business model seems to be getting more traction because it prioritizes sustainability, convenience, and added value to the property. These are factors that are appealing to many customers. What makes it stand out is that it provides low-emission energy without placing the burden of managing or maintaining the infrastructure on the end users. The business model will be adapted in the future, depending on the development of e.g. the prices of electricity. Maybe in the future, electricity prices will stabilize more and a flat rate could be offered. To see wider adoption, there may need to be a greater effort in raising awareness about the benefits offered by this model offers.

Examples of Good Practices

The HaaS model has seen increasing adoption in Germany, especially in residential and commercial sectors. It offers an attractive proposition for those unwilling or unable to take on large upfront infrastructure investments. However, adoption still depends on trust in the technology and long-term agreements, which can be a barrier for some users. Companies in Germany, such as Novocarbo y Stadtwerke München (SWM), have explored such solutions for efficient heating in residential and commercial buildings.

Naturgy (Spain): As one of Spain's leading energy companies, Naturgy is innovating its HaaS offerings by integrating geothermal energy into its subscription services, catering to residential and commercial sectors, including multi-family buildings and offices in Madrid and Barcelona. Their geothermal initiatives focus on reducing energy costs for clients through scalable, sustainable solutions.

<https://www.naturgy.com/conocenos-naturgy/presencia-internacional/espana/>

Repsol (Spain): Traditionally a fossil fuel provider, Repsol has shifted towards green energy solutions and recently began investing in geothermal projects as part of their HaaS services. Repsol aims to develop tailored geothermal packages for high-density residential areas in Spain to meet specific heating demands sustainably.

<https://www.repsol.com/es/index.cshtml>

Wien Energie (Municipal Energy provider, Austria) - This business model fits well with shallow geothermal energy solutions, which is both highly efficient and available locally. Geothermal can significantly reduce carbon emissions, works well with existing buildings, and provides reliable heating and cooling. While each project will have its own specific needs, the business model itself coupled with GHPs is scalable and adaptable to different user needs. It is big advantage that it can be combined with other energy/heat/cold sources, e.g. air source heat pumps, photovoltaic. It is crucial for this business model to work, to have regeneration available for the BHE field. E.g. the energy provider can offer a combination of district heating (for DHW and heating supply that cannot be met with the BHE field) and a BHE field (sized according to the cooling demand to be able to run it in a balanced mode). The BHE field provides all the cooling demand and as much as of the heating demand as possible to stay in balanced mode. Heat storage is and will be more and more important. It will become vital to avoid blowing waste heat into the air. Currently it is difficult to incorporate commercial buildings with waste heat, e.g. supermarkets or data centres, as they could move away again, leaving a gap in the heat supply. Storing heat with higher temperatures above 30 °C will become more and more interesting as it increases the regeneration of the BHE field. This is not allowed yet in Austria (only for experimental purposes), however might be in the future.

Heat-as-a-Service Pilot – UK Energy Systems Catapult

- Project: Residential HaaS trials using heat pumps with fixed comfort plans (e.g., 21°C 6am–10pm).
- Model: Customers paid monthly fee based on selected comfort levels. Energy provider took all energy risk.
- Results:

- High satisfaction from users
- Encouraged efficient heat pump behavior
- Supported new revenue streams for service providers

5.3 Heat as a Service (HaaS) business model with GHP systems – project developers

This business model differs from the one described in 5.2 by the fact, that here project developers provide the service (heat). Project developers deliver emission free heating and cooling. Cooling is always included, as it is assumed, that in future cooling will always be necessary. Heating and cooling are guaranteed for the customers via an energy supply contract or as a flat rate. In return for offering a flat rate to the developer, the company receives a share of the developed project. In order to be able to offer a flat rate, the company also runs photovoltaic and small wind power plants, with the goal of reducing the costs of primary energy and becoming independent of external grids and therefore the energy market. Goal is to increase the share of primary energy produced in-house, leaving the volatile share of the energy costs below 20%. The company owns the heating and cooling system itself, customers can buy it after a certain period of time.

If the heat/cold is provided via an energy supply contract, this is usually a light version of contracting. Within real heat contracting the companies would have to ensure the contract for 30 years. This is not possible for smaller companies because the financial burden lies on them completely. Within "contracting light" the contracts are open, without a run-time.

Other way to go is: (1) that the client owns the installation, but the company runs and maintains it, or (2) Supplier credit: The Customer owns the installation but pays it back over a certain time period. Interesting for the company, because they can charge high interest rates.

1. Customer Segment

Building developers with projects of all sizes, ranging from single buildings up to solutions for a whole city neighborhood. The projects often have a 50/50 or 70/30 share of residential/commercial. Industrial objections and single office buildings are considered as well as hotels, especially existing ones that are more and more interested in decarbonization. Industry (with temperatures between 40 – 90 °C for heating) without a specific preference of the sector is in general a popular customer. They usually all have heat and cold demand.

Low temperature heating grids are offered mainly by bigger companies.

2. Value Proposition

Cheap prices – possible if combination of photovoltaic and wind power is used. Considering all available heating and cooling sources on site helps decreasing the price.

High energy efficiency - because the heating and cooling demands are not calculated following standards and norms, but alternative calculations also including lessons learned from previous projects. This already reduces energy consumption, often decreases it by 50%.

Energy self-sufficiency – possible with a high share of primary energy produced in-house.

High reliability – everything is state of the art and maintained frequently in the case, where the installations belong to the company. E.g. even working heat pumps get replaced after a couple of years, if newer heat pumps reach a higher efficiency.

Increases the value of the real estate – if it's possible to offer a flat rate, the developer/owner can include this directly in the rent that is charged from the end user. This formal increase of the rent drastically increases the value of the real estate.

Green energy – contributes to decarbonization, for some customers this is a special value, they are interested in. Sole interest in green energy, however, is not enough to choose geothermal, price-performance ratio is most important.

One-stop-shop – The business model can also take care of everything from planning (including building technologies – heating and cooling demand) to installation, maintenance and service. However, if only parts of it are required, this can also be possible, offering a high flexibility.

3. Distribution Channels

- Personal contacts: especially valuable are contacts directly in the real estate sector.
- Personal contacts: due to a lot of outreach activities – podcasts, key note speaker, presentations at various organizations and events
- Recommendations from previous project partners (construction companies, building services planners)
- Research projects for general outreach together with research organizations
- Satisfied customers become recommenders for new projects
- Homepage of the company

4. Customer Relationship

To have a smooth relation with the customer, once the system is installed, the system is updated ideally before any failure occurs. In this way the customer ideally does not have to complain. Staying in good contact with the customers is important anyway.

5. Revenue Streams

Heat and cold is sold to the customers within different models.

- a) Long-time energy supply contract with the option to buy the system after a certain (~20 years) run time. The price is made up of the energy rate and the base price.
- b) Flat rate: The developer includes the costs for heating and cooling directly in the rent. Flat rate is only possible, if the prices only increase according to consumer price index. Volatile electricity costs disable the possibility to offer a flat rate.

6. Key Resources

- Know-how: This is the most important resource. It includes experiences and lessons learned from previous projects. Getting enough qualified staff is difficult and will become even more so, if the demand increases, which is to be expected. It takes a long time (~6 years) to educate engineers in this field, making them the most important resource. Planning is seen as especially important, as good planning helps to build big installations with good quality.
- Financing: Financing is necessary to be available to cover the investment costs for the heating and cooling systems. It was a long road to convince banks from this business model to get a loan.
- IT and cyber security: get more and more important, if the systems are operated remotely

Installers are not seen as key resource, as the complexity of these systems is too high. This business model including the flat rate offer requires engineers.

Equipment: Drilling rigs are not part of this business model, regardless of the company. They either rent the drilling rigs, or hire drilling companies. An important reason for not owning the rigs is that you would always have the wrong number and wrong kind of drilling rigs.

7. Key Activities

- Project acquisition and preparation of offers
- Conception and planning (including heating/cooling demand) of the heating and cooling system
- Sizing of the underground part of the system (conducting or contracting TRTs for bigger systems)
- Ensuring financing of the CAPEX for the system
- Setting up servitudes to ensure access and usage of the system
- Operating the system including detailed monitoring and system optimization
- Billing

- Research and development. Current hot topics: (1) Digitalization and standardization of the whole value chain to accelerate the process, goal is to standardize 70-80% of the process for residential and commercial buildings. (2) Incorporating AI in the control system to include predictive behavior, this includes cooperation with universities.

8. Key Partners

- Drilling companies: drilling is the biggest cost item, framework contracts facilitate the availability of drilling rigs
- Building services to derive heating and cooling demand (the demand provided by the building services is usually updated and decreased, because their calculations are very conservative)
- Civil engineers for modelling, especially for complex hydrogeological/geological situations and bigger installations
- Authorities and Funding organizations: to find solutions for each individual project
- Installation personnel

9. Cost Structure

- Staff costs: Team for operation, service and maintenance; another Team elaborates concepts and conducts planning, includes the calculation of heating and cooling demand.; another Team monitors and optimizes the systems
- CAPEX has to be covered to finance the system upfront

This business model is efficient, but not well known. There is a demand for it and it is to be expected that the demand increases, due to the EU energy performance of buildings directive, which requires buildings to decarbonize. Hence, there is a strong shortage to be expected in the whole process (not only drilling and in the authorities regarding the licensing procedure, but also in e.g. planning). This business model with a strong focus on improving digitalization and standardization intends to prepare for an increasing demand in the planning and operating phases. It has been proven that offering the services in a full package as one-stop-shop is more efficient and important for the customers than only solving parts. The business model is very efficient and well suited for GHPs. This solution with integrating shallow geothermal energy works very well, because it has a very high-energy efficiency. A benefit of geothermal energy is that it can be combined with other sources (e.g. air source heat pumps) as well.

Examples of Good Practices

Austria:

- Beyond Carbon Energy
- ENERGREEN Group

5.4 Public-Private Partnerships (PPPs) with GHP systems

This business model combines public investment with private-sector capital and expertise. It encourages risk-sharing and faster deployment. This model is based on a collaboration between government entities and private investors to finance, install, and operate large-scale GHP systems. It is often used in district heating projects, public housing, and municipal buildings. Governments may provide grants, tax incentives or low-interest loans to reduce investment risks.

1. Customer Segments

- Municipalities & local governments: Seeking sustainable heating/cooling infrastructure with public benefit and long-term savings.
- District developers & urban planners: Integrating low-carbon energy systems into smart cities and new urban zones.
- Public institutions (schools, hospitals, universities): Anchor tenants ensuring base demand for thermal energy.
- Commercial tenants & residential users: Indirect beneficiaries of GHP services via shared district infrastructure.

2. Value Proposition

- Shared investment & risk: Government shares capital cost, land, or regulatory support; private sector provides technology and operational expertise.
- Stable, long-term returns: Predictable revenue streams via heat service contracts, long-term offtake agreements, or utility tariffs.
- Public benefit infrastructure: Delivers clean, efficient, and affordable energy while reducing GHG emissions and dependence on fossil fuels.
- Credibility & compliance: Public involvement supports transparency, policy alignment, and access to grants or green finance.

3. Distribution Channels

- Public procurement & tendering: PPPs often begin with open calls or negotiations under public-private infrastructure frameworks.
- Infrastructure funds & green investment Platforms: Vehicles to mobilize capital for low-carbon energy projects.
- Urban planning partnerships: Integrated via zoning, city spatial plans, or climate mitigation strategies.
- Community engagement programs: Stakeholder buy-in through public consultations and co-design.

4. Customer Relationships

- Contractual agreements: Long-term public-private contracts (e.g., design-build-operate-maintain or concession models).
- Public accountability: Transparent KPIs, reporting, and audit structures ensure trust and compliance.
- Stakeholder collaboration: Formalized governance structures (e.g., joint committees, project boards) between public and private actors.

5. Revenue Streams

- Concession fees/service payments: Government or anchor customers pay fixed or usage-based fees over 15–30 years.
- Heat sales or tariffs: Revenue from distributing heating/cooling to district customers (residential or commercial).
- Carbon credit revenues: Monetization of CO₂ reductions via voluntary or compliance markets.
- Grants and incentives: Public or international funding to de-risk investment.
- Green Bonds and climate financing: Municipal or corporate issuance through platforms like the London Green Exchange or EU Green Bond Standard.
- Multilateral development banks: European Investment Bank, World Bank, or Green Climate Fund may co-finance large GHP infrastructure.

6. Key Resources

- Public support & land access: Critical enabler for large-area deployment and public trust.
- Private capital & engineering expertise: Financial and technical resources to design, build, and operate systems.
- Contract frameworks & legal expertise: PPP contracts, risk-sharing models, performance guarantees.
- Digital Platforms: Smart metering, billing, and optimization tools to support district-wide operations.

7. Key Activities

- Project structuring & feasibility: Legal, technical, and financial design of PPP agreement and energy infrastructure.
- System design & implementation: Engineering, drilling, network installation or integration of GHPs into existing systems.
- Operations & maintenance: Long-term service delivery, performance optimization, and user support.
- Performance monitoring & reporting: Transparent data collection for energy efficiency, billing, and emissions savings.

8. Key Partners

- Local authorities/municipal governments: Enable planning, policy support, and co-investment.

- Private developers/energy companies: Handle project execution, technical operation, and customer service.
- Green banks/climate finance institutions: Provide concessional loans, guarantees, or co-funding.
- Utility companies & grid operators: Coordinate energy flows, peak demand management, and system integration.

9. Cost Structure

- Capital expenditure (CAPEX): High initial cost for drilling, network piping, GHPs, and central control.
- Operation & maintenance costs: Ongoing servicing, labor, monitoring, and customer support.
- Financing costs: Interest on loans, investor returns, or bond repayments.
- Legal & transaction costs: Contract drafting, procurement, stakeholder consultation.
- Regulatory compliance & permits: Environmental assessments, land rights, safety certifications.

Examples of Good Practices

PPP-Led District GHP in Grenoble, France:

- Project: Public-private district heating and cooling network powered by geothermal
- Structure: 30-year PPP between city council and private energy company
- Highlights:
 - 65% renewable energy share
 - Anchored by university campus, hospital, and municipal buildings
 - €50M investment, 40% funded through EU and green bond financing

Vienna's Green Bond-Funded Geothermal Retrofit:

- Issuer: City of Vienna
- Project: Retrofit of public housing using deep GHPs for heating and cooling.
- Bond Size: €50 million green bond issued in line with EU Taxonomy.
- Results: 60% emissions cut, lower operating costs, strong investor uptake due to robust reporting.

5.5 Green Bonds and Climate Financing business model with GHP systems

Green Bonds enable capital-raising and investment for new and existing projects with environmental benefits. Governments and financial institutions can issue green bonds dedicated to residential heat pump installations, attracting environmentally conscious investors and offering favorable terms for homeowners.

Green bonds are debt instruments where money raised is earmarked for environmentally beneficial projects.

- Issuers (who raise the money):
 - Municipalities/local governments (e.g., issue bonds to fund district heating networks, public building retrofits with GHPs).
 - Public utilities or energy companies (fund large GHP infrastructure like geo-utilities).
 - Commercial banks & green banks (bundle smaller projects into one bond issue).
 - Project developers/ESCOs (if large enough to access capital markets).
- Investors (who buy the bonds):
 - Pension funds, insurance companies, asset managers, impact investors.
 - Retail investors (sometimes, via "community green bonds").

Here's a simplified flow of financing for a large-scale GHP project:

1. Project planning: Municipality/utility identifies the GHP system (e.g., 10 MW district heating).
2. Bond issuance: A green bond is issued (e.g. €50M) - investors buy the bond.
3. Capital raised: Funds are earmarked exclusively for the GHP project (audited under green bond standards like International Capital Market Association (ICMA), Green Bond Principles or EU Green Bond Standard).
4. Construction & ownership:
 - If municipal bond → city owns the system.
 - If corporate bond → utility or ESCO owns the system.
5. Operation:
 - Utility/ESCO runs it, sometimes with performance guarantees.
6. Revenue stream: Heat sales to end-users (via long-term contracts).
7. Debt service: Revenues are used to repay bondholders (interest + principal) over time.

The Green Bond Principles (GBP) seek to support issuers in financing environmentally sound and sustainable projects that foster a net-zero emissions economy and protect the environment. GBP-aligned issuance should provide transparent green credentials alongside an investment opportunity. At the EU level, the European Green Bond Standard regulation was recently adopted, which sets out the requirements that "environmentally sustainable bonds" should meet, starting from the EU Taxonomy.

1. Customer Segments

- City governments seeking to decarbonize district energy
- Universities, hospitals, and public buildings
- Utilities financing large-scale GHP infrastructure

- Industrial zones adopting clean thermal energy
- Real estate developers with green building mandates

2. Value Proposition

- Enables large-scale, capital-intensive GHP projects through low-interest, long-term debt
- Aligns infrastructure with sustainability and climate resilience goals
- Attracts impact-oriented investors and enhances ESG profiles
- Provides stable, predictable cash flows for repayment
- Demonstrates government or developer commitment to green infrastructure

3. Distribution Channels

- Municipal energy transition strategies
- Green finance platforms and ESG investor networks
- National and regional development programs
- Energy performance contracting (ESCOs)

4. Customer Relationships

- Municipalities and regional governments
- Institutional investors (e.g., pension funds, ESG funds)
- Public-private project developers
- Utilities and large energy service companies (ESCOs)
- Certifying bodies (e.g., Climate Bonds Initiative, International Capital Market Association (ICMA))

5. Revenue Streams

- Long-term energy service contracts (with municipalities or users)
- Repayment through utility bills (on-bill recovery) or lease payments
- Savings from avoided fossil fuel use
- Government-backed repayments (in case of public projects)

6. Key Resources

- Creditworthy project sponsors or municipalities
- Technical teams (design, drilling, installation)
- Legal frameworks for bond issuance
- Transparent MRV systems to track environmental impact
- Access to capital markets or bond platforms

7. Key Activities

- Feasibility studies and technical planning

- Bond structuring, certification, and issuance
- Aggregation of GHP projects (where needed)
- Construction, installation, and commissioning of the GHP system
- Monitoring, Reporting, and Verification (MRV) of energy and emissions performance under green bond standards

8. Key Partners

- Local and national governments
- Green bond certifiers (e.g., Climate Bonds Initiative, European Green Bond Standard)
- Development banks (e.g., EIB, KfW, World Bank)
- GHP system integrators and EPC contractors
- Legal and financial advisors

9. Cost Structure

- Capital expenditure for drilling, installation, and equipment
- Bond issuance and transaction costs
- Legal, compliance, and certification fees
- MRV and administrative overheads

There are several types of financing models for Green Bonds and Climate Financing:

- Green Bonds: Issued by public or private entities to finance GHP installations and infrastructure; certified by a recognized standard (e.g., CBI, ICMA, European Green Bond Standard)
- Climate Bonds: Specifically targeting climate mitigation/adaptation; often aligned with Nationally Determined Contribution (NDC) or Sustainable Development Goals (SDG)
- Blended Finance: Combines public funding (grants or concessional finance) with private investment via bond proceeds
- Project Bundling: Multiple small-scale GHP projects aggregated into a single bond issuance for scale and risk-sharing

Examples of Good Practices

1. Renewable Energy Infrastructure Bonds – France

- Project: Multiple municipalities in France issued green municipal bonds to finance clean heating systems, including ground-source heat pumps for schools and public buildings.
- Model: Public sector bond issuance backed by property taxes or energy service fees.
- Impact: Enabled large-scale deployment with reduced interest rates; improved public building energy efficiency.

- Stakeholders: Municipal governments, local utilities, retail green bond investors.
- Key Success Factors: Clear carbon savings metrics and transparent reporting.

2. EIB Green Bond Financing – Netherlands

- Project: The European Investment Bank (EIB) provided climate financing to Dutch housing associations to install GHP systems in retrofitted buildings.
- Model: Blended finance using EIB climate bond proceeds with matching national subsidies.
- Impact: Reduced heating costs for low-income households; improved building energy labels.
- Stakeholders: EIB, Dutch Housing Federation, technology providers.
- Key Success Factors: Programmatic approach with bundled projects and streamlined reporting.

3. Massachusetts Green Bonds – USA

- Project: The Commonwealth of Massachusetts issued green bonds partly used for installing GHP systems in state colleges, libraries, and administrative buildings.
- Model: State-backed bond issuance with dedicated funds for clean energy upgrades.
- Impact: Increased adoption of clean thermal technologies within public infrastructure.
- Stakeholders: State government, engineers/installers, rating agencies.
- Key Success Factors: Strong credit rating and defined climate benefits.

4. Vienna Climate Bonds for Energy-Efficient Buildings – Austria

- Project: The City of Vienna launched a climate bond program to retrofit social housing, including shared-loop GHP installations.
- Model: Municipal bond certified by Climate Bonds Initiative (CBI).
- Impact: Promoted equitable energy transition and district-scale renewable heating.
- Stakeholders: Vienna Housing Authority, financial intermediaries, residents.
- Key Success Factors: CBI certification and high public trust in local government.

5. KfW Green Financing – Germany

- Project: KfW Development Bank supports municipalities and private investors installing GHP systems via green-labelled loans and climate protection programs.
- Model: Green loan financing supported by federal guarantees and low interest rates.
- Impact: Thousands of energy-efficient homes and facilities using GHPs.
- Stakeholders: Local governments, building owners, KfW, certified planners.
- Key Success Factors: Alignment with national climate goals and technical support.

5.6 Challenges and solutions at the large scale

1. Very high upfront capital investment

- Challenge:
 - Borehole fields, large-scale heat pumps, and distribution networks are a huge investment.
 - Long payback horizons (15–25 years) discourage private investors.
- Solutions:
 - Public-Private Partnerships (PPP) to share risk.
 - Financing via green bonds, EU funds, or climate banks.
 - Staged investments (phased expansion of borehole fields as demand grows and cascadeable GHP systems).

2. Complex permitting and regulatory barriers

- Challenge:
 - Deep drilling permits, groundwater protection laws and environmental impact assessments create delays.
 - Different rules across regions → uncertainty for investors.
- Solutions:
 - Early engagement with regulators to define project pathway.
 - Creation of “one-stop-shop” permitting offices for renewable heating projects.
 - Standardized environmental assessment protocols at national level.

3. System design and grid integration

- Challenge:
 - Large GHP networks need careful balancing of supply/demand.
 - Seasonal imbalance can deplete or overheat the ground source.
- Solutions:
 - Integration with Seasonal Thermal Energy Storage (STES) (e.g., aquifer or borehole storage).
 - Hybridization with other renewables (solar thermal, waste heat recovery).
 - Smart thermal grids with dynamic load management.

4. Operational and maintenance complexity

- Challenge:
 - Requires specialized expertise for monitoring, optimization and fault detection.
 - Risk of cascading failures if central plant malfunctions.
- Solutions:
 - SCADA and IoT systems for real-time monitoring and predictive maintenance.
 - Professional utility operators with service-level agreements.
 - Redundancy systems to ensure resilience in case of failures.

5. Market and customer uptake risk

- Challenge:
 - Large investments require long-term commitments from many customers.
 - If customers opt out, it may result in revenue shortfalls that threaten viability.
- Solutions:
 - Secure anchor clients (e.g., hospitals, universities, municipal buildings) before investment.
 - Regulatory frameworks (e.g., zoning laws requiring or forbidding connection to district heating).
 - Flexible connection contracts (tiered pricing for different user groups).

6. Awareness, trust, and political acceptance

- Challenge:
 - Local communities may resist drilling (“not in my backyard”).
 - Lack of knowledge about geothermal safety and benefits.
- Solutions:
 - Public engagement campaigns showing environmental and comfort benefits.
 - Involve local stakeholders in project ownership (co-ops, community shares).

7. Scalability and replicability

- Challenge:
 - Each large-scale GHP is highly site-specific (ground geology, demand profiles).
 - Difficult to standardize and replicate quickly.
- Solutions:
 - Develop reference designs for common building clusters (universities, districts).
 - Use digital twin simulations to optimize design before drilling.
 - Share best practices databases across municipalities.

Figure 10. presents an overview of main challenges and solutions at the large scale:



Fig. 10. Illustration of challenges and solutions at the large scale GHPs

6. Business model innovation for GHP systems

The widespread adoption of GHPs depends not only on technology readiness but on the evolution of innovative business models that align with decarbonization, digitalization and decentralized energy trends. This section outlines key innovation vectors driving the next generation of GHP business models.

6.1 Demand-side flexibility and aggregation

GHP systems, due to their thermal inertia and predictable load profiles, can be integrated into flexible energy systems that respond to real-time grid signals.

Business model implications:

- Aggregators can pool GHP-equipped buildings to participate in demand response or capacity markets, offering new revenue streams.
- Energy-as-a-Service providers can optimize thermal storage and load shifting to lower energy costs and monetize flexibility.
- Performance contracting models (ESCO) may include flexibility services as a premium offering.

Examples:

- Virtual Power Plant (VPP) models integrating GHPs with thermal storage.
- Community energy cooperatives offering flexibility-as-a-service.

6.2 Integration with other renewable energy sources

Pairing GHP systems with local renewable electricity (e.g., solar PV or wind) enhances decarbonization and supports self-consumption strategies.

Business model innovations:

- Hybrid systems (GHP + PV) with integrated financing under third-party ownership or leasing.
- Zero-energy buildings with bundled heating, electricity, and storage services.
- Collective self-consumption models in multi-family or district-level applications.

Key considerations:

- Coordinated investment planning between heating and electrical systems.
- Optimized load balancing using predictive controls and real-time weather data.

Examples:

- Multi-tenant buildings with shared GHP and rooftop solar under a cooperative business model.
- Smart grid neighborhoods integrating GHPs with community solar and battery storage.

6.3 Role of digital technologies and smart controls

Digitalization is critical for unlocking performance-based, service-oriented GHP business models. Technologies include IoT sensors, AI-based optimization, digital twins, and customer-facing apps.

Digital-driven business models:

- Heat-as-a-Service (HaaS): Monetizing comfort levels and system uptime rather than kWh or equipment.
- Predictive maintenance and remote monitoring reduce O&M costs and improve service reliability.
- Dynamic pricing models enabled through smart controls and data analytics.

Customer value:

- Greater transparency and control.
- Tailored energy services with optimized performance and cost savings.

Examples:

- GHP system providers offering subscription models with smart thermostats and app-based control.
- ESCOs using AI to enhance energy performance guarantees in schools and commercial buildings.

6.4 Incentives, policies, and regulations supporting GHP business models

A supportive policy environment is essential for scaling innovative business models. Regulatory frameworks can reduce risk, enhance bankability, and align incentives with societal goals.

Key policy mechanisms:

- Capital subsidies or tax credits for GHP installation and drilling – see Deliverable 4.2 of the GeoBOOST project
- Operational incentives (e.g., performance-based payments or CO₂ savings rewards).
- On-bill financing or tariff-based models enabled by utility regulation.
- Green public procurement requiring life-cycle emissions and total cost of ownership analysis.

- Standardized contracts and measurement protocols to facilitate ESCO and HaaS models.

Enabling regulatory innovations:

- Regulatory sandboxes to pilot novel ownership and service structures.
- Mandates for thermal decarbonization in new and existing buildings.

Examples:

- Germany's Renewable Heating Law incentivizing GHP deployment in new buildings.
- Netherlands' Heat Transition Vision supporting municipal GHP district systems.

Business model innovation is essential to realizing the full potential of GHP systems in the energy transition. By integrating flexibility, renewables, digital tools, and enabling policy frameworks, GHP solutions can transition from niche to mainstream - delivering sustainable, affordable, and scalable heating and cooling services.

7. Target audience and recommendations

The report supports multiple stakeholder groups involved in the development, financing, installation, and operation of GHP systems. It accounts for their distinct roles and demonstrates how different business models can be applied within specific project contexts.

Homeowners and small property owners

Residential GHP systems are gaining recognition among homeowners seeking efficient and eco-friendly heating solutions. The appeal lies in the cost-effectiveness, possibility of free-cooling, and environmental sustainability offered by these systems, aligning with the growing awareness of responsible energy consumption among residential consumers. Especially in warmer climates, but also in moderate climates with increasing cooling demand and considering the urban heat island effect, cheap cooling becomes more and more important. Geothermal heat pumps can provide that. However, most people prefer ASHPs because of their lower capital costs. However, large-scale adoption of ASHPs is limited by grid load constraints, whereas GHPs have roughly half the grid impact.

- Interest: Reducing energy costs, increasing home value, and adopting renewable heating solutions.
- Challenges: High upfront investment, lack of awareness, and complex installation processes.
- Relevant business models:
 - Self-financed ownership (for long-term cost savings).
 - Leasing or on-bill financing (to minimize upfront costs).
 - Energy-as-a-Service (EaaS) (for hassle-free heating).

Recommendations for homeowners and small businesses

Adopt flexible ownership and financing models:

- Explore third-party financing (e.g. leasing, Heat-as-a-Service) to reduce upfront investment barriers.
- Participate in utility on-bill repayment schemes or Pay-As-You-Save (PAYS) programs where available.

Engage in community energy initiatives:

- Consider joining or forming community GHP networks to benefit from economies of scale and shared infrastructure.

Utilize smart controls and digital services:

- Invest in systems with remote monitoring, optimization, and performance guarantees for better comfort and savings.

Take advantage of incentives and tax credits:

- Stay informed about local, regional, and national incentives for GHP systems, including subsidies, energy tax credits, and technical support programs.

Commercial property owners & real estate developers

The scope of GHP applications extends seamlessly to commercial buildings, where owners recognize the economic and environmental benefits of incorporating these systems. From reduced operational costs to meeting sustainability benchmarks, GHPs are becoming integral to the heating and cooling infrastructure of commercial properties. Especially in warmer climates, but also in moderate climates with increasing cooling demand and considering the urban heat island effect, cheap cooling becomes more and more important. Geothermal heat pumps can provide that.

- Interest: Improving energy efficiency, meeting sustainability goals, and enhancing property value.
- Challenges: Balancing capital costs vs. return on investment, integrating GHPs into existing buildings.
- Relevant business models:
 - ESCO performance-based models (to ensure energy savings).
 - Utility-led and third-party financing (to spread costs over time).
 - District geothermal networks (for large commercial developments).

Industrial and large-scale facility owners

Industrial and large-scale facility owners play a critical role in the adoption of GHP systems, as they have high and consistent heating and cooling demands. Their participation in GHP deployment can lead to significant cost savings, improved energy efficiency, and reduced carbon emissions. Industrial processes and large facilities (e.g., manufacturing plants, hospitals, data centers, and warehouses) require large amounts of thermal energy – heating and cooling. Many industrial sectors are under pressure to reduce their carbon footprint and comply with emission regulations (e.g., EU ETS, corporate sustainability initiatives).

- Interest: Reducing energy costs, ensuring operational reliability, and lowering carbon footprints.
- Challenges: High heat demand, long payback periods, and complex integration with existing systems.
- Relevant Business Models:
 - ESCO model with performance guarantees (to minimize financial risk).
 - Public-private partnerships (PPP) (to secure funding and policy support).
 - Carbon credit financing (to leverage sustainability incentives).

Recommendations for property developers and institutional users

Integrate GHPs into early design and planning:

- Plan geothermal systems during the design phase to optimize integration with building envelopes, orientation, and renewable systems.

Utilize aggregated business models:

- Implement shared-loop GHP systems for multi-unit buildings or campuses, using cooperative or joint-ownership structures.

Pursue innovative financing structures:

- Work with ESCOs or Heat-as-a-service providers to deliver GHP systems under performance contracts or service agreements.
- Consider green building certifications (e.g., LEED, BREEAM) that reward GHP integration.

Monitor long-term performance:

- Use digital platforms to ensure system efficiency and identify performance issues early, supporting lifecycle cost management.

Government, municipalities & public sector organizations

Governments at various levels are emerging as key stakeholders in the GHP market. The commitment to sustainable energy practices has encouraged local and state authorities to subsidize the adoption of GHP systems in their buildings. Through regulatory support and financial incentives, governments are fostering an environment conducive to the widespread integration of GHPs in buildings in their cities and regions. On the other hand, local governments also often limit implementation due to environmental concerns installing boreholes.

- Interest: Decarbonizing public infrastructure, reducing energy costs, and promoting sustainable urban development.
- Challenges: Budget constraints, regulatory barriers, and long project timelines.
- Relevant business models:
 - Public-private partnerships (PPP) (to attract private investment).
 - District heating networks (to serve multiple public buildings efficiently).
 - Green financing & subsidies (to access government funding).

The successful deployment and scaling of GHP systems require coordinated action and tailored strategies across stakeholder groups. This section outlines actionable recommendations for key stakeholders based on lessons learned from best practice business models and emerging trends.

Recommendations for governments, utilities and policymakers

Create stable and long-term policy frameworks:

- Offer consistent financial incentives (e.g., tax credits, rebates, grants, subsidy schemes) and reduce regulatory uncertainty around third-party ownership and service models.

Support utility-led and district GHP projects:

- Encourage utilities to invest in on-bill financing, tariff-based recovery mechanisms, and shared geothermal networks.

Promote business model innovation:

- Provide funding for pilot projects, regulatory sandboxes, and public-private partnerships (PPPs) to test new ownership and service models.

Establish standards and certification:

- Develop technical and contractual standards for drilling, system performance, and Heat-as-a-Service models to ensure market trust and scalability.

Invest in capacity building:

- Support training and certification programs for installers, designers, drillers and project developers to foster a skilled geothermal workforce.

These stakeholder-specific recommendations aim to create a robust ecosystem that supports the deployment of GHP systems at all scales - residential, commercial, and industrial - accelerating the transition to sustainable heating and cooling.

8. Business Model Selection Toolkit - recommendation matrix for choosing the right business model for a certain investment

The Business Model Selection Toolkit provides a structured, criterion driven approach for matching geothermal heat pump investment scenarios to optimal financing and ownership arrangements. By aligning project scale, stakeholder preferences, and capital availability, the recommendation matrix helps decision-makers rapidly identify viable implementation strategies, reducing the risk of cost overruns or misaligned incentives.

Scenario / Criteria	Recommended business models	Suitable stakeholders	Financing features
Based on investment type:			
Residential (small scale <20 kW) – homeowner, single building	<ul style="list-style-type: none"> • Direct Ownership (retailer, one-stop shop) • Leasing and rental 	Homeowners, installers, drillers	Self-funded, consumer loans, leasing
Small commercial – restaurant, shop, office, hotel	<ul style="list-style-type: none"> • Direct Ownership (retailer, one-stop shop) • Heat as a Service • Leasing and rental 	Small businesses, installers, drillers	Shared savings, monthly service fees
Multi-family / Housing Cooperative (medium scale 20 kW - 150 kW)	<ul style="list-style-type: none"> • Cooperative / Shared Ownership • Heat as a Service • Utility-led on-bill 	Housing associations, Co-ops, Property managers, Utilities	Member equity, performance contracting
Institutional (Schools, Hospitals, etc.)	<ul style="list-style-type: none"> • Public-Private Partnership (PPP) • ESCO • Green Bonds 	Municipalities, Energy agencies	Blended finance, performance guarantees
Industrial Parks / Large Commercial / Campus (big scale > 150 kW)	<ul style="list-style-type: none"> • Heat as a Service • ESCO • One-stop shop 	Facility owners, Utilities, Developers	Service-based billing, CAPEX-neutral models
District Energy Networks – community-wide	<ul style="list-style-type: none"> • Public-Private Partnership (PPP) • Utility-led on-bill • Cooperative / Shared Ownership 	Utilities, Municipalities, Investors	Public grants, green bonds, utility tariff
Based on decision criteria:			
Low upfront capital available	<ul style="list-style-type: none"> • Leasing and rental • Heat as a Service • ESCO 	All segments	Monthly payments, third-party investment
Desire for long-term operational support	<ul style="list-style-type: none"> • ESCO • Heat as a Service 	Institutional clients, property developers	O&M bundled with energy delivery
High sustainability/ESG goals	<ul style="list-style-type: none"> • Green Bonds • Cooperative / Shared Ownership • Utility-led on-bill 	Universities, Governments, ESG Investors	Climate finance, labelled green instruments
Need for demand flexibility & grid integration	<ul style="list-style-type: none"> • Digital-enabled ESCO • Aggregator-integrated HaaS 	Smart grid operators, Tech providers	Digital + energy service revenue

Fig. 11. Recommendation matrix for choosing the right business model for a certain investment

9. Conclusions

9.1 Summary of key insights

This report has explored the diverse range of business models that support the deployment of GHP systems across residential, commercial, institutional, and industrial sectors. Key takeaways include:

- Business model innovation is essential to overcome barriers such as high upfront costs, regulatory hurdles, and market fragmentation.
- User-tailored approaches, from small homeowners to large-scale industrial campuses, ensure that the business model aligns with stakeholder capacity, risk tolerance, and energy needs.
- Models like direct ownership, leasing, energy-as-a-service, ESCOs, cooperatives, and public-private partnerships provide a flexible toolbox for different deployment scales.
- Integration with digital tools, renewables, and demand-side flexibility can improve system performance, value stacking, and user satisfaction.
- Policy support and financial mechanisms (e.g., tax incentives, green bonds, on-bill financing) remain vital in de-risking investments and scaling adoption.

9.2 Call to Action - Scaling GHP systems through tailored business models

To achieve wide-scale implementation of GHP systems in support of climate neutrality and energy security goals, the following actions are recommended:

- Homeowners and small businesses should explore tailored financing and ownership models, supported by local incentives and trusted technology providers.
- Developers and institutional stakeholders must incorporate GHPs into early planning stages, leveraging shared-loop and ESCO models to unlock economies of scale.
- Utilities and municipalities should drive district geothermal initiatives and support shared infrastructure through inclusive investment and policy frameworks.
- Investors and financial institutions are urged to develop products (e.g., leasing, green bonds) that lower capital barriers and reflect the long-term value of GHP systems.

- Policymakers must streamline permitting, improve access to subsurface data, and implement consistent support schemes that build investor and consumer confidence.

By embracing and adapting these business models, stakeholders can not only accelerate GHP deployment but also reshape energy systems to be more local, resilient, and sustainable. By gathering and analyzing proven examples from across Europe, Deliverable D5.3 shows that geothermal heat pumps are not only an efficient technology but also a sound business opportunity. With the right financing structures, partnerships, and awareness, shallow geothermal energy can play a key role in achieving Europe's climate neutrality goals while creating local jobs and sustainable value chains.

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Appendix 1. Questionnaire

Questionnaire:

WP 5 (Technology and business solutions)

Tasks 5.3 (Business models for successful services)



Your information			
First name		Last name	
First name		Last name	
Organisation			
Country			
City			
Email			
Date			
Goal			
The goal of this questionnaire is to identify and assess Good Practice Examples of Business Models integrating geothermal heat pumps addressing different market actors in the project partner countries.			
Instructions			
<p>This questionnaire can be used for reporting on up to three Business Models. The main sections of the questionnaire are called 'Business model 1', 'Business model 2', and 'Business model 3'.</p> <p>In this questionnaire we skip the traditional business models (retailer model, manufacturing model and one-stop shop) as they are very well known in all project partner countries. Instead we will focus on new and promising business models such as:</p> <ul style="list-style-type: none"> • Performance-Based Contracts as basis for ESCO business models • Rental and leasing models • Community-Based Projects (Energy communities) • Energy as a Service (EaaS) or Heat as a Service (HaaS) • Energy-consumption optimization (flexibility for energy suppliers) • Heat pumps for 1 EUR (grid integration and aggregators) • ... <p>Please choose at least 3 business models from above or add additional one (if needed and existing in your country) and evaluate them using below described methodology.</p> <p><i>If you need to provide information on more than three business models, please copy a 'Business model' section and paste it at the end of the document as many times as needed. Then, rename each new section accordingly (e.g., 'Business model 4', 'Business model 5', and so on).</i></p>			

Business model 1

General Business Model Information

1. **Business model name**
 - What is the name of the business model?
2. **Business model short description (3-4 sentences)**
 - Please specify short description of the business model
3. **Examples of companies**, who operate with this business model in your country.

Detailed Business Model Description according to Business Model Canvas by Alexander Osterwalder (see description above)

4. **Customer Segment**
5. **Value Proposition**
6. **Distribution Channels**
7. **Customer Relationship**
8. **Revenue Streams**
9. **Key Resources**
10. **Key Activities**
11. **Key Partners**
12. **Cost Structure**

Stakeholder Perception

13. In your opinion, how efficient this business model is on you market? Please rate your answer on a scale of 1 to 5. Justify the answer if you feel necessary.
14. In your opinion, how efficient this business model is with geothermal heat pumps? Please rate your answer on a scale of 1 to 5. Justify the answer if you feel necessary.

Appendix 2. Summary of individual Business Model Canvases for GHPs



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<p>Key Partners</p> <ul style="list-style-type: none"> • Manufacturers, suppliers • Drilling companies • Installers, maintenance • Consultancy companies • Government agencies • Financial institutions • Energy efficiency certification bodies • Marketing agencies 	<p>Key Activities</p> <ul style="list-style-type: none"> • Sales and distribution • System design and customization • Installation management • After-sales support • Customer education • Securing incentives • Technology integration 	<p>Value Propositions</p> <ul style="list-style-type: none"> • Energy efficiency • Environmental sustainability • Customizable solutions • Turnkey service • Long-term durability • Convenient financing • Techno-economic assessment • Performance certificates 	<p>Customer Relationships</p> <ul style="list-style-type: none"> • Consultative sales process • Loyalty programs • Dedicated support teams • Educational engagement • Performance monitoring 	<p>Customer Segments</p> <ul style="list-style-type: none"> • Residential customers • Small and medium enterprises (SMEs) • Real estate developers • Educational and public institutions • Environmentally conscious consumers
	<p>Key Resources</p> <ul style="list-style-type: none"> • Technical expertise • Inventory • Partnership contracts • Customer database • Showrooms and online platforms • Brand reputation • Technology 		<p>Channels</p> <ul style="list-style-type: none"> • Manufacturers / installers showrooms • 2-tier channel • 3-tier channel • Online sales platforms • Partnership networks • Marketing campaigns • Exhibitions and trade shows 	
<p>Cost Structure</p> <ul style="list-style-type: none"> • Product procurement • Drilling and installation costs • Marketing and advertising • Customer support • Maintenance and warranty fulfillment • Technology investments • Overhead costs 			<p>Revenue Streams</p> <ul style="list-style-type: none"> • System sales • Installation and drilling services • Maintenance contracts • Leasing and financing plans • Smart technology integration • Training and consulting • Referral programs 	

Business model canvas for a retailer business model with GHP Systems

Key Partners <ul style="list-style-type: none"> • Suppliers of components • Drilling companies • Installers & servis teams • Consultancy & design firms • R&D institutions • Financial institutions • Government & regulatory bodies • Technology providers 	Key Activities <ul style="list-style-type: none"> • Design & manufacturing • Integrated turnkey solutions • Customer education • R&D innovation • Logistics & distribution • Installation & deployment services • After-sales support • Certification & compliance management 	Value Propositions <ul style="list-style-type: none"> • End-to-end solution • High-quality products • Cost-effective energy • Convenience • Sustainability • Customizable systems • Flexible financleasing options • Smart integration 	Customer Relationships <ul style="list-style-type: none"> • Direct consultation • Turnkey long-term partnerships • After-sales • Educational engagement • Smart system monitoring • Ongoing feedback loops & surveys 	Customer Segments <ul style="list-style-type: none"> • Residential homeowners • Commercial entities • Industrial clients • Real estate developers • Public sector
	Key Resources <ul style="list-style-type: none"> • Manufacturing facilities • Design & engineering teams • Robust supply chain • Drilling resources • Installation & maintenance network • Customer database • Technology tools • Distribution networks • Strong brand reputation 		Channels <ul style="list-style-type: none"> • Direct sales • E-commerce & virtual design platforms • Trade shows & events • Contractor collaborations (installation outsourcing) • Digital & traditional marketing campaigns • Educational marketing (forums, social media) 	
Cost Structure <ul style="list-style-type: none"> • R&D and innovation • Raw materials, labor, equipment • Shipping & distribution • Marketing & customer acquisition • Installation team costs • Drilling service costs • After-sales support • Certification & compliance 			Revenue Streams <ul style="list-style-type: none"> • System & component sales • Turnkey solution contracts • Leasing & financing programs • Maintenance & monitoring fees • Technology licensing & partnerships • Government incentives 	

Business model canvas for a manufacturing business model with GHP systems as a one-stop shop

Key Partners <ul style="list-style-type: none"> • Suppliers of components • Drilling companies • Installers & servis teams • Consultancy & design firms • R&D institutions • Financial institutions • Government & regulatory bodies • Technology providers 	Key Activities <ul style="list-style-type: none"> • Design & manufacturing • Integrated turnkey solutions • Customer education • R&D innovation • Logistics & distribution • Installation & deployment services • After-sales support • Certification & compliance management 	Value Propositions <ul style="list-style-type: none"> • End-to-end solution • High-quality products • Cost-effective energy • Convenience • Sustainability • Customizable systems • Flexible financleasing options • Smart integration 	Customer Relationships <ul style="list-style-type: none"> • Direct consultation • Turnkey long-term partnerships • After-sales • Educational engagement • Smart system monitoring • Ongoing feedback loops & surveys 	Customer Segments <ul style="list-style-type: none"> • Residential homeowners • Commercial entities • Industrial clients • Real estate developers • Public sector
	Key Resources <ul style="list-style-type: none"> • Manufacturing facilities • Design & engineering teams • Robust supply chain • Drilling resources • Installation & maintenance network • Customer database • Technology tools • Distribution networks • Strong brand reputation 		Channels <ul style="list-style-type: none"> • Direct sales • E-commerce & virtual design platforms • Trade shows & events • Contractor collaborations (installation outsourcing) • Digital & traditional marketing campaigns • Educational marketing (forums, social media) 	
Cost Structure <ul style="list-style-type: none"> • R&D and innovation • Raw materials, labor, equipment • Shipping & distribution • Marketing & customer acquisition • Installation team costs • Drilling service costs • After-sales support • Certification & compliance 			Revenue Streams <ul style="list-style-type: none"> • System & component sales • Turnkey solution contracts • Leasing & financing programs • Maintenance & monitoring fees • Technology licensing & partnerships • Government incentives 	

Business model canvas for a rental and leasing model with GHP systems

<p>Key Partners</p> <ul style="list-style-type: none"> • Local authorities & municipalities • Private investors • Energy cooperatives • Financial institutions • Technology providers • Real estate developers • Policy makers 	<p>Key Activities</p> <ul style="list-style-type: none"> • Network design & development • Stakeholder coordination • Maintenance & monitoring • Community education • Financing & fundraising 	<p>Value Propositions</p> <ul style="list-style-type: none"> • Cost efficiency • Sustainability • Energy security • Community benefits • Customizability 	<p>Customer Relationships</p> <ul style="list-style-type: none"> • Collaborative governance • Dedicated customer support • Community partnerships • Education & awareness • Collaborative governance 	<p>Customer Segments</p> <ul style="list-style-type: none"> • Residential communities • Commercial buildings • Public & institutional users • Utilities & energy cooperatives • Residential communities
<p>Key Resources</p> <ul style="list-style-type: none"> • Geothermal infrastructure • Technical expertise • Partnerships • Digital platforms • Financial capital 			<p>Channels</p> <ul style="list-style-type: none"> • Community engagement programs • Partnerships with developers • Partnerships with local governments & energy suppliers • Direct marketing • Digital platforms 	
<p>Cost Structure</p> <ul style="list-style-type: none"> • Upfront costs • Operational costs • Administrative costs • Technology costs • Financing costs 			<p>Revenue Streams</p> <ul style="list-style-type: none"> • Connection fees • Subscription fees • Energy usage charges • Incentives & subsidies • Surplus energy sales 	

Business model canvas for shared ownership / community-based models with GHP systems

Key Partners <ul style="list-style-type: none"> • Technology providers • Drilling & installation contractors • Financing institutions • Government & incentive agencies • Property developers & ESCO aggregators 	Key Activities <ul style="list-style-type: none"> • Energy auditing & feasibility studies • System design & engineering • Financing structuring • Installation & commissioning • Monitoring & optimization 	Value Propositions <ul style="list-style-type: none"> • Turnkey energy solution • No upfront costs • Guaranteed performance • Lower operational costs • Decarbonization support • Transfer of ownership 	Customer Relationships <ul style="list-style-type: none"> • Long-term contracts • Ongoing maintenance & support • Transparent monitoring • Risk-sharing 	Customer Segments <ul style="list-style-type: none"> • Commercial & industrial buildings • District heating and cooling providers • Public sector • Multi-family residences • Large single-family homes
	Key Resources <ul style="list-style-type: none"> • Capital access • Technical expertise • Monitoring & data systems • Contract templates & legal expertise • Professional network 		Channels <ul style="list-style-type: none"> • Direct sales teams • Energy audits & assessments • Public tenders • Partnerships with utilities, installers and drilling companies 	
Cost Structure <ul style="list-style-type: none"> • Capital investment • Labor, operation & maintenance • Financing costs • Marketing & sales • Insurance & risk management 			Revenue Streams <ul style="list-style-type: none"> • Shared energy savings • Guaranteed savings model • Pay-As-You-Save (PAYS) • Maintenance fees • Incentives/subsidies • Transfer of ownership 	

Business model canvas for energy service companies (ESCOs) with GHP systems

<p>Key Partners</p> <ul style="list-style-type: none"> • Geothermal technology providers & installers • Financial institutions • Government agencies • Regulators • Nonprofits & community groups 	<p>Key Activities</p> <ul style="list-style-type: none"> • Program design and administration • Customer outreach and marketing • Partnerships with installers and drilling companies • Regulatory compliance • Monitoring and maintenance 	<p>Value Propositions</p> <ul style="list-style-type: none"> • No upfront costs • Affordable payments • Energy savings • Low-risk adoption • Increased property value 	<p>Customer Relationships</p> <ul style="list-style-type: none"> • Long-term engagement • Personalized support • Trust-based • Convenience focused 	<p>Customer Segments</p> <ul style="list-style-type: none"> • Residential homeowners • Small and medium businesses (SMEs) • Low-to-middle-income households • Municipal and institutional customers
	<p>Key Resources</p> <ul style="list-style-type: none"> • Billing infrastructure • Capital access • Workforce/installers • Data and analytics • Customer trust and brand 		<p>Channels</p> <ul style="list-style-type: none"> • Utility customer service portals • In-Home energy audits • Installer networks • Community outreach 	
<p>Cost Structure</p> <ul style="list-style-type: none"> • Capital deployment • Administrative costs • System integration • Marketing and outreach • Maintenance support 			<p>Revenue Streams</p> <ul style="list-style-type: none"> • Repayment through utility bills • Interest or admin fees • Energy sales • Incentives/subsidies 	

Business model canvas for utility-led on-bill model with GHP systems

<p>Key Partners</p> <ul style="list-style-type: none"> • Designers for BHE • Technology providers • Installation, drilling & maintenance subcontractors • Financial partners • Utilities or aggregators • Government programs 	<p>Key Activities</p> <ul style="list-style-type: none"> • System design, installation, and commissioning • Operations & maintenance • Energy monitoring & optimization • Customer engagement • Risk management 	<p>Value Propositions</p> <ul style="list-style-type: none"> • Comfort, not equipment • No upfront costs • Performance guarantee • Transparent, predictable pricing • Free cooling with GHP 	<p>Customer Relationships</p> <ul style="list-style-type: none"> • Subscription-based • Responsive support & maintenance • Performance-based trust • Customization 	<p>Customer Segments</p> <ul style="list-style-type: none"> • Homeowners & tenants • Commercial buildings • Public institutions • Property managers & housing associations
<p>Cost Structure</p> <ul style="list-style-type: none"> • Capital expenditure (CAPEX) • Operational costs • Financing costs • Customer acquisition & retention • Insurance & risk contingency 	<p>Revenue Streams</p> <ul style="list-style-type: none"> • Monthly subscription fees • Optional add-ons • Carbon credits / ESG value 			

Business model canvas for a Heat as a Service (HaaS) business model with GHP systems – service provider

Key Partners <ul style="list-style-type: none"> • Drilling companies (framework contracts) • Building services planners • Civil engineers for complex sites • Authorities & funding organizations • Installation personnel 	Key Activities <ul style="list-style-type: none"> • Project acquisition • Conception & planning • Underground sizing & TRTs • CAPEX financing • Establishing servitudes • Operation, monitoring & optimization • Billing processes • R&D: digitalization & AI 	Value Propositions <ul style="list-style-type: none"> • Cheap prices • High efficiency • Energy self-sufficiency • High reliability • Increased real estate value • Green energy • One-stop-shop 	Customer Relationships <ul style="list-style-type: none"> • Dedicated service department • Proactive system updates before issues • Continuous customer engagement 	Customer Segments <ul style="list-style-type: none"> • Building developers • Industrial and office buildings • Hotels • Industry • Low-temperature heating grids by larger firms • Located in D-A-CH and broader Europe
	Key Resources <ul style="list-style-type: none"> • Know-how & skilled engineering staff • Access to financing for CAPEX • IT & cybersecurity platforms 		Channels <ul style="list-style-type: none"> • Real estate contacts • Outreach via podcasts & presentations • Recommendations from project partners • Collaborative research projects • Referrals from satisfied clients • Company homepage 	
Cost Structure <ul style="list-style-type: none"> • Staff costs (operations, planning, maintenance) • CAPEX financing for system installations 		Revenue Streams <ul style="list-style-type: none"> • Long-term supply contracts with buy-out option (~20 yrs) • Flat-rate rents indexed to CPI 		

Business model canvas for a Heat as a Service (HaaS) business model with GHP systems – project developers

Key Partners <ul style="list-style-type: none"> • Local authorities / municipal governments • Private developers / energy companies • Green banks / climate finance institutions • Utility companies & grid operators 	Key Activities <ul style="list-style-type: none"> • Project structuring & feasibility • System design & implementation • Operations & maintenance • Performance monitoring & reporting 	Value Propositions <ul style="list-style-type: none"> • Shared investment & risk • Stable, long-term returns • Public benefit infrastructure • Credibility & compliance 	Customer Relationships <ul style="list-style-type: none"> • Contractual agreements • Public accountability • Stakeholder collaboration 	Customer Segments <ul style="list-style-type: none"> • Municipalities & local governments • District developers & urban planners • Public institutions • Commercial tenants & residential users
	Key Resources <ul style="list-style-type: none"> • Public support & land access • Private capital & engineering expertise • Contract frameworks & legal expertise • Digital Platforms 		Channels <ul style="list-style-type: none"> • Public procurement & tendering • Infrastructure funds & green investment platforms • Urban planning partnerships • Community engagement programs 	
Cost Structure <ul style="list-style-type: none"> • Capital expenditure (CAPEX) • Operation & maintenance costs • Financing costs • Legal & transaction costs • Regulatory compliance & permits 			Revenue Streams <ul style="list-style-type: none"> • Concession fees / service payments • Heat sales or tariffs • Carbon credit revenues • Grants and incentives • Green Bonds and climate financing • Multilateral development banks 	

Business model canvas for a Heat as a Public-Private Partnerships (PPPs) with GHP systems

Key Partners <ul style="list-style-type: none"> • Government bodies • Green certifiers • Development banks • System integrators • Legal advisors 	Key Activities <ul style="list-style-type: none"> • Feasibility studies • Bond issuance • Project aggregation • System commissioning • MRV reporting 	Value Propositions <ul style="list-style-type: none"> • Low-interest debt • Sustainable infrastructure • Impact investing • Predictable cashflows • Green commitment 	Customer Relationships <ul style="list-style-type: none"> •Dedicated personal investor assistance •Self-service green bond platform •Automated impact reporting and billing •Collaborative stakeholder forums and networks •Ongoing technical support and refinancing 	Customer Segments <ul style="list-style-type: none"> • City governments • Public institutions • Utility companies • Industrial customers • Real estate developers
	Key Resources <ul style="list-style-type: none"> • Credit sponsors • Technical teams • Legal frameworks • MRV systems • Capital markets 		Channels <ul style="list-style-type: none"> • Procurement tenders • Finance platforms • Development programs • ESCO contracts 	
Cost Structure <ul style="list-style-type: none"> • CAPEX costs • Issuance fees • Legal fees • MRV overheads 		Revenue Streams <ul style="list-style-type: none"> • Service contracts • On-bill recovery • Fuel savings • Government backing 		

Business model canvas for a heat as a Green Bonds and Climate Financing business model with GHP systems