Interreg
CENTRAL EUROPE
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GeoPLASMA-CE

THE GEOPLASMA-CE POSITION PAPER

to foster the use of shallow geothermal in central europe

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NOMENCLATURE

CLS	Closed loop systems (borehole heat exchangers)
GSHP	Ground source heat pump
OLS	Open loop systems (thermal ground-water wells)
RES	Renewable Energy Source
SGE	Shallow geothermal energy
SPF	Seasonal performance factor
UTES	Underground thermal energy storage

The GeoPLASMA-CE team, Vienna, April 2019

PREFACE

Shallow Geothermal energy is an unlimited source of renewable heat located everywhere below ground across Europe. It can be channeled and used efficiently for heating and cooling purposes irrespective of weather conditions, daytime or season. **This makes Shallow Geothermal one of the most widespread, clean, reliable, safe and renewable heating and cooling solutions.**

Energy policy and climate protection are the most crucial European and global challenges requiring urgent and robust action by 2030. Whist primary energy consumption for heating and cooling still represents the largest share of the energy sector, the share of renewable energy sources is still under capitalised in the EU 28 comprising only 19.5% of 2017 consumption . In March 2019, the European Commission published the "Clean energy for all Europeans" package, which prioritises investment in cleaner decarbonised energy. The new binding energy target set for 2030 covers, among others, the increase of renewables to a share of at least 32% and the enhancement of energy efficiency by 32.5%. In reference to the Clean Energy package, the revised Renewable Energy Directive (RED II), which entered into force in December 2018, includes a stronger focus on mainstreaming renewables in the heating and cooling sector and demands the growth of share of RES in heating and cooling by 1.3 % per year between 2020 and 2030.

INTRODUCTION

Shallow geothermal energy can make a significant contribution to meeting the EU's 2030 low carbon heating and cooling objectives and is critical to meeting 2050 net zero targets.

The GeoPLASMA-CE project, co-funded by the Interreg Central Europe programme of the EU, promotes the sustainable use of shallow geothermal energy for heating, cooling and seasonal heat storage in Central European member states: Austria, Czech Republic, Germany, Poland, Slovakia and Slovenia. The project team comprises geoscientists from the public bodies and research sector, professionals in planning and geoscientific data processing, a national geothermal association as well as a municipality administration unit. The goal of GeoPLASMA-CE is to foster the use of shallow geothermal technologies in Central Europe and to ensure uniform application of high environmental and technical standards.

Our joint position paper aims at transferring and upscaling strategic findings from GeoPLASMA-CE to accelerate investment **in shallow geothermal energy systems as a key technology for renewable heating, cooling and heat storage to 2030 and net zero by 2050.**
This document is addressed to the policy makers, agencies as well as non-governmental and governmental organisations dealing with meeting renewable heating and cooling targets in Europe.

What is shallow geothermal energy?

Shallow geothermal energy benefits from the ability of the Earth to store heat in solid rocks or shallow groundwater bodies, called the subsurface or underground. The heat stored is available everywhere below our feet and originates from the inner part of our planet (geothermal heat) and the atmosphere (solar energy). In Central Europe, the heat stored in the uppermost parts of the subsurface in general varies around 10°C – that's why shallow geothermal energy is often given the name 'environmental heat'. Heating demand in EU commercial and residential buildings sector accounts for about 79%

of total final energy use according to the European Commission. Shallow geothermal is uniquely placed to satisfy this demand with clean, reliable and renewable energy.

The most common way of using shallow geothermal energy is given by:

- Heating in combination with a heat pump to raise the underground temperature level for supplying the heating system of a building (ground-source heat pump)
- The most effective way to use shallow geothermal energy is to consider it as a heat store applied to:
- Seasonal heating and cooling with the same shallow geothermal installation
- Underground Thermal Energy Storage (UTES) of waste heat to use it during the next heating period

Ground source heat pumps are a means of safely extracting natural heat and integrating it into heating and cooling needs for residential and commercial users as outlined in Figure 1: Technical overview of shallow geothermal energy systems used for heating of buildings.
How to exchange heat between the underground and the heating or cooling facility
In general, we differ between two major technical concepts to exchange heat:

How to exchange heat between the underground and the heating or cooling facili-ty

In general, we differ between two major technical concepts to exchange heat:

- **Closed loop systems** consist of simple polyethylene tubes, installed into the subsurface and filled with brine (a mixture of water and a refrigerant like glycol or ethanol). Closed loop systems either might be installed as horizontal collectors in the uppermost 150 cm of the underground or put into vertical boreholes of depths between tens and several hundreds of meters (borehole heat exchangers). Horizontal collectors might be applied in case the drilling is not allowed and in case enough surface space is available – these systems allow transferring 10 to 40 Watt of heat per square meter of the installed device. Borehole heat exchangers require drillings but are more efficient and moreover enable underground heat storage – these systems allow transferring heat in the order of 20 to 80 Watt per meter of the installed vertical tubing.

SHALLOW GEOTHERMAL IN A NUTSHELL

- **Open loop systems** can be applied in case groundwater is present. By using one or several well doublets consisting of a production and injection well, the heat stored in the groundwater is transferred via a heat exchanger to the heating or cooling circle – with one liter of extracted groundwater per second you might be able to transfer heat in the order of 4 Kilowatt per Kelvin temperature change.

In order to use geothermal energy more efficiently, the supplied building should be equipped with a panel heating and cooling system running at temperatures below 40°C as well as with a hot water tank for domestic water use. **Shallow geothermal can be applied to new- as well as retrofitted buildings**

Ground source heat pump – generates at least 4 portions of heat out of one por-tion of electricity!

Compression derived from electric power raises the temperature of the refrigerant fluid in the heat pump from around 10 up to 60 °C. After passing the heat exchanger the brine returns to the ground and a new cycle begins. For cooling in summer, the process is reversed: the heat is extracted from the building and carried back to the ground. This can be done in a very economical way as a free cooling process.

The coefficient of performance (COP) represents the fraction of exergy invested for the compressor (e.g. electricity) to produce heat and delineates the efficiency of a heat pump. The effective COP is highly dependent on operating conditions. The seasonal performance factor (SPF) describes the share of electricity in relation to the heat produced over a year. The higher the SPF gets, the more efficient the heat pump system works.

Note that in most cases ground source heat pumps show a higher SPF than air-based heat pumps – on the top, you might use the cold for free!

SHALLOW GEOTHERMAL IN A NUTSHELL

Geothermal Energy can be used by closed-loop systems using vertical tubes (A) or horizontal collectors (B). Another possibility is the installation of a well doublet (C) as an open-loop system.

(1) While water flows in tubes or collectors, it is heated by the ground. Well doublets use the groundwater directly as they pump water to the surface and reinject it after heat exploitation.

(2) The heat of the fluid is transferred to the heat pump. Compression raises the temperature of the refrigerant fluid in the heat pump from around 10˚C up to 60˚C.

(3) The energy can be used for room heating as well as for hot water. A hot water tank can also store the heat for several hours.

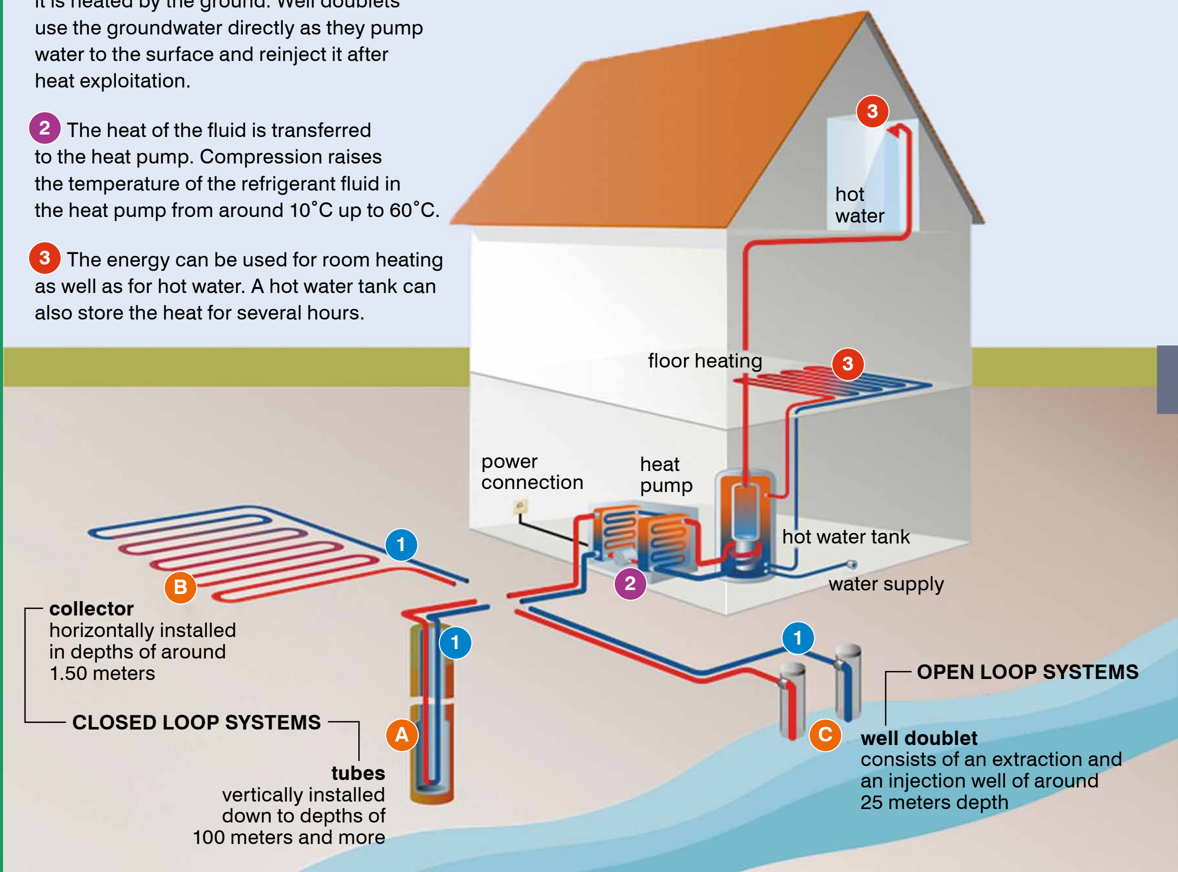


Figure 1: Practical example of a single-family home

To supply a new built single-family home with heating and hot water, you either need a 100 to 150 meters deep borehole heat exchanger or use two groundwater wells exchanging less than 0.5 litres per second.

INTRODUCTION

Shallow geothermal – the clean and efficient alternative for heating, cooling and seasonal heat storage!

It is **available everywhere** under your feet and it reduces the dependency on energy imports!

- ✔ It is **a reliable heating and cooling source**. Shallow geothermal energy is stable and capable of providing heat and cold during day and night and independently from the weather conditions!
- ✔ The **same system can provide heating and cooling**. No bulky and noisy air chillers are required to keep the home or office cool!
- ✔ It **avoids emissions like smog or greenhouse gases**. In contrast to coal, oil and gas boilers, no emissions are set free!
- ✔ It **reduces ambient heat and noise**. In contrast, air-based heat pumps and air chillers increase ambient noise!
- ✔ It **does not consume much space on the surface and is not visible from outside**. Suitable for special applications such as urban environments and historic buildings!
- ✔ It is **supporting European climate and environmental strategies**. Shallow geothermal energy facilitates the decarbonisation of Europe and the reduction of greenhouse gases!
- ✔ It can **support a new generation of local heating and cooling grids** using the underground as a seasonal storage for interconnected buildings!
- ✔ No special infrastructure is required – just a normal electricity connection. SGE provides a **high level of self-reliance and resilience**, especially if combined with other renewables such as photovoltaics!

SHALLOW GEOTHERMAL ENERGY – THE GAME CHANGER FOR RELIABLE, LOCAL ZERO-CARBON HEATING AND COOLING!

Shallow geothermal – breaking out of a niche market

According to the 2018 EGEC Market Report, around **1.9 million shallow geothermal systems** were installed by the end of 2018 in Europe **producing around 27 TWh of heat at installed capacities** of around **23GW**. In average, around **4 shallow geothermal units** are installed **per 1,000 inhabitants of the EU**.

By 2018, shallow geothermal energy just covered around 2% of the renewable heating and cooling con-sumption in the EU. The precise number of installed shallow geothermal systems in the EU is not exactly known due to the lack of comprehensive registers and as direct uses without the support of heat pumps for free cooling is not covered in statistics.

There are no technical barriers inhibiting urgently needed investment in shallow geothermal energy. So policy-makers need to ensure appropriate awareness and investment architecture is in place so that shallow geothermal energy can displace harmful fossil fuel usage to meet 2030 and 2050 targets. These non-technical barriers are outlined below.

MARKET TOPOLOGIES

The Scandinavians and the Baltic region: Sweden is the largest and most mature market for SGE in the EU with 55 installed units per 1,000 inhabitants. It is followed by Finland (21.5), Estonia (12.5) and Denmark (11.3). Estonia and Lithuania had growth rates above EU average (what is the average growth rate?).

The GeoPLASMA-CE countries: Like the Scandinavians countries, Austria and Germany have invested in SGE for a long time. Slovenia, which opted for SGE much later than Austria and Germany, is investing at a rapid pace. Poland and the Czech Republic are lucrative emerging markets for investment. Slovakia repre-sents the only country in the GeoPLASMA-CE region which an underdeveloped market.

MARKET TOPOLOGIES

Rank	Installed units (per 1000 inhabitants)	Growth rate (sales2018/stocks 2017)
#1	Sweden (55.0)	Bulgaria (+100%)
#2	Finland (21.5)	Belgium (+21.2%)
#3	Estonia (12.7)	Luxembourg (+17.3%)
#4	Austria (12.4)	The Czech Republic (+15.0%)
#5	Denmark (11.3)	Poland (+12.5%)
#6	Slovenia (5.7)	Estonia (+12.4%)
#7	Germany (4.7)	The Netherlands (+10.4%)
#8	The Netherlands (3.5)	Lithuania (+10.2%)
#9	France (2.4)	United Kingdom (+9.2%)
#10	Lithuania (2.0)	Spain (+8.4%)
#11	Poland (1.4)	Portugal (+8.3%)
#12	Luxembourg (1.3)	Finland (+6.8%)
#13	Bulgaria (1.2)	Germany (+6.6%)
#14	Belgium (1.2)	Italy (+6.1%)
#15	The Czech Republic (1.1)	Ireland (+5.5%)
#16	Ireland (0.9)	Austria (+5.1%)
#17	Slovakia (0.7)	Slovenia (+4.8%)
#18	United Kingdom (0.5)	Sweden (+4.3%)
#19	Hungary (0.2)	Hungary (+4.0%)
#20	Italy (0.2)	Slovakia (+3.4%)
#21	Portugal (0.1)	Denmark (+3.3%)
#22	Spain (<0.1)	France (+2.1%)
Average: 7.9		Average: +6.3%

Green color: GeoPLASMA-CE countries

MARKET TOPOLOGIES

The Benelux countries and the UK: These countries represent emerging markets with significant growth opportunities estimated to be above the EU average. However, apart from the Netherlands, all countries still have a very moderate level of deployment.

The Southern Countries: Due to their lower heating demand, SGE has not become established so far in Italy, Portugal and Spain. However, the latest statistics indicate a growing market above EU average in all mentioned countries

Efficiency does matter on the EU level!

From 2017 to 2018, the shallow geothermal market grew at a rate of +6%, which is rather moderate compared to the growth of the overall heat pump market of +12% for the same period. In 2018, the share of ground source heat pumps in the overall heat pump market was around 16% referring to installed units and around 20% referring to the estimated annual heat production.

While the air-based heat pump market almost doubled between 2006 and 2016, the annual sales of ground source heat pumps went down by 17% in the same period. This results in a loss of efficiency on an EU level when it comes to peak load electricity consumption for heat pumps and grid capacities during the year.

Decreasing the gap between air and ground source heat pumps from 2006 to 2016 means **saving peak load electricity supply or more than 500 MWe and reducing workloads of around 1 TWh each year <u>without any loss of comfort!</u>** This could displace 2 coal-fired power plants in the EU.

THE GEOPLASMA-CE VISION FOR 2030 REGARDING SHALLOW GEOTHERMAL

New ways towards a decarbonised heating and cooling market in Europe

The GeoPLASMA-CE coalition recommends, given it is a high efficiency, carbon-free heating and cooling baseload renewable energy source, shallow geothermal energy is given additional support measures to accelerate decarbonisation of households, commercial and public buildings. Incentives will help it move from wide deployment in the housing sector to applications like:

- Self-sustained buildings combining shallow geothermal with solar energy (Solar heat and power)
- Commercial buildings at an alternating heating and cooling demand
- Refurbished buildings at a higher heating demand
- Public buildings acting as demonstrators of good practice for the society
- Local heating and cooling grids at low temperatures coupled to waste heat producers and the electricity sector
- Stabilisation for heat pumps used in smart grids

Central to maximising this immense opportunity is shifting the perception of **subsurface heat for use solely for heating and cooling and facilitating its application in energy storage.** Moreover, shallow geothermal is the **key technology in urban areas**, which cannot be supplied by district heating or gas. The consumption of surface space in buildings for the installation of heating and cooling systems, minimal emissions, the ability to provide efficient heating and cooling with the same appliance as well as the compatibility with other renewables give it a significant advantage over other heating and cooling technologies. Harvesting heat from buildings and sealed surfaces like paved squares, sidewalks and streets will enhance the **mitigation of urban heat island effects** and provide heat for the subsequent cold season.

THE GEOPLASMA-CE VISION FOR 2030 REGARDING SHALLOW GEOTHERMAL

The GeoPLASMA-CE target indicators for 2030

Following a linear development path of the HRE 2050 for heating and cooling supply in the entire E U by efficient heat pumps requires:

- A total heat production of 420 TWh/year from individual and large-scale heat pumps (2018: 128 TWh)
- A total heat production of 210 TWh/year from ground source heat pumps or heat pumps linked to underground heat storage (2018: around 27 TWh).
- A raise of the share of ground source heat pumps from within the heat pump market around 21% in 2018 to 50% in 2030

Ambitious but achievable targets for 2030 are needed!

The Heat Roadmap Europe (HRE) project analysed efficient decarbonisation scenarios for the heating and cooling market in 14 EU Member States until 2050, which cover 90% of all EU end energy consumption. By redesigning the heating and cooling market using only proven and market ready technologies the CO2 emissions could be reduced by 86% or 4,340 million tonnes compared to 1990 making it a key solution to meeting the EU's 2030 and 2050 climate targets.

The HRE 2050 scenario considers two major technologies providing heating in cooling in 2050: (1) efficient district heating and cooling (supply up to 50% of the energy demand) and (2) individual heat pumps where district heating and cooling cannot be applied (share around 45%). Heat Roadmap Europe also revealed that the use of bioenergy for heating and cooling supply does not need to be further increased as future resources might be reserved for other applications like producing biofuels or electricity. Inside the modelled future heat pump market, highly efficient applications like ground source heat pumps are required to avoid additional investments into peak load electrical capacities as well as into electrical grids – a threshold system COP of at least 3.5 is assumed in the HRE 2050 scenario. Moreover, around 25% of the heat produced in 2050 might result from recovered waste heat from space- and process cooling (2015: 7.3%).

THE GEOPLASMA-CE VISION FOR 2030 REGARDING SHALLOW GEOTHERMAL

The 2030 target indicators of the overall heat pump market in the range of 420 TWh heat produced for approximating the HRE2050 scenario is very likely to be achieved under the current conditions. The present growth rate of around +12%, which is dominated by air-based heat pumps, is well above the required rate of 10.4% to reach the target value. More efforts are need to be done to realise the demanded share of ground source heat pumps in the heating supply in 2030 requiring an expansion of the market by 7 times compared to 2018.

Major non-technological barriers for shallow geothermal energy use

- **Barrier 1:** Complex legal framework
- **Barrier 2:** Upfront investment costs
- **Barrier 3:** Low public awareness and missing political support
- **Barrier 4:** Limited access to detailed information
- **Barrier 5:** Limited access to qualified services
- **Barrier 6:** Lack of detailed market knowledge

We designed **three scenarios** for the possible growth of the shallow geothermal market in the EU until 2030 to evaluate the associated implications:

“Business as usual” scenario based on an extrapolation of the current growth rate of 6%.

“Participation” scenario” following the current growth rate of the overall heat pump market of 12%.

“GeoPLASMA-CE” scenario covering the required path to fulfil the 2030 target indicators requiring an average growth rate of +18% (almost 3 times of the current growth rate).

The **business as usual scenario** covers the actual market trend without further intervention by incentive-, informative or normative measures and will result to a further loss of market share of shallow geothermal in an air-based dominated heat pump market. The heat produced by ground source heat pumps will increase and double from 30 TWh in 2018 to 60 TWh in 2030. On the other hand, the shallow geothermal share inside the heat pump market regarding produced heat will decrease from around 21% in 2018 to around 14% in 2030.

THE GEOPLASMA-CE VISION FOR 2030 REGARDING SHALLOW GEOTHERMAL

The **participation scenario** leads to an increase of the heat produced by shallow geothermal in 2030 by a factor of almost four (heat production 2030 114 TWh). At the same time, the share of ground source inside the heat pump market slightly raises from around 21% in 2018 to 27% in 2030. Following this path, the system efficiency of heat pump based heating could be enhanced by around 3% leading to electricity savings in the EU of around 5 TWh per year.

The **GeoPLASMA-CE scenario,** which is capable to fulfil the 2030 target indicators, leads to a significant increase of the overall heat pump efficiency of around 9% and a reduction of the electricity consumption for heating of around 8 TWh/year.

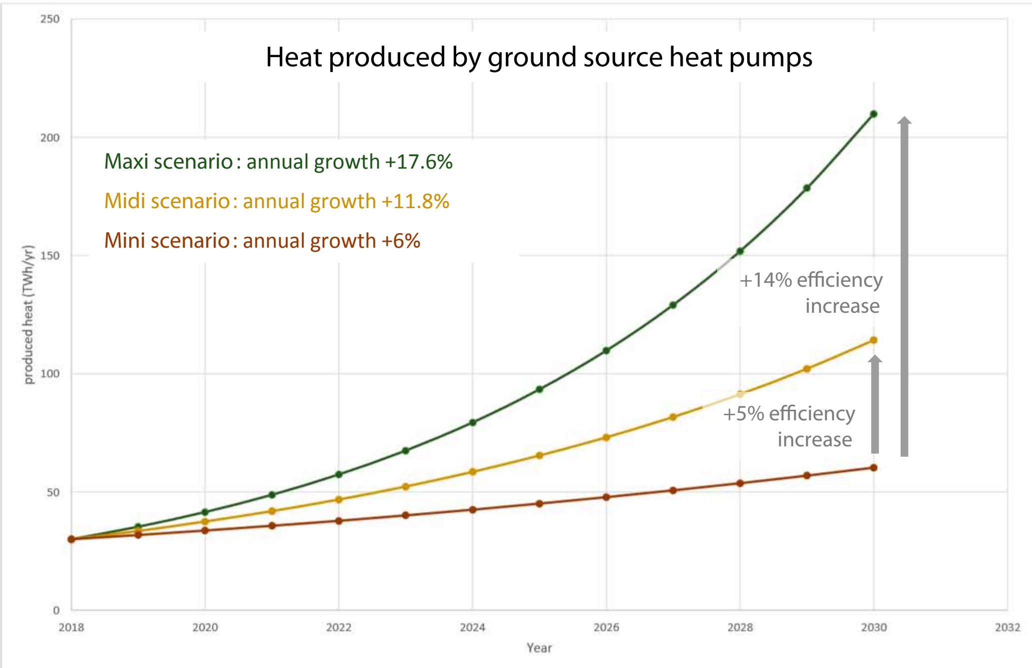
However, this scenario requires a redesign of the European heat pump – as well as the shallow geothermal market by intervention at a national as well as European level. **The major obstacles to overcome are however of non-technological nature!**

TIME TO ACT NOW

Shallow geothermal energy can significantly increase the efficiency of the heating and cooling of buildings and therefore supports the Clean Energy Package of the European Union. The required resources are just below our feet, but we need to unlock them.

As the next decade is crucial for the transition of the heating and cooling sector in Europe a new course needs to be set out now! Losing three years in boosting the shallow geothermal market might cost 20 to 60 TWh of heat produced in 2030.

THE GEOPLASMA-CE VISION FOR 2030 REGARDING SHALLOW GEOTHERMAL



Note: The increase of efficiency refers to expected seasonal performance factors of 3 for air- and 4 for ground source heat pumps.

HOW TO OVERCOME NON-TECHNOLGICAL BARRIERS

The GeoPLASMA-CE team identified **six major barriers** to overcome in order to achieve our vision of shallow geothermal energy use in 2030. The barriers are relevant to Central European countries and other Member States. **Note that these barriers are of a non-technological nature!**

The GeoPLASMA-CE coalition proposes solutions simple yet effective solutions to each non-technical barrier below:

HOW TO OVERCOME NON-TECHNOLGICAL BARRIERS

BARRIER 1 Complex legal framework

The legal framework referring to shallow geothermal energy in EU member states is often too complex and heterogeneous. It varies very much and depends on the country and region. In most countries, shallow geothermal is hardly recognised in the jurisdiction, which leads to anachronistic and thus inefficient legal framework. Diverse and complex legislation hampers the development of shallow geothermal resources and leads to time consuming licensing procedures by dispersion of responsibilities among authorities. This situation is uncomfortable for the investors, developers and users. Still, in several EU countries application of “one-stop-shop” concept as well as the e-government principle is insufficient.

Due to lacking energy concepts, licensing mostly follows the first come first served principle, which often results in a low efficiency of using the resource.

PROPOSED SOLUTIONS

- **Simplification and unification of legal regulations:** The national legal regulations and procedures should be simplified in order to become more straightforward and investor-friendly, developers and users by following the recommendations of the Renewable Energy Directive (RED). This includes utilisation of the ‘one-stop-shop’ concept, facilitated procedures for small-scale installations and limited response time for authorities.
- **Supporting administrative procedures and SGE licensing with development of e-government:** SGE licencing and other administrative procedures should be accessible via electronic means at all levels – from national to local. A possibility of on-line SGE licence application is crucial for the investors and developers. This will improve efficiency of the administrative bodies, shorten and ease the procedures. A facilitated communication between authorities also supports the exchange of data, for instance related to system monitoring, which in turn feed into updated resource maps and energy strategies provided by the communities themselves.

HOW TO OVERCOME NON-TECHNOLGICAL BARRIERS

- **Promoting a shift of paradigm towards integrative management concepts:** Linked to web infor-mation systems and e-government licensing and monitoring procedures, integrative management concepts prioritise energy efficiency- and environmental protection standards. By considering summation effects and abandoning the principle of first come first served, the overall sustainability of shallow geothermal use can be significantly improved at a local to regional scale.

BARRIER 2 — Upfront investment costs

The initial investment (CAPEX) related to shallow geothermal for individual heating and cooling is significantly higher than fossil fuels or competitive renewables like air-based heat pumps. In contrast, the operational costs (OPEX) are significantly lower. However, the current energy-economical boundary conditions, especially highly taxed electricity prices, lead to unfavourable payback periods and social exclusiveness. **Supporting the social inclusion of the energy transition, as demanded in the Clean Energy for all Europeans initiative, requires making shallow geothermal affordable for everyone by decoupling this technology from the income of households!**

PROPOSED SOLUTIONS

- **Collaborative use of shallow geothermal:** Support local heating and cooling networks to benefit from economic scaling of investments and empower households to prosumers (producers & consumers) based on fair and transparent contracting models.
- **Reduce CAPEX barriers:** Low interest loans for scale independent investment into shallow geothermal installations may significantly reduce barriers, as shallow geothermal systems well pay off considering the lifetime of the installations, which can be several decades for borehole heat exchangers. In addition to the installation of the ground heat source, financial incentives addressing the retrofitting of buildings should include the replacement of radiation-based heating systems into panel-based systems at low temperature levels.

- **Link incentives to system efficiencies:** Operational costs of shallow geothermal use are dominated by the consumption of electricity. In many regions, electricity is highly charged with fees to support renewable energy sources. OPEX related incentives therefore should address taxes and fees related to the use of electric energy in the heating cooling system. A simple and very effective way is to link tax- and fee reductions of electricity costs to proven system efficiencies, expressed by a seasonal performance factor of heat pump supported shallow geothermal utilizations. The same concept might be applied as well to initial investments (CAPEX).
- **Promoting a harmonized framework for national funding schemes:** A harmonized framework, provided by the EU to national funding schemes, supports fulfilling joint European strategies by amending the socio-economic implications and avoiding negative rebound effects. This includes a list of supportive measures acknowledged by the EU and joint schemes for evaluating the implications of funds towards national energy and climate strategies as well as towards unwanted rebound effects.

BARRIER 3 Low public awareness and missing political support

There is a general lack of awareness by decision makers of the multitude of solutions shallow geothermal provides to households, private and public buildings.

At national level, the European countries are in different phases of market development due to differences in socio-economic growth, but also in their attitude to climatic issues and use of fossil fuels in the context of promoting renewables. Consequently, shallow geothermal is hardly mention in National Energy and Climate Plans (NECPs), which are obligatory for each EU member state by 2020.

HOW TO OVERCOME NON-TECHNOLGICAL BARRIERS

PROPOSED SOLUTIONS

- **Provide strong support by dedicated interest groups on European- and national levels:** Dedicat-ed interest groups inside geothermal associations or technological federations help to raise the visibility and awareness of decision makers. A European umbrella organization may help to raise the impact of national groups.
- **Foster the acknowledgement shallow geothermal:** A list of supported renewable energy technol-ogies, provided by the EU Commission, would facilitate the harmonization of mandatory national energy and climate plans in the future and raise the awareness towards shallow geothermal.
- **Include shallow geothermal in energy strategies and energy planning tools:** If a technology is not mentioned, it simply disappears or lead to prejudged negative opinions ("it is not mentioned because it does not work"). There is still a little time left to promote shallow geothermal in NECPs. After 2020, focus may be put on promoting shallow to be included in spatial energy plans and follow-up strategies and action plans linked to NCEPs.
- **Initiate the effective information campaigns:** New forms of promotional and information campaigns on SGE should be executed, i.e. online marketing, information events on site, TV appearances led by known celebrities – "geothermal ambassadors" - for advocating geothermal energy use.
- **Promoting good practices and innovative solutions:** Making good practices accessible to decision makers and the public may lead to emulation and further growth. Public buildings act as important demonstrators for the technology.

BARRIER 4 Limited access to information

Access to information is the ability for an individual to seek and receive information in an easy and effective way. The correct and successful installation of a shallow geothermal system requires and depends on the investor obtaining the sound information and supportive data. This includes information about the proper handling of the technology, the spatial subsurface conditions and about available financial supports.

Although the geological surveys of the Member States conduct research and collect data related to shallow geothermal energy, these data are not always publicly available and translated into information for non-experts. Moreover, technical guidelines on the current state of the art and licensing requirements are often difficult to find on the internet. Until now, single point web access points to shallow geothermal are available in just a few European countries and regions.

PROPOSED SOLUTIONS

- **Harmonize the technical language and translate key values for non-geoscientists:** Technical terms describing available resources are still lacking harmonized definitions and calculation schemes. A joint European catalogue on reporting shallow geothermal resources may significantly help to standardize language. Furthermore, pure geoscientific resource indicators need to be translated into terms directly used by energy planners, architects of real estate developers (e.g. heat available per surface unit and year). The EU's Horizon research framework should facilitate harmonisation of definitions and calculations with the relevant trade associations.
- **Provide technical guidelines on the current state of the art:** Transferring international standards on planning, installation and operation to national guidelines helps enhancing the quality, efficiency and sustainability of shallow geothermal installations. These guidelines should be regularly updated in order to consider technological developments and changing environmental standards. These guidelines should be updated every five years by trade associations and possibly EU bodies such as the Joint Research Centre (JRC) to ensure effective dissemination. **Provide single point web access on shallow geothermal:** Web based information systems, which include spatial data on resources and limitation of use, are crucial to reduce informative barriers during the investment decision process. Efficient web systems provide intuitive and easy understandable

interfaces. Data queries for specific locations, which provide the results in electronic reports are highly efficient to attract energy consultants and investors. Moreover, web platforms should provide consolidated information on technical guidelines, licensing requirements and available financial supports. Member States should provide this service to fulfill their requirements for one-stop-shops under the RED II legislation.

BARRIER 5 Limited access to qualified services

A significant future expansion of shallow geothermal energy use cannot be realized without ensuring qualified services. These services cover on the one hand the planning & installation process and the operational service one the other hand and do not necessarily need to be provided by the same actor. However, reducing the needed interfaces for planning, installing and running geothermal installations is crucial to facilitate the access to service (“one stop shop”). Moreover, the market of providing services for the planning and installation of high-quality geothermal systems needs to grow accordingly to the future diffusion into the European heating and cooling market. Furthermore, operational services for running local heating and cooling grids are needed to overcome the gap of interests between real estate investors (low CAPEX) and consumers (low OPEX). **Shortcomings in the capacity of providing high quality services can be serious showstopper for shallow geothermal in the next decade!**

PROPOSED SOLUTIONS

- **Support standardised qualification schemes:** In accordance to Article 18 of the revised Renewable Energy Directive REDII (EU) 2018/2001, Member States should ensure certification schemes or equivalent qualification schemes are available for installers and that information on qualified services are available to the public. Annex IV of the directive regulates the minimum requirements for qualification schemes. Article 18 also requires that Member States shall recognise certifications awarded by other Member States. International platforms of competence like “Geotrainet” play an important role to disseminate and periodically update joint international qualification standards and should therefore be acknowledged by international and European entities to become an effective interface to national qualification procedures.

- **Support all in one hand services:** Reducing the number of companies to be contracted in order to realise a shallow geothermal installation makes this technology more attractive and competitive to other simple to install but less efficient renewable heating and cooling sources. This requires service providers, who have the competence for planning, installing including subsurface drilling and connecting the shallow geothermal installation to the heating and cooling facility. All in one hand services may reduce the number of companies involved from 3 or 4 to just 1 single. This requires financial and human resource capacities to run all in one hand services sustainable, efficient and at a high-quality level. Energy suppliers may become a key actor for such services. Targeted information and awareness raising campaigns are needed to unlock these business opportunities.
- Support a competitive heating and cooling market: Operating local heating and cooling grids sup-ported by shallow geothermal energy represent stable long-term business models. Public energy suppliers may represent a key-actor in this field but do not necessarily need to be the only one. In accordance to Article 24 of the RED II, public tenders for heating and cooling supply should emphasise planned efficiency performances as well as concepts for the inclusion of renewables. As it has been done for the electricity market in the past, an European initiative for liberalising the heating market, which allows for competition, may trigger investments into highly efficient and sustainable heating and cooling concepts.

BARRIER 6 — Lack of detailed market knowledge

It is crucial to have access to the full range of market data and statistics including stocks, sales and growth rates to effectively monitor and control target indicators. In the optimum case these statistics do not just refer to installed units but moreover cover thermal capacities as well produced- or stored heat. In contrast to other renewables, the exact number of installed shallow geothermal systems is not available in most EU countries leading which leads to estimates.

Market statistics in the annual EGEC Geothermal Market Reports mostly refer to sales numbers reported by the heat pump industry or deduced figures provided by national EGEC delegates. Sales numbers also include renovated heat pump systems and does not account for direct use of shallow geothermal (free cooling and heating or seasonal heat storage).

PROPOSED SOLUTIONS

- **Amend statistics provided by the heat pump industry:** Define harmonized methods for identifying the renovation rate inside the heat pump sales and provide guidelines The Horizon Research framework and/or the EU's JRC should rectify this barrier.
- **Introduce registers of shallow geothermal systems on regional and national levels:** Only a few countries have a legal framework, which requires an obligatory registering of shallow geothermal systems. We propose to include registers of installed shallow geothermal systems into environmental information directives on both, a European as well as national level, even in case they are not linked to a ground source heat pump. This could be achieved by adapting the Directive 2003/4/EC on public access to environmental information.
- **Statistics should focus on capacities and heat produced:** Statistics, which focus on units sold, do not fully reflect actual trends and the share of shallow geothermal in the renewable heating and cooling market. Therefore, the commissioned capacities and planned operational settings (annual production of heat or cold as well as storage sizes) should be included into registers of shallow geothermal installations.

IS YOUR REGION FIT TO BOOST SHALLOW GEOTHERMAL ENERGY?

Answer our checklist and see, which non-technological barriers need to be removed in your region!

Knowing the shallow geothermal market

- [ ] Are shallow geothermal installations licensed and registered? Are sold heat pump units registered considering installed capacities?
- [ ] Do you know the stock of already installed shallow geothermal systems referring to (1) units, (2) installed capacity and (3) produced heat? Do you have access to information on the exchange rate of abandoned heat pumps related to shallow geothermal?

Benefitting from awareness and political support

- [ ] Does a competence and interest group (e.g. geothermal association), which supports the use of shallow geothermal energy exist?
- [ ] Is shallow geothermal energy included or at least explicitly mentioned in energy strategies for the period 2021 to 2030?
- [ ] Are good practice examples and lighthouse projects for shallow geothermal made public?

Access to information

- [ ] Are guidelines providing the technological state of the art available?
- [ ] Is information on financial support for shallow geothermal energy use easily accessible?
- [ ] Are web platforms existing, which offer geoscientific information on resources and possible limitations related to shallow geothermal energy use?

Providing an efficient legal framework

- [ ] Are licensing procedures compliant to the “one-stop-shop” principle as required by the Renewable Energy Directive?
- [ ] Are e-government services offered for administrative procedures, including licensing and permits on shallow geothermal use?
- [ ] Are facilitated licensing procedures available for small scale SGE uses?
- [ ] Does the legal framework promote underground heat storage or the use of SGE in heating and cooling grids?

IS YOUR REGION FIT TO BOOST SHALLOW GEOTHERMAL ENERGY?

Providing financial incentives for social inclusion

- [ ] Are incentives available for supporting scale independent long-term investments in shallow geothermal (e.g. low interest loans)?
- [ ] Do incentives for renovation of buildings include the adaption of heat distribution systems?
- [ ] Are tax reductions available for highly efficient heat pump utilisations based on proven SPFs?
- [ ] Are business models existing for operating de-centralised heating and cooling grids supported by shallow geothermal?

Providing qualified services

- [ ] Are qualification schemes and certificates available for shallow geothermal installation?

NOTES

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Editors: Geological Survey of Austria: Gregor Goetzl; geoENERGIE Konzept GmbH: Ruediger Grimm

Involved GeoPLASMA-CE partners:

Geological Survey of Austria (LP): G. Goetzl (coordination); German Geothermal Association (PP02): J. Kaufhold, A. Deinhardt; geoENERGIE Konzept GmbH (PP03): R. Grimm, K. Zschoke; Saxon state agency for environment, agriculture and geology (PP04): M. Heiermann; Czech Geological Survey (PP05): Z. Bukovska; State Geological Institute of Dionýz Štúr (PP06): R. Černák; Geological Survey of Slovenia (PP07): M. Janža; Polish Geological Institute - National Research Institute (PP08): M. R. Kłonowski, W. Kozdrój; AGH University of Science and Technology (PP09): M. Hajto; City of Ljubljana (PP11): Š. Gregorin

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Contact:

Geological Survey of Austria (LP), Gregor Goetzl, Neulinggasse 38, 1030 Wien, Austria???
phone: +49 3731 294-1409??? **e-mail:** Gregor.Goetzl@geologie.ac.at

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