Smart energy systems

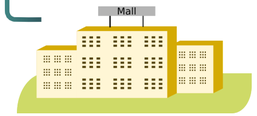
Shallow geothermal energy systems have an important role to play in smart cities and communities. These systems can be used in all parts of a city, at any scale, from individual single family houses to a whole city district as a part of a district heating/cooling network.

In **denser areas**, large geothermal seasonal storage systems are more competitive or even necessary to grant everyone access to underground heat/cold. Large systems can also be shared between buildings. In denser zones with large buildings/ systems less densely built zones nearby like parks can be used for the underground part of the shallow geothermal installation.

At a **city zone level**, there are several different aspects of shallow geothermal energy use to be considered, dependent on the area and its use. As an example, a small visual footprint and a low noise level (neither chimneys nor fan-coolers) is a benefit of shallow geothermal systems in general, however it is more important in areas where preservation is a key issue like an old town than it is for a new commercial centre. Other benefits in addition to low outdoor noise level and small visual impact are the lack of air polluting emissions elimination of the risks from legionella in evaporative roof coolers.

Smart Thermal Grid

In **sparse urban settlements** there is enough space between individual systems for a natural thermal recovery, while large systems needs to be thermally balanced for example by annually using as much heat as cold, or by recharging with a free source like a solar collector.



For more information on smart thermal grids and shallow geothermal in cities, consult the *ReGeoCities factsheets*

Visit

REGEOCITIES.eu

Geothermal heat pumps for heating and cooling

The heat under your feet

@heatunderurfeet

www.heatunderyourfeet.eu

Co-funded by the Intelligent Energy Europe Programme of the European Union

REGEOCITIES

Shallow geothermal in cities

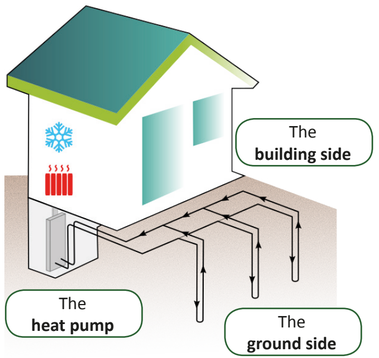
What can shallow geothermal do for you and your community?

Shallow geothermal energy is a local, renewable, efficient and versatile source which can provide buildings and industry with clean and competitive heating and cooling.

Available across Europe, shallow geothermal energy systems use the heat from the top layers of the earth (up to 400m) to supply heating, cooling and hot water to homes and businesses. More than 1 million ground source heat pumps are installed in the EU, with average energy savings of as much as 50% in winter and 40% in summer. For cooling, savings of up to 90% are possible.

How shallow geothermal systems work

Ground source heat pump systems have three main components:



There are two main types of system for heating and domestic hot water:

- **Open-loop systems**, where the main heat carrier, ground water, flows freely in the underground and is directly used through ground water wells.
- **Closed-loop systems**, which use several types of heat exchangers placed in the underground. There are several types of closed loops systems.

The low temperature in the ground can also be changed artificially by storage of heat or cold, creating geothermal energy storage: these systems are known as UTES, Underground Thermal Energy Storage systems. There are two types of UTES:

- Aquifer Thermal Energy Storage (ATES)
- Borehole Thermal Energy Storage (BTES)

The highest storage temperature achieved in geothermal energy systems is about 90°C, the lowest ca. 5°C.

Residential houses

For small houses, 1-2 borehole heat exchangers (BHE) or horizontal collectors (brine or direct expansion) are the best suited options. The installation is not visible from the outside, and the heat pumps do not require much space.

Offices and commercial buildings

For applications in the commercial sector, large borehole heat exchanger (BHE) fields or groundwater wells are the preferred groundside alternative. BHE are feasible virtually everywhere and promise maintenance-free operation, however their individual capacity is limited, so sometimes large fields are required if more than 100 BHE are used.

Groundwater wells can deliver much higher thermal output per well however they require specific geological site conditions and diligent well management.

Benefits

Shallow geothermal energy systems are ...

... Renewable

Using the clean, inexhaustible and local heat from the earth, shallow geothermal systems can supply heating and cooling 24 hours a day without producing emissions.

... Efficient

Geothermal heat pumps are one of the few heating technologies in the highest category of the new EU labelling system (A+++). The huge reduction in energy consumption leads to financial savings.

... Competitive

Despite its higher upfront cost, geothermal heat pumps guarantee a quick return on investment. Case studies demonstrate that a gas boiler becomes more expensive than the geothermal heat pump after less than 3 years of operation: this indicates that savings of a geothermal system can quickly compensate the costs of installation.

... Reliable

The heat pumps used in shallow geothermal systems have the lowest number of failures per installed unit compared to similar technologies, making systems easy and simple to maintain.

... Versatile

The end uses of shallow geothermal systems are varied: they can provide space heating and cooling, hot water, and energy storage. They can also be installed in buildings of various sizes and uses.

Costs and financing

The installation cost of shallow geothermal systems varies slightly depending on site conditions, whilst operational costs are affected by electricty and fuel prices, as well as the efficiency of the system.

The operation and maintenance costs are lower than those of conventional systems, however the initial installation cost is often higher. Overcoming this unusual expenditure curve, where most costs are concentrated at the beginning of a project, has been a barrier to shallow geothermal development.

Financial incentives schemes for geothermal heat pumps are not available in all European countries, although competition in the heating sector can be considered unfair with fossil fuels still receiving subsidies.

Financial support is still required in emerging markets, where they should be tailored for both individual and collective installations. Possible schemes are grants, tax reduction, loans with zero interest rates.

Developing shallow geothermal energy

Market

There are more than 1.3 Million GSHP installations in the EU, with a capacity of at least 17,700 MWth. The overall installation growth is steady for both UTES and GSHP. The countries with the highest amount of geothermal heat pumps are Sweden, Germany, France and Switzerland. These four countries alone account for ca. 65% of all installed capacity for shallow geothermal energy in Europe.

Looking at the time period 2010-2015, these four big players will have the greatest increase in terms of number of installations. In relative terms, Italy, Poland and the Czech Republic are among the countries with the highest growth rate.

Regulation

The regulatory system for shallow geothermal systems is, at present, complex and fragmentary. In many EU countries there is over regulation, in others there is none, whilst still more areas have disjointed procedures which need to be streamlined.

A number of studies have now been conducted, establishing where problems lie and how national, local, and regional authorities can improve and develop their regulatory regimes.

Detailed information about each stage of the regulation process and full recommendations can be found at *regeocities.eu*.

Action areas	Content	Authorities involved
Policy	Concerns the understanding and implementation of legislation, regulation, standards, and definitions	Local, national, and European Authorities
Permitting and Licencing	Different processes for small and large installations	Regional, municipal, and local Authorities
Construction	Concerns qualification and certification of professionals	European, national, and regional Authorities
Monitoring	Concerns data collection, performance monitoring, and future energy planning	National, regional, municipal Authorities
Information and Communication	Concerns understanding potential, energy savings potentials, communication information to the public, and impact on urban planning	National, regional, municipal Authorities