Geothermal energy integration into smart cities

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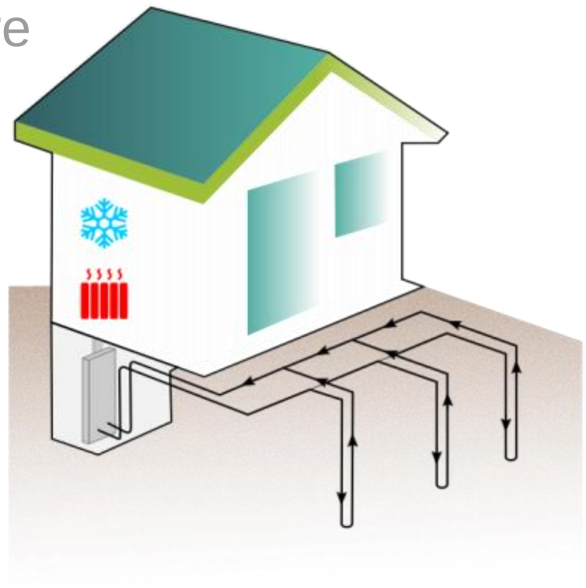
Topics

1. Technologies for the use of geothermal energy
2. Geothermal market and trends in Europe
3. Geothermal technologies for Smart Cities
4. Towards smart thermal grids

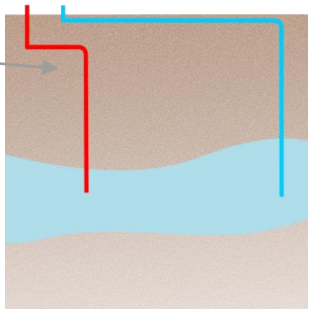
1. Technologies for the use of geothermal energy

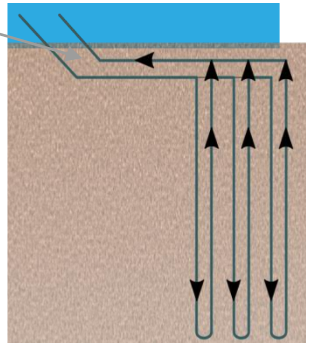
Shallow Geothermal Energy

Geothermal Heat Pumps are used to transport heat from low temperature sources to high temperature sources. They can work either in heating mode, or in cooling mode. The heat source / sink is the shallow underground, having rather low temperatures. The heat is extracted / injected by using various methods:



- horizontal loops
- borehole heat exchangers (BHE, vertical loops)
- energy piles
- ground water wells
- water from mines and tunnels
- other





1. Technologies for the use of geothermal energy

Shallow Geothermal Energy

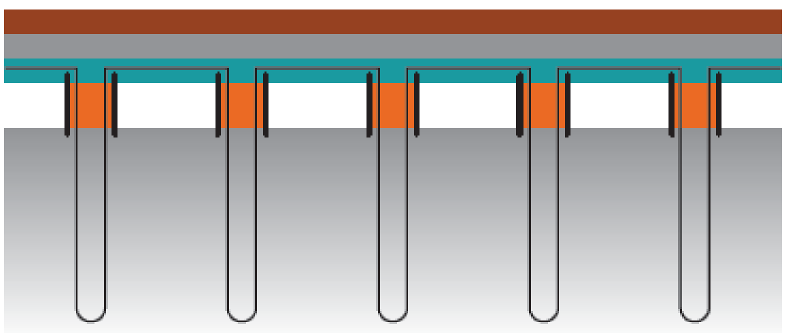
Underground Thermal Energy Storage (UTES)

The temperature in the underground is changed artificially by heat extraction or heat injection

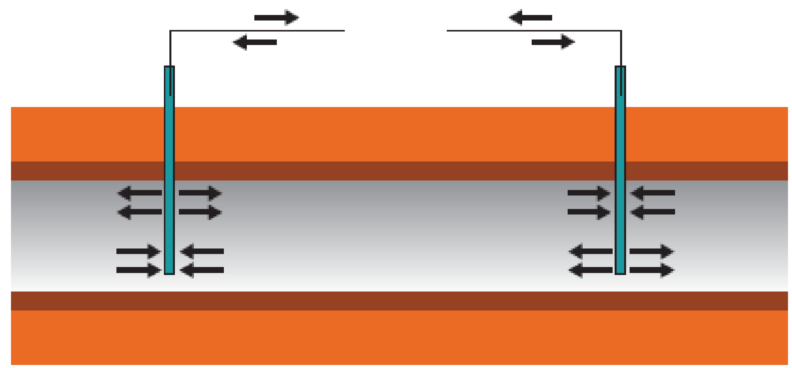
Two main methods*:*

- Use of groundwater for storage – ATES
- Use of the soil or rock mass for storage - BTES

BTES



ATES

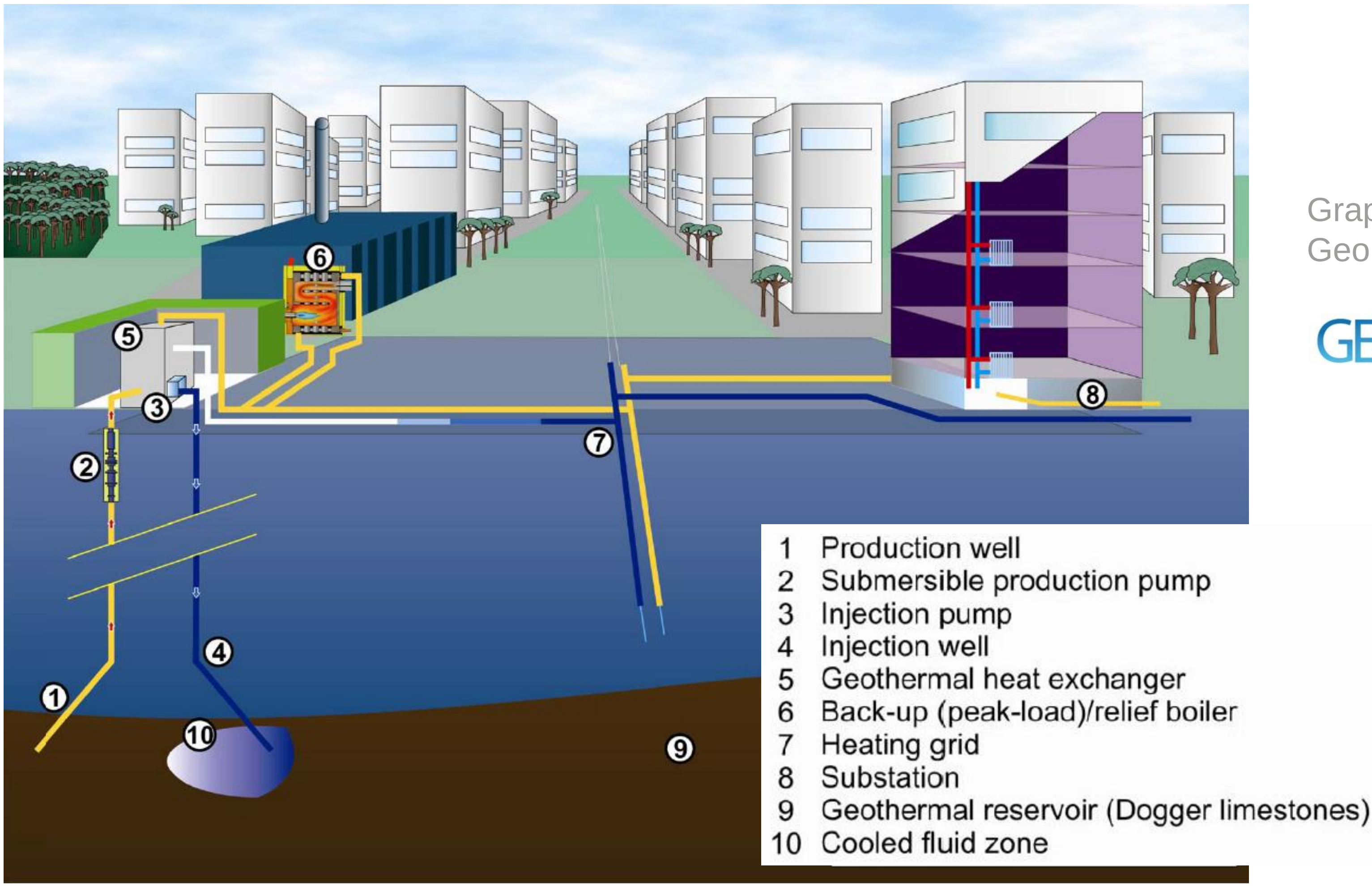


Graph from RHC-Platform – SRIA, 2013

1. Technologies for the use of geothermal energy

Deep Geothermal Resources – direct use of geothermal energy

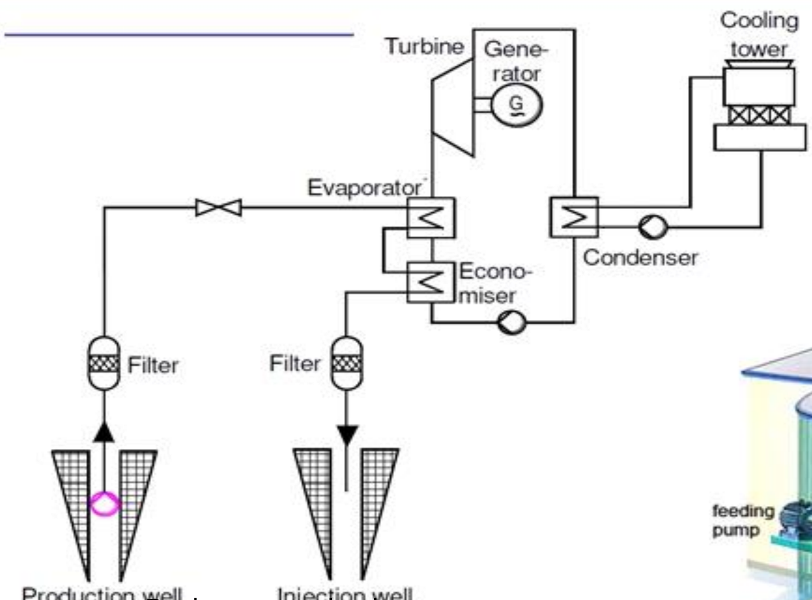
Generic schematic of geothermal district heating in Paris area, FR



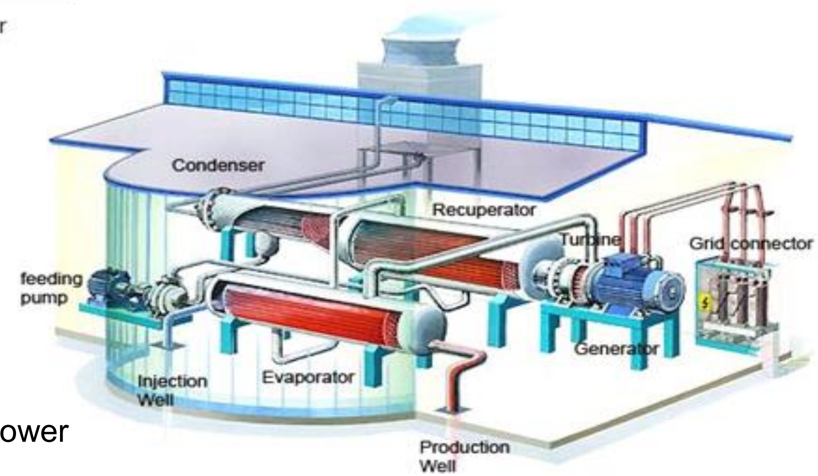
Graph: GeoDH-project

1. Technologies for the use of geothermal energy

Deep Geothermal Resources – electricity production through ORC



Basic system circuit



Geothermal ORC plant

- most commonly used process for geothermal power generation
- closed system: external cooling tower in peripheral circuit

1. Technologies for the use of geothermal energy

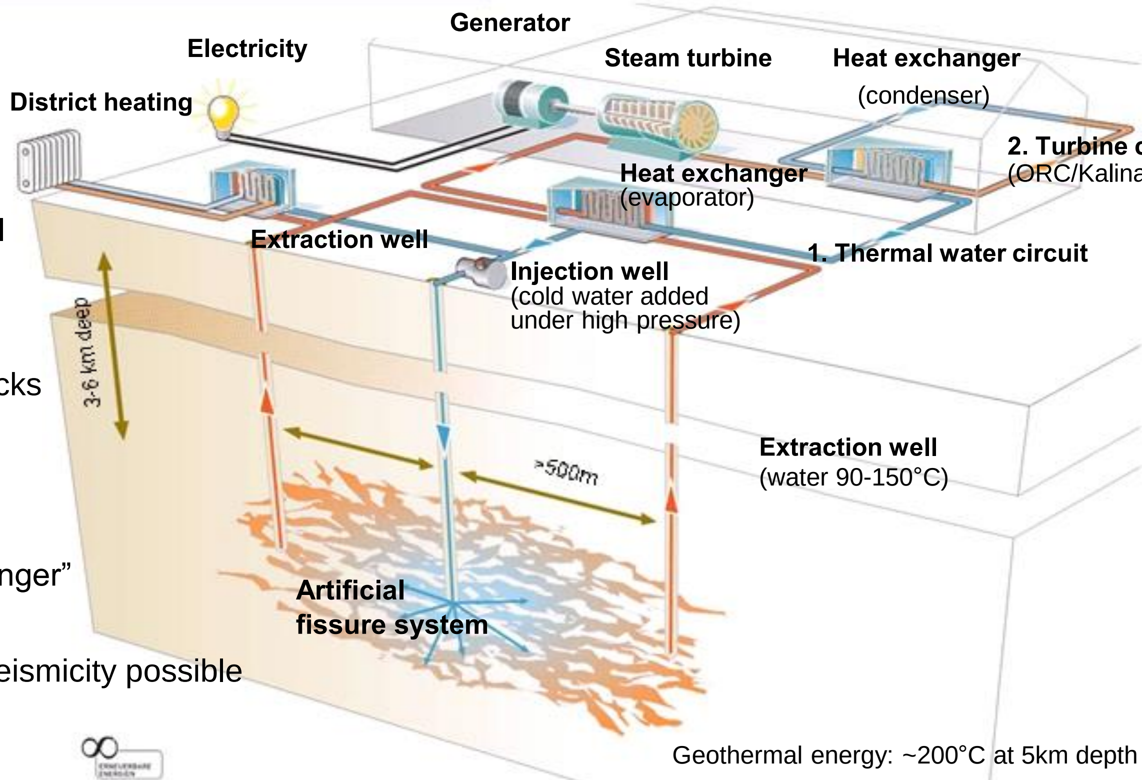
Deep Geothermal Resources – EGS (Enhanced Geothermal Systems)

Enhanced Geothermal Systems (EGS)

• hydraulic & chemical stimulation produce cracks and fissures in the rock

• increase of water permeability
→ “artificial heat exchanger”

Problem: triggering of seismicity possible



Geothermal energy: ~200°C at 5km depth

http://www.unendlich-viel-energie.de/

2. Geothermal DH market and trends in Europe

State of Play in 2015

- Total Installed Capacity in Europe: 4701.7 MWth

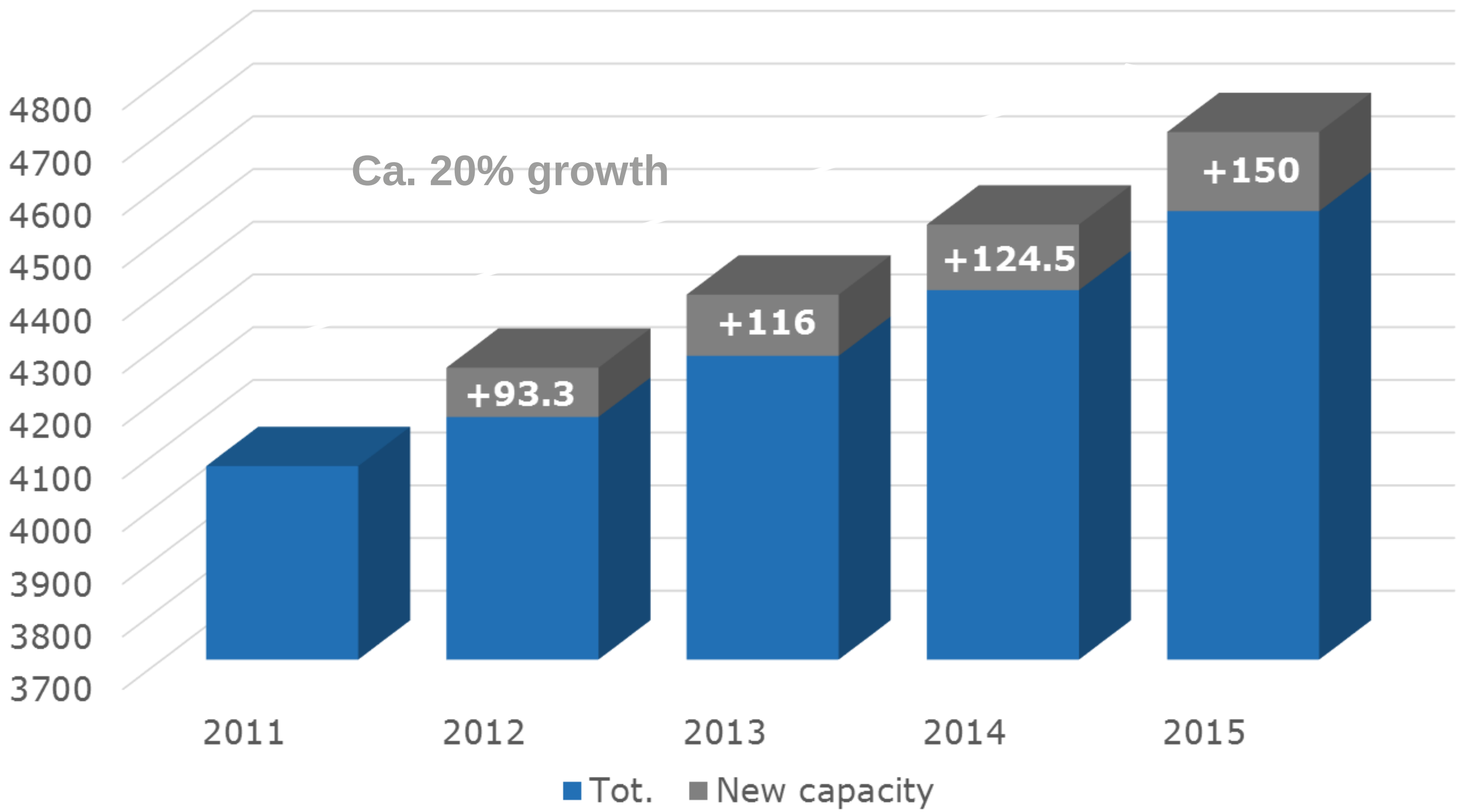
257 Geothermal DH Plants

- 23 new district heating plants were commissioned in 2014 and 2015

(Data according to EGEC Market Report 2015)

EGEC GEOTHERMAL

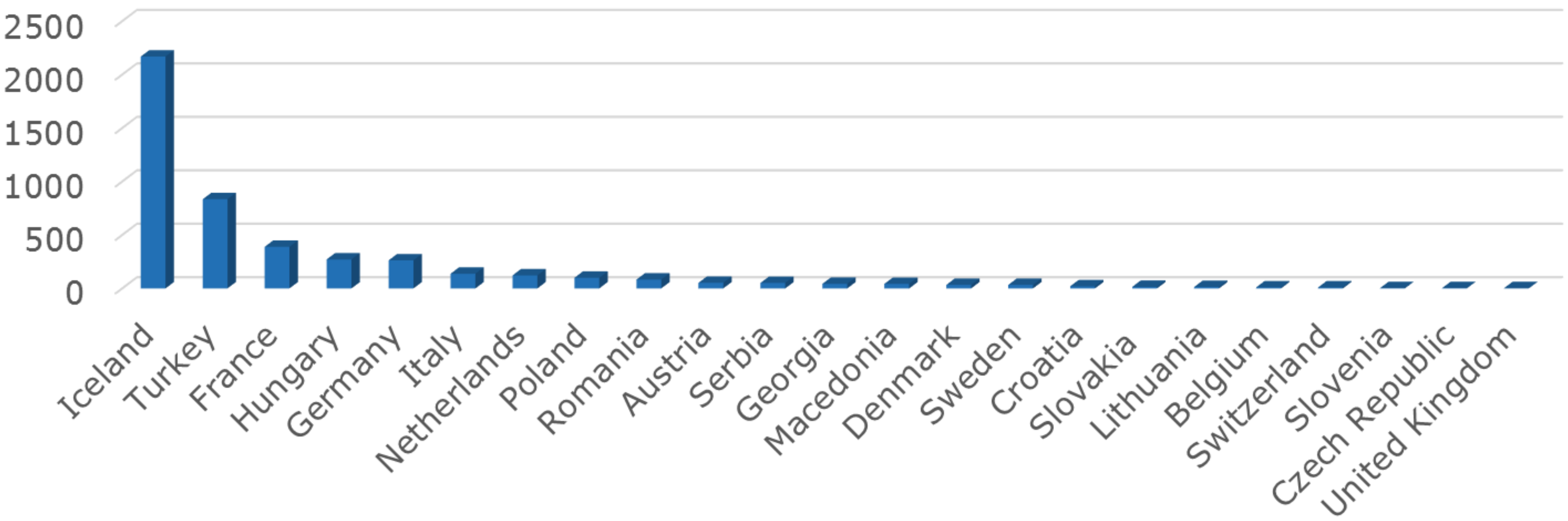
2. Geothermal DH market and trends in Europe



Cumulative installed capacity in Europe 2011- 2015 (MWth)
(data according to EGEC Market report 2015)

2. Geothermal DH market and trends in Europe

Installed Capacity per Country

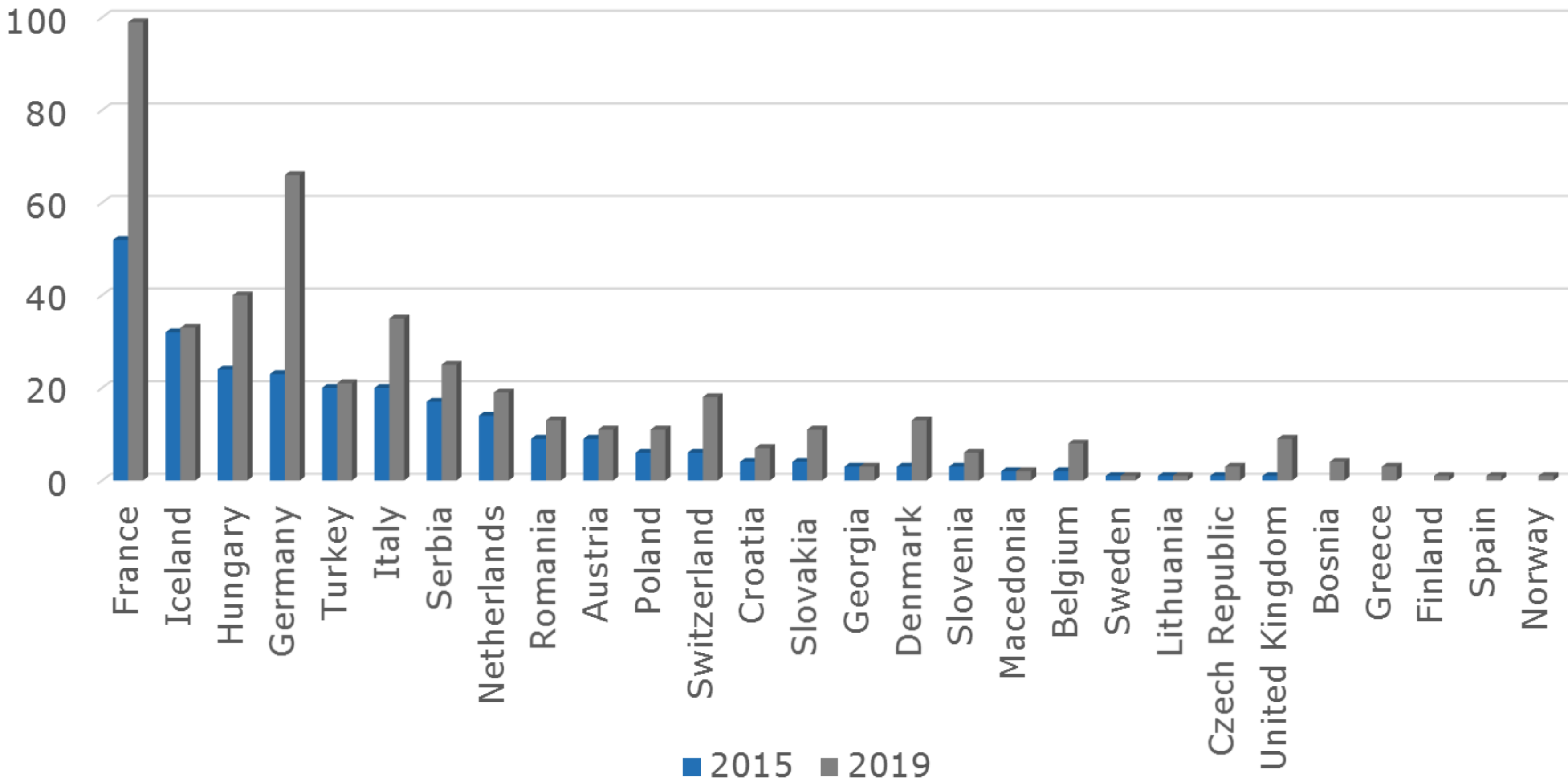


Geothermal DH capacity installed in Europe, per country in 2015 (MWth)

(data according to EGEC Market report 2015)

2. Geothermal DH market and trends in Europe

Number of GeoDH systems



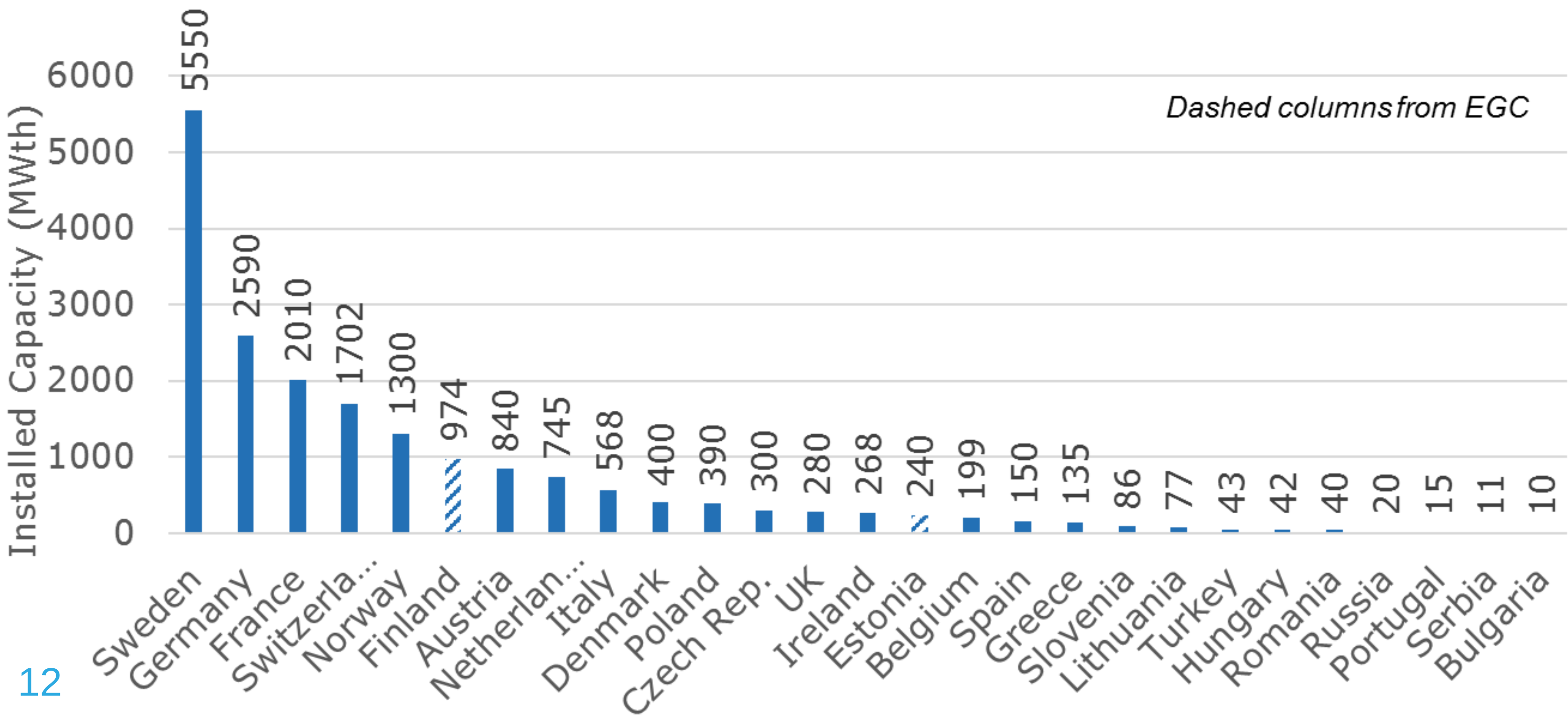
Number of geoDH systems in Europe in 2015 and 2019
(data according to EGEC Market report 2015)

2. Geothermal DH market and trends in Europe

Summary of Key Conclusions

State of Play in 2014

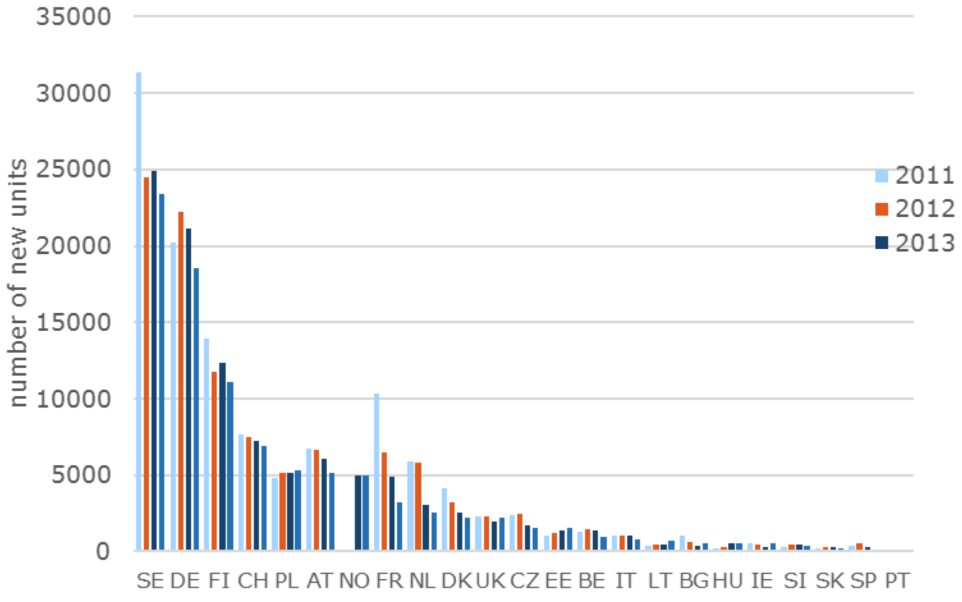
- Total Installed Capacity in Europe: ca.19000 MWth
- Five countries alone account for ca 69% of all installed capacity in Europe

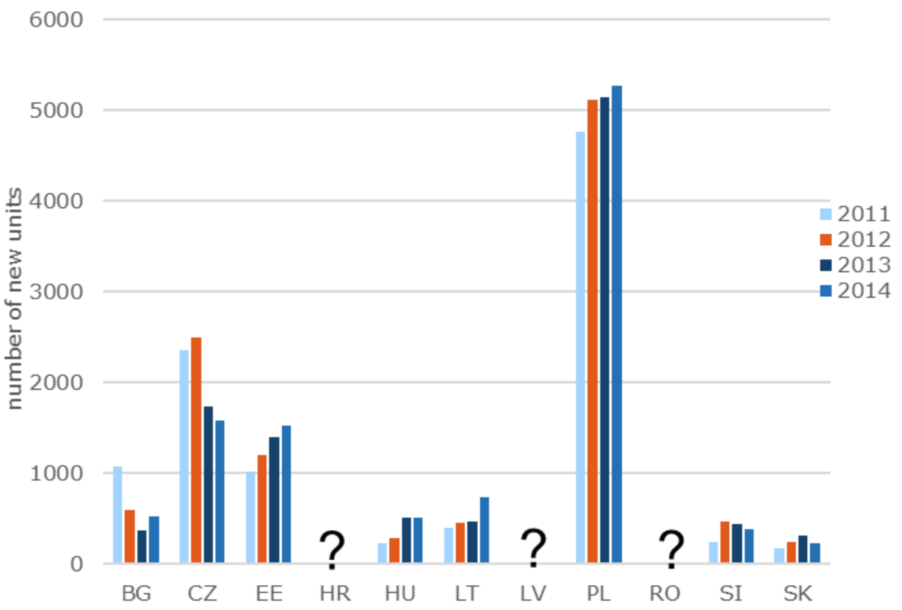


2. Geothermal DH market and trends in Europe

Summary of Key Conclusions

More than 1.4 Mio GSHP installed





Sales numbers for geothermal heat pumps in Europe, for EU countries and countries from Central and Eastern Europe (according to EGEC Market report 2015)

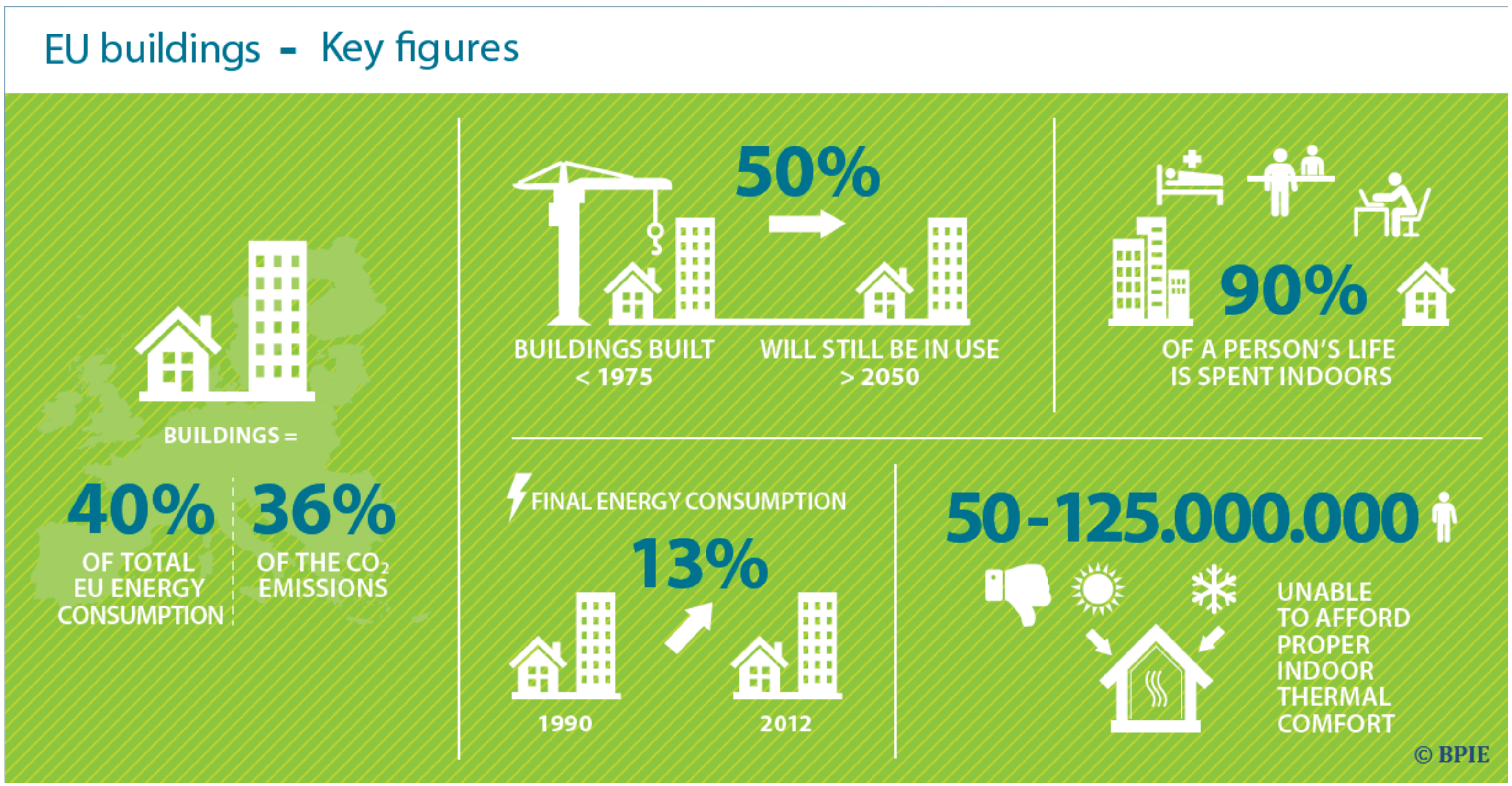
3. Geothermal technologies for Smart Cities and Communities

Urban density

About 3/4 of the population in Europe lives in and around urban areas, consuming 70% of the EU energy and emitting about the same share of greenhouse gases and the trend is rising…

Sustainable Buildings

75% of the EU building stock is energy inefficient…



3. Geothermal technologies for Smart Cities and Communities

Contribution to the 2nd generation, smart thermal grids

renewable, intelligent and efficient

- Geothermal HP for individual and tertiary buildings
- Geothermal DH and other direct uses
- Geothermal CHP

+

- connection to electricity
- Storage: UTES (BTES or ATES)

3. Geothermal technologies for Smart Cities and Communities

Geothermal HP for individual and tertiary buildings

- for low-temperature heating and cooling

UTES: BTES or ATES

- for heat or cold storage (low and medium temperature)

Geothermal DH and other direct uses

- for low to medium temperature heating
- for district cooling via absorption chillers

Geothermal CHP

- for medium to high temperature heating
- for electricity

Smart Cities Stakeholder Platform

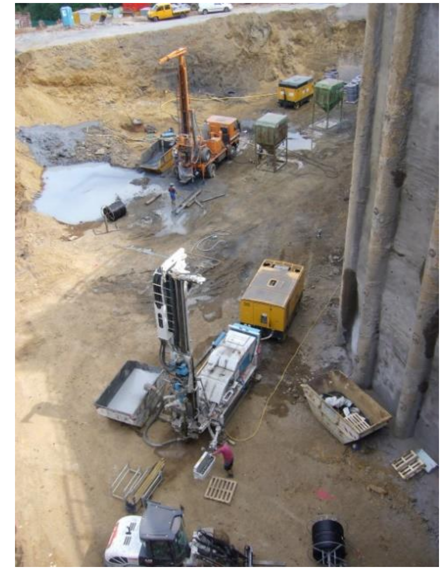
3. Geothermal technologies for Smart Cities and Communities

Shallow geothermal in cities

Cities show specific environment and problems

A specific challenge for large plants with borehole heat exchangers (BHE) is drilling in given area and timeframe; often drilling on site of later building

Drilling with 3 rigs simultaneously within city limits



Drilling in construction pit

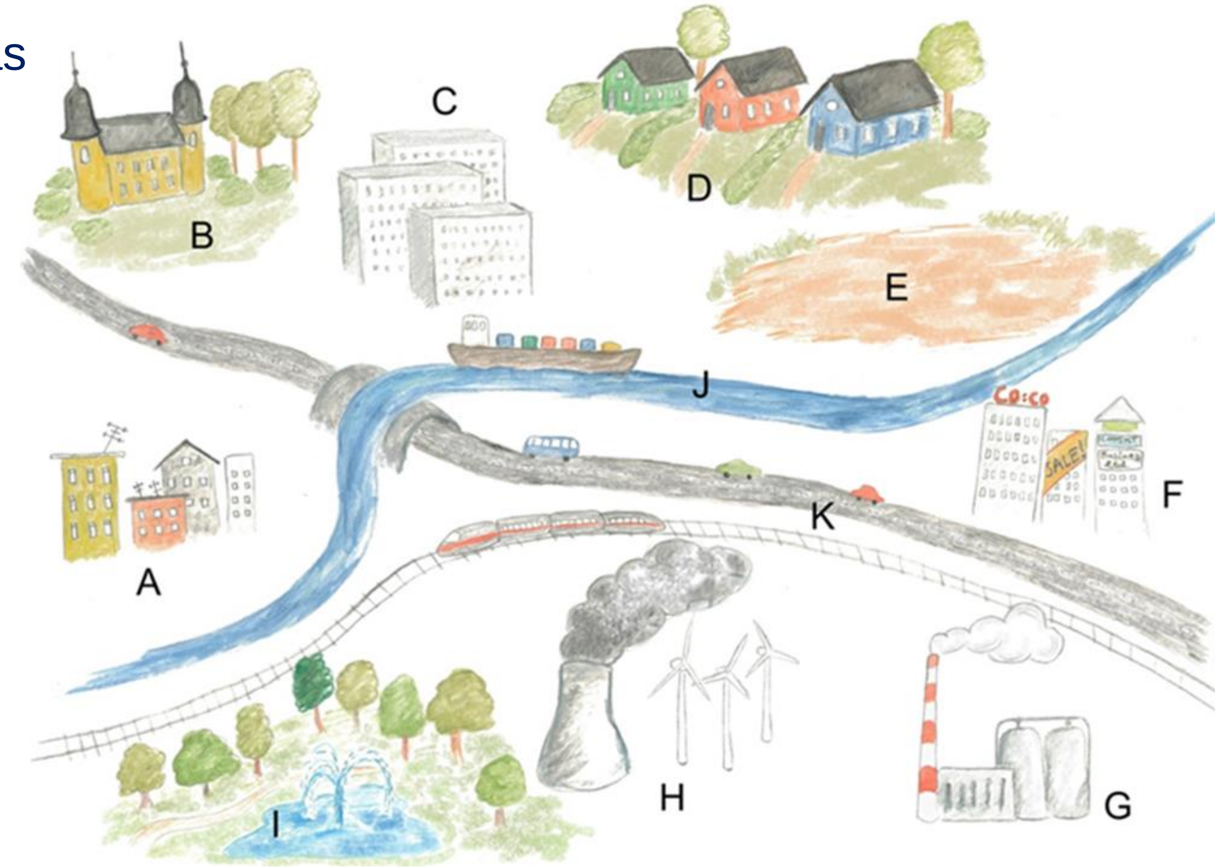
Drilling for supermarket

3. Geothermal technologies for Smart Cities and Communities

Business models, the challenge

HOW ? Integration of geothermal systems in cities and in buildings

- RES Heating & Cooling and Energy Efficiency in DH and for small-scale installations
- In dense urban areas and isolated places
- For buildings and the industry



4. Towards smart thermal grids

Geothermal HP for individual and tertiary buildings

- for low-temperature heating and cooling

UTES: BTES or ATES

- for heat or cold storage (low and medium temperature)

Geothermal DH and other direct uses

- for low to medium temperature heating
- for district cooling via absorption chillers

Geothermal CHP

- for medium to high temperature heating
- for electricity

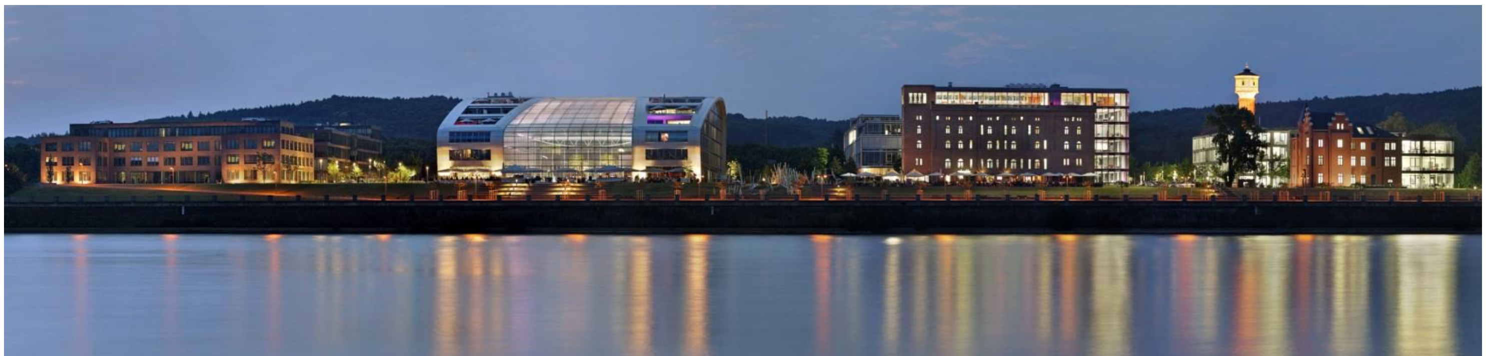
Small Thermal Grids using Geothermal Energy in Riverside Development in Bonn, DE

Photos und Graphs: UBeG / BonnVisio - Bonner Bogen

4. Towards smart thermal grids

1st generation of Small Thermal Grids using Geothermal Energy

Riverside Development in Bonn, DE



Groundwater heat pump, 6 wells

Providing about 1 MW baseload for heating and cooling

heat exchangers, heat pumps, distribution grid

Photos: BonnVisio - Bonner Bogen

4. Towards smart thermal grids

1^{st} generation of Small Thermal Grids using Geothermal Energy

Heat and Cold Production in Paris, FR

Issue: supply heat and cold to buildings where heated/cooled areas exceed land availability

144 Rue de Rivoli, Paris

Louvre district

7000 m² (offices + shops)

470 kW_{th} heating

850 kW_{th} cooling

Groundwater wells

Balanced consumption, with consideration of COPs of the heat pumps

4. Towards smart thermal grids

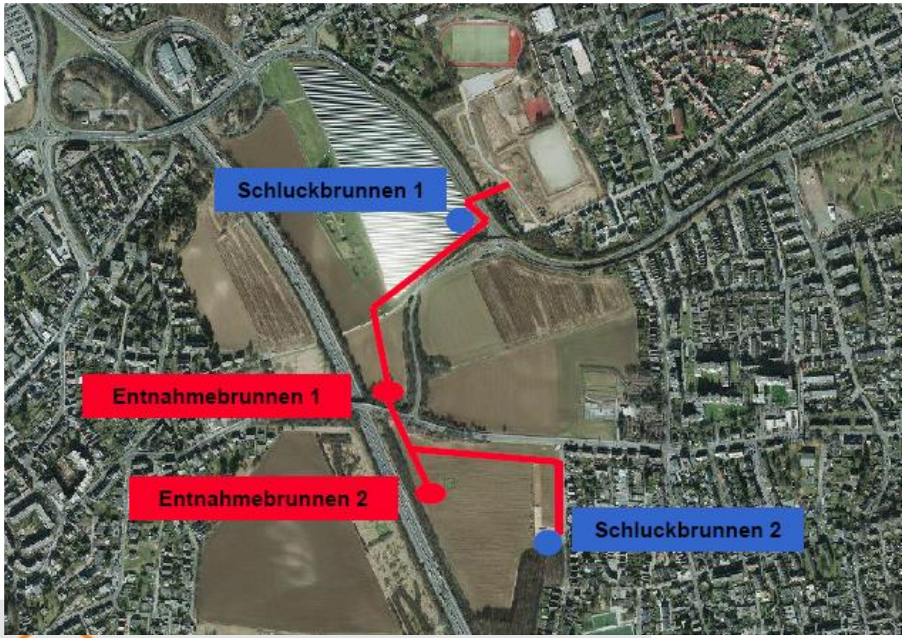
1st generation of Small Thermal Grids using Geothermal Energy

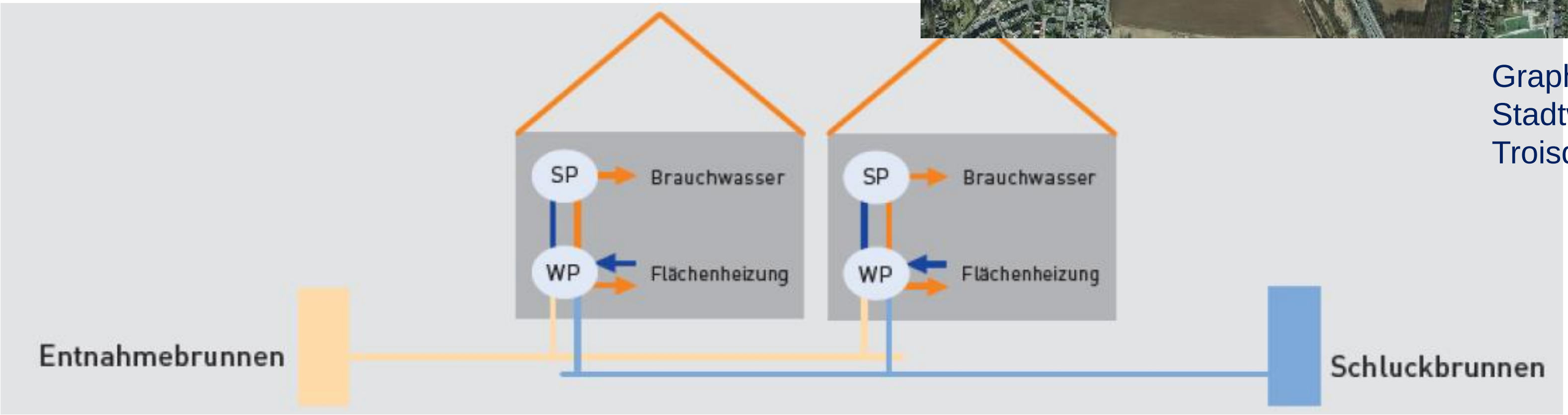
"Cold" District Heating in Troisdorf, DE

Groundwater is circulated to two new residential development areas (ca 5 km plastic pipe)

Individual heat pumps in the houses (ca 100) use the circuit as heat source and -sink

Operation started 2014



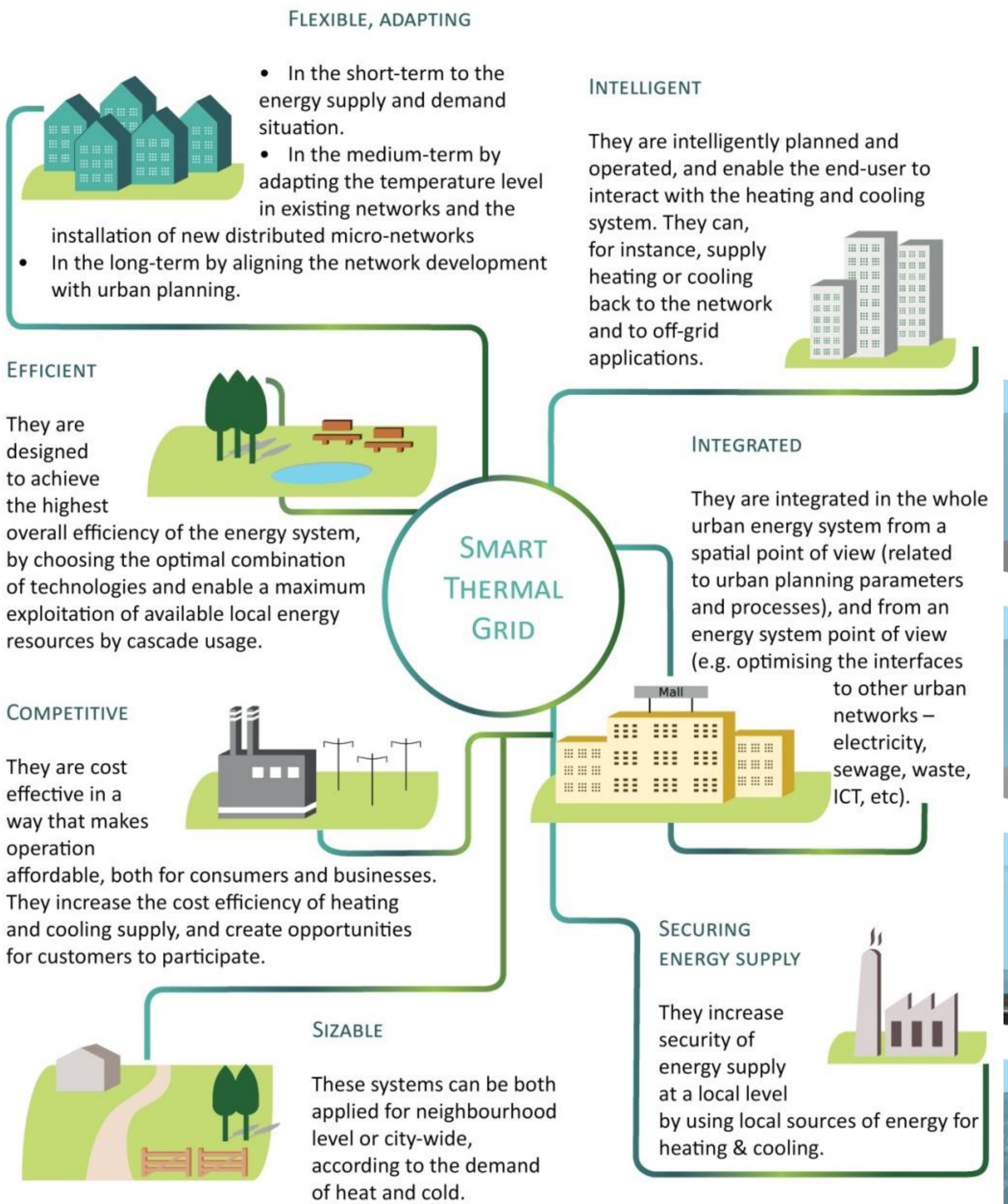


Graphs: Stadtwerke Troisdorf

4. Towards smart thermal grids

Towards the 2nd generation of Small Thermal Grids using Geothermal Energy

- Flexible and adapting
- Intelligent
- Efficient
- Integrated
- Competitive
- Sizable
- Securing Energy Supply



4. Towards smart thermal grids

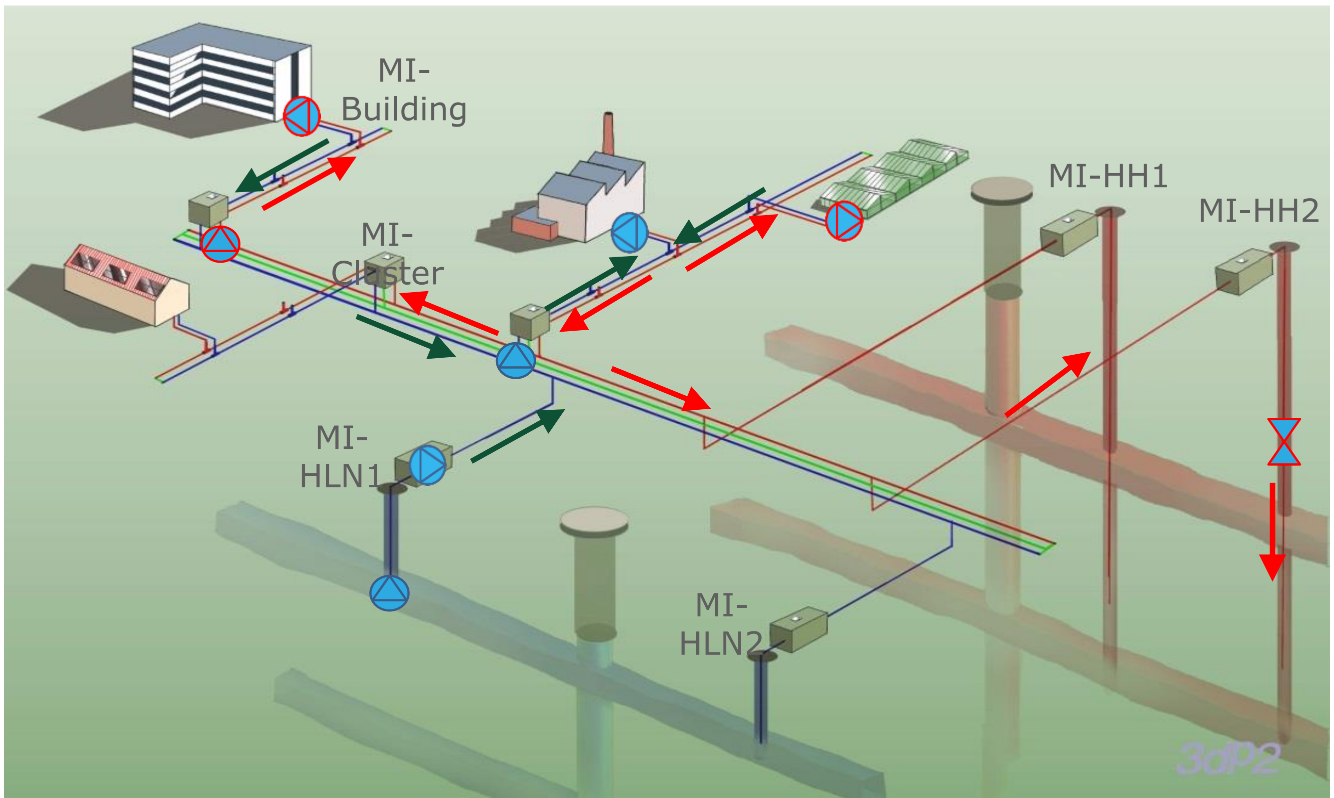
2nd generation of Small Thermal Grids using Geothermal Energy

Example of thermal grid based on mine water

Several development stages towards a smart grid

Minewater 2.0

Mijnwater B.V.

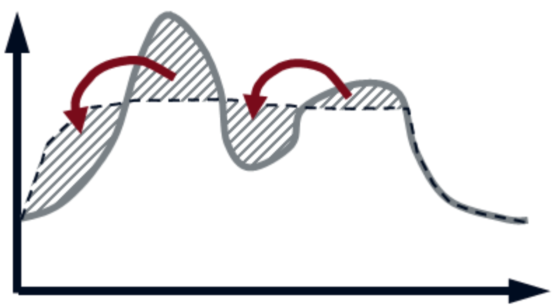


Artist impression Minewater 2.0

4. Towards smart thermal grids

2nd generation of Small Thermal Grids using Geothermal Energy

adjusting the network development with urban planning processes

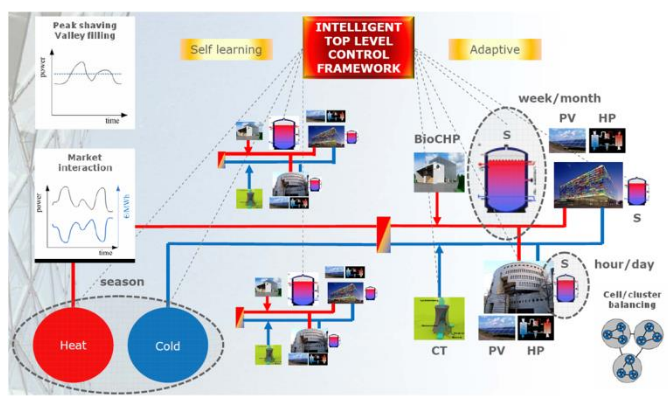


Graphs: Deltares

supply and demand side management

adapting the temperature level in the network

Intelligent and integrated



4. Towards smart thermal grids

The next stage: smart energy grids

Combination of heat/cold and electricity:

- Storing excess electricity in form of heat
- an idea for the power grid, “smart-grid ready” an issue e.g. in Germany, but how the integration in thermal grids works?

Combination of energy grid and communication:

- using common infrastructure

Combination with transport?

- electric cars as power storage, and what else?

The key issues to make smart energy grids work:

- develop the right system architecture
- develop the operation strategies and control hardware + software

Smart Cities Stakeholder Platform

ROMANIA

Geothermal Energy Use

Robert Gavriliuc, Marcel Rosca, Radu Polizu, Doina Cucueteanu

DEEP GEOTHERMAL ENERGY RESOURCES AND EXPLOITATION

The geothermal systems discovered on the Romanian territory are located in porous permeable formations such as Pannonian sandstone, interbedded with clays and shales specific for the Western Plain, and Senonian specific for the Olt Valley. Some geothermal systems are located in fractured carbonate formations of Triassic age in the basement of the Pannonian Basin (Oradea, Bors, Beius), and of Malm-Aptian age in the Moesian Platform (North Bucharest) – see Figure 1.

The total capacity of the existing wells is about 480 MWt (for a reference temperature of 25°C). Of these total, currently only 96 wells are used (of which 40 only for balneology and bathing), that are producing hot water in the temperature range of 40÷115°C, equivalent of 200 MW_{th}. For 2015, the annual energy utilisation from these wells was about 400 GWh.

The main direct uses of the geothermal energy are: space and district heating; bathing; greenhouse heating; industrial process heat, and fish farming.

1.2 Main geothermal reservoirs

The Pannonian geothermal aquifer is multilayered, confined and is located in the sandstones at the basement of the Upper Pannonian (late Neocene age), on an approximate area of 2,500 km² along the Western border of Romania, from Satu Mare in the North to Timisoara and Jimbolia in the South. The aquifer is situated at the depth of 800 to 2,400 m. It was investigated by more than 100 geothermal wells, all possible producers, out of which 37 are currently exploited. The thermal gradient is 45¸55°C/km. The wellhead temperatures range between 50 and 85°C. The mineralisation (TDS) of the geothermal waters is 4¸5 g/l (sodium-bicarbonate-chloride type) and most of the waters show carbonate scaling, prevented by downhole chemical inhibition. The combustible gases, mainly methane, are separated from the geothermal water and not used (yet). The wells are produced mainly artesian, and very few of them with downhole pumps.

The main geothermal areas are - from North to South - Satu Mare, Tasnad, Acas, Marghita, Sacuieni, Salonta, Curtici-Macea-Dorobanti, Nadlac, Lovrin, Tomnatic, Sannicolau Mare, Jimbolia and Timisoara. The main uses are: heating of about 10 hectares of greenhouses; district heating for about 2,500 flats, only sanitary hot water supply for 2,200 flats, health and recreational bathing, and fish farming. Other applications, such as ceramics drying, timber drying; hemp and flax processing, went broke and stopped operations (Bendea and Rosca, 1999).

The Oradea-Felix Spa geothermal reservoir is located in the Triassic limestones and dolomites at depths of 2,200¸3,200 m, on an area of about 75 km², and it is exploited by 12 wells with a total potential flow rate of 140 l/s geothermal water with well head temperatures of 70¸105°C. There are no dissolved gases, the mineralisation is 0.9¸1.2 g/l, the water being of calcium-sulphate-bicarbonate type. The water in the Oradea reservoir is about 20,000 years old and the recharge area is in the Northern edge of the Padurea Craiului Mountains and the Borod Basin. Although there is a significant recharge of the geothermal system, the exploitation with a total flow rate of over 300 l/s generates pressure draw down in the system that is prevented by reinjection. Reinjection is the result of successful completion and beginning operation of the first doublet in the Nufarul district in Oradea city, in October 1992 (Lund, 1997). The new well drilled in 2016 (project financed by the EEA Grants and the Romanian Environmental Fund Administration in the RONDINE programme) is 2,900 m deep. After acidizing, it produced in artesian discharge 38 l/s geothermal water with a well head temperature of 80°C. This well is intended to be used for reinjecting the heat depleted geothermal water produced by the well in the University of Oradea campus (about 1.2 km away).

The Bors geothermal reservoir is situated about 6 km north-west of Oradea. This reservoir is completely different from the Oradea reservoir, although both are located in fissured carbonate formations. The Bors reservoir is a tectonically closed aquifer, with a small surface area of 12 km². The geothermal water has 13 g/l TDS, 5 Nm³/m³ GWR, and a high scaling potential, prevented by chemical inhibition. Dissolved gasses are 70% CO_2 and 30% CH_4. The reservoir temperature is higher than 130°C at an average depth of 2,500 m. The installed power is about 8 MW_t, and the annual energy savings was about 3,000 toe. In 2014 one well was put in production for heating a metal factory located in Bors industrial park. The well is used in artesian flow, with 3 l/s and the well head temperature does not exceed 85°C (even if at the maximum artesian flow 15 l/s the well head temperature is over 110°C).

The Beius geothermal reservoir is situated about 60 km south-east of Oradea. The reservoir is located in fissured Triassic calcite and dolomite 1,870 – 2,370 m deep. The first well has been drilled in 1996, down to 2,576 m. A line shaft pump was set in the well in 1999, now producing up to 45 l/s geothermal water with 72°C wellhead temperature. A second well has been drilled in early 2004, and a line shaft pump was being installed later that year and can also produce up to 45 l/s geothermal water with 85°C wellhead temperature. The geothermal water from these wells has a low mineralization (462 mg/l TDS), and 22.13 mg/l NCG, mainly CO_2 and 0.01 mg/l of H_2S. The geothermal water from both wells is currently used to supply district heating to part of the town of Beius (for a district heating system with 22 substations supplying a block of flats area, two hospitals, two schools, public buildings, for heating system of many individual houses in open loop, swimming pool, etc.).

The Sacuieni geothermal reservoir is located in the Pannonian sandstones at 1,800 – 2.200 m depth, The main dissolved gas is CH_4, the GWR being 0,9 Nm³/m³. In Sacuieni there are 8 geothermal wells, of which 3 are in production. The wells are exploited in artesian flow and the geothermal water is treated with inhibitors against scaling. The geothermal water is used for heating purposes in the block of flats down town, the city hall, schools, kindergarten, individual houses, public institutions.

Figure 1. Location of the main deep geothermal energy resources of Romania (including the Bucharest reservoir)

1.2 Main geothermal reservoirs

The Cozia-Calimanesti geothermal reservoir (Olt Valley) produces artesian geothermal water, with flow rates between 8.5 and 22 l/s, and shut-in wellhead pressures of 30¸33 bar, from fissured siltstones of Senonian age. The reservoir depth is 2,700-3,250 m, the well head temperature is 70¸95°C, the TDS is 15.7 g/l, and there is no major scaling. Although the reservoir was exploited for more than 25 years, there is no interference between the wells and no significant pressure draw down. The thermal potential possible to be achieved from the 4 wells is about 14 MW_t (of which 3.5 MW_t from the combustible gases – if used), but only about 7 MW_t is used at present. The energy equivalent gained in this way is 3,500 toe/year. The geothermal water is mainly used for district heating (2,250 equivalent flats), and for health and recreational bathing.

The Otopeni geothermal reservoir is located North to Bucharest. It is only partially delimited (about 300 km²). The 7 drilled wells (all potential producers or injectors) show a huge aquifer located in fissured limestone and dolomites, situated at a depth of 2,000¸3,200 m, belonging to the Moesian Platform. The geothermal water has wellhead temperatures of 58¸84°C, and a rather high TDS (1.5¸2.2 g/l), with a high H_2S content (up to 30 ppm), reinjection being compulsory for environmental protection. The production was carried out in the Otopeni area using downhole pumps, because the water level in the wells is at 80 m below surface. The total flow rate was 22¸28 l/s. At present, one well is in use (up to 3.5 l/s), almost all year round, for health and recreational bathing. The new well, drilled in 2016, is 3140 m deep. A line shaft pump has been launched into the well, that can produce up to 32 l/s. Up to 25 l/s will be used for a small district heating system for a hospital complex in the vicinity. Based on recent research and hidro-geological tests of FORADEX, there is, apart from the known Otopeni reservoir, another shallower aquifer located at a depth of 800÷1000m and with a wellhead temperature of about 40°C (currently unused), which lays under the entire area of Bucharest, with important expansion toward south, called the "Bucharest geothermal".

Locality	Plant Name	Year comm.	No of units	Status	Type	Total inst. Capacity (MW_e)	Total running cap. (MW_e)	2015 product. (GWh_e/y)
Oradea	CE Iosia Nord	nov.2012	1	O	B-ORC	0.05	0.05	0.4
total			**1**			**0.05**	**0.05**	**0.4**

Key for status:		Key for type:			
O	Operating	D	Dry Steam	B-ORC	Binary (ORC)
N	Not operating (temporarily)	1F	Single Flash	B-Kal	Binary (Kalina)
R	Retired	2F	Double Flash	O	Other

Table D: Existing geothermal district heating (DH) plants

Locality	Plant Name	Year commiss	Installed geother. capacity (MW_{th})	Total installed capacity (MW_{th})	2015 geo-thermal heat prod. (GWh_t/y)	Geother. share in total prod. (%)
Oradea	Iosia Nord	2005	19	24.2	25	78.5
Oradea	Nufarul	1992	5	5	10	100
Oradea	Calea Aradului	2002	1.6	1.6	3.9	100
Beius	Beius	2001	21	21	25.6	100
Sannicolau	Sannicolau	1980's	2.7	2.7	3.3	100
Saravale	Saravale	1980's	1.34	1.34	2.21	100
Lovrin	Lovrin	1980's	1.44	1.44	2.16	100
Jimbolia	Jimbolia	1980's	1.44	1.44	2.85	100
Teremia	Teremia	1980's	1.88	1.88	3.45	100
Calimanesti	Calimanesti	1980's	10.73	10.73	18.7	100
Otopeni*	Otopeni	1980's	10.6	10.6	17.67	100
Moara Vlasiei	Moara Vlasiei	1980's	29.9	29.9	33.5	100
total			**106.63**	**111.83**	**148.34**	

geothermal energy

	in 2015		Expected in 2018	
	Investment (million €)	Personnel (number)	Investment (million €)	Personnel (number)
Geothermal electric power	0.2	3		
Geothermal direct uses	0.5	6	8	7
Shallow geothermal	1.0*	20	5.0**	50**
total	**1.8**	**31**	**25.5**	**310**

* - Estimate
** - Without **ELI-NP** - Extreme Light Infrastructure - Nuclear Physics. Only ELI-NP will require minimum 250 specialized heat pump installers and geothermal ground heat exchanger installers.

SHALLOW GEOTHERMAL ENERGY RESOURCES AND EXPLOITATION

Overview on the shallow geothermal market

- Opened only in the late 1990
- Open and close vertical systems, rarely horizontal heat exchangers (due to the climate)
- The majority of applications are commercial
- Closed-loop systems - the current drilling depth is 70 ÷ 120 m
- Very few applications in public buildings
- Notable exception: ELI-NP (EU fundings)
- The current data base is "under construction" (it covers approx. 75% of the existing applications) and it is installed in RGS site: www.geoexchange.ro

Large GSHP systems - BHE longer than 10000 m

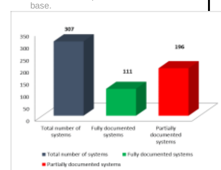
City – Objective name	No. of BHE	Depth BHE [m]	Length BHE [m]
Bucharest - ELI-NP (under constr.)	1080	125	135000
Valul lui Traian-Cardinal Motors (2009)	357	70	24990
Snagov - Vila 23 Hotel (2008)	224	70	15680
Focsani - ARTIFEX (2012)	120	125	15000
Bucharest - [illegible] (2008)	[illegible]	[illegible]	10800

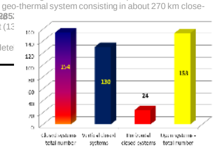
Extreme Light Infrastructure - Nuclear Physics

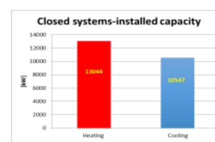
- The most advanced research facility in the world focusing on the study of photonuclear physics and its applications, comprising a very high intensity laser of two 10PW ultra-short pulse lasers and the most brilliant tunable gamma-ray beam;
- Wide range of research topics in fundamental physics, nuclear physics and astrophysics, materials science, management of nuclear materials and life sciences;
- Selected by the most important science committees in Nuclear Physics in Europe - NuPECC - in the *Nuclear Physics Long Range Plan in Europe* as a major facility;
- Covers an area of approx. 33,000 m² of new, high quality, energy efficient buildings;
- The maximum heating/cooling load [illegible] equipment is about 4 MW;
- Large geo-thermal system consisting in about 270 km close-loop circuit (13[illegible] which complete[illegible]

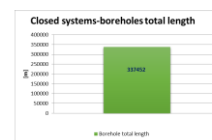
Building up a data base for GSHP systems in Romania

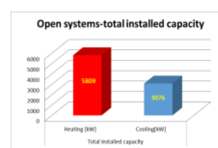
Duty and challenge for Romanian Geoexchange Society: **Duty**: Romania is absent from European statistics in this matter
Challenge: RGS had to aggregate the information provided by [illegible] and to persuade them to join this common effort.
The National Report for EGC 2016 includes a statistical analysis with regard to the information presented in the data base.

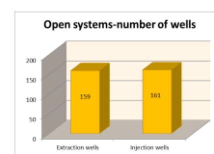


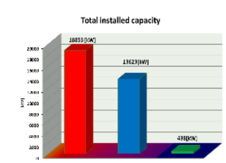


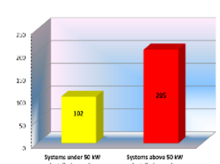








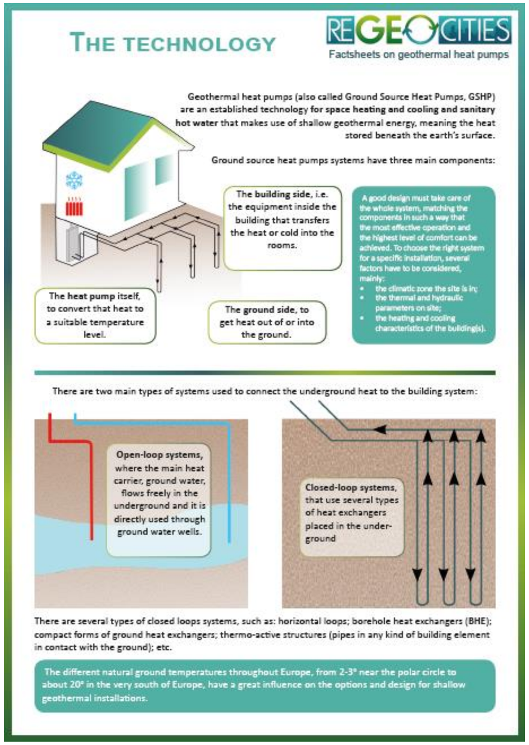




Public Awareness

Project Regeocities

http://regeocities.eu/



The technology

REGEOCITIES Factsheets on geothermal heat pumps

Geothermal heat pumps (also called Ground Source Heat Pumps, GSHP) are an established technology for space heating and cooling and sanitary hot water that makes use of shallow geothermal energy, meaning the heat stored beneath the earth's surface.

Ground source heat pumps systems have three main components:

The building side, i.e. the equipment inside the building that transfers the heat or cold into the rooms.

The heat pump itself, to convert that heat to a suitable temperature level.

The ground side, to get heat out of or into the ground.

A good design must take care of the whole system, matching the components in such a way that the most effective operation and the highest level of comfort can be achieved. To choose the right system for a specific installation, several factors have to be considered, mainly:

- the climatic zone the site is in;
- the thermal and hydraulic parameters on site;
- the heating and cooling characteristics of the building(s).

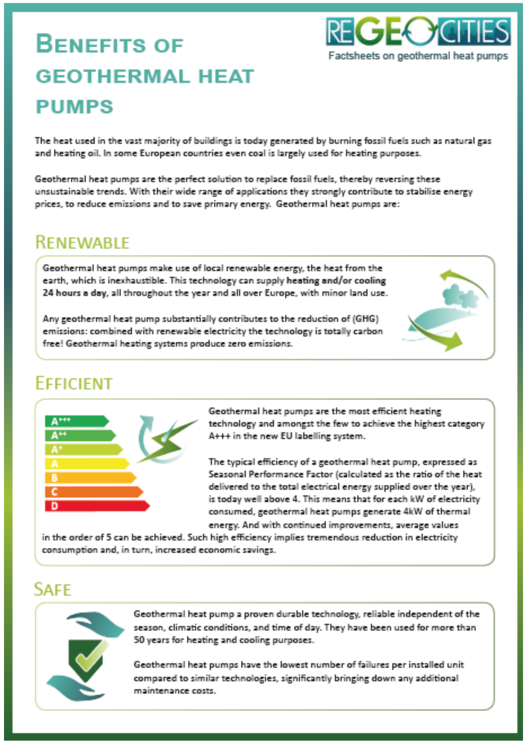
There are two main types of systems used to connect the underground heat to the building system:

Open-loop systems, where the main heat carrier, ground water, flows freely in the underground and it is directly used through ground water wells.

Closed-loop systems, that use several types of heat exchangers placed in the under-ground

There are several types of closed loops systems, such as: horizontal loops; borehole heat exchangers (BHE); compact forms of ground heat exchangers; thermo-active structures (pipes in any kind of building element in contact with the ground); etc.

The different natural ground temperatures throughout Europe, from 2-3° near the polar circle to about 20° in the very south of Europe, have a great influence on the options and design for shallow geothermal installations.



Benefits of geothermal heat pumps

REGEOCITIES Factsheets on geothermal heat pumps

The heat used in the vast majority of buildings is today generated by burning fossil fuels such as natural gas and heating oil. In some European countries even coal is largely used for heating purposes.

Geothermal heat pumps are the perfect solution to replace fossil fuels, thereby reversing these unsustainable trends. With their wide range of applications they strongly contribute to stabilise energy prices, to reduce emissions and to save primary energy. Geothermal heat pumps are:

Renewable

Geothermal heat pumps make use of local renewable energy, the heat from the earth, which is inexhaustible. This technology can supply **heating and/or cooling 24 hours a day**, all throughout the year and all over Europe, with minor land use.

Any geothermal heat pump substantially contributes to the reduction of (GHG) emissions: combined with renewable electricity the technology is totally carbon free! Geothermal heating systems produce zero emissions.

Efficient

A+++ A++ A+ A B C D

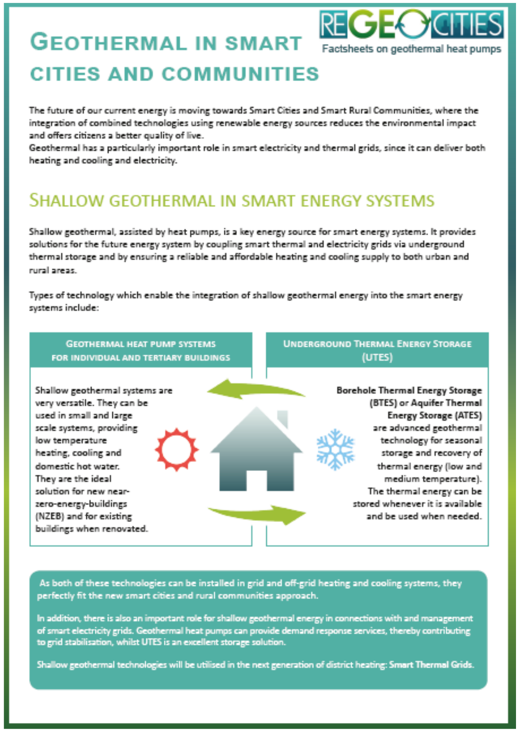
Geothermal heat pumps are the most efficient heating technology and amongst the few to achieve the highest category A+++ in the new EU labelling system.

The typical efficiency of a geothermal heat pump, expressed as Seasonal Performance Factor (calculated as the ratio of the heat delivered to the total electrical energy supplied over the year), is today well above 4. This means that for each kW of electricity consumed, geothermal heat pumps generate 4kW of thermal energy. And with continued improvements, average values in the order of 5 can be achieved. Such high efficiency implies tremendous reduction in electricity consumption and, in turn, increased economic savings.

Safe

Geothermal heat pump a proven durable technology, reliable independent of the season, climatic conditions, and time of day. They have been used for more than 50 years for heating and cooling purposes.

Geothermal heat pumps have the lowest number of failures per installed unit compared to similar technologies, significantly bringing down any additional maintenance costs.



Geothermal in smart cities and communities

REGEOCITIES Factsheets on geothermal heat pumps

The future of our current energy is moving towards Smart Cities and Smart Rural Communities, where the integration of combined technologies using renewable energy sources reduces the environmental impact and offers citizens a better quality of live.
Geothermal has a particularly important role in smart electricity and thermal grids, since it can deliver both heating and cooling and electricity.

Shallow geothermal in smart energy systems

Shallow geothermal, assisted by heat pumps, is a key energy source for smart energy systems. It provides solutions for the future energy system by coupling smart thermal and electricity grids via underground thermal storage and by ensuring a reliable and affordable heating and cooling supply to both urban and rural areas.

Types of technology which enable the integration of shallow geothermal energy into the smart energy systems include:

Geothermal heat pump systems for individual and tertiary buildings

Shallow geothermal systems are very versatile. They can be used in small and large scale systems, providing low temperature heating, cooling and domestic hot water. They are the ideal solution for new near-zero-energy-buildings (NZEB) and for existing buildings when renovated.

Underground Thermal Energy Storage (UTES)

Borehole Thermal Energy Storage (BTES) or Aquifer Thermal Energy Storage (ATES) are advanced geothermal technology for seasonal storage and recovery of thermal energy (low and medium temperature). The thermal energy can be stored whenever it is available and be used when needed.

As both of these technologies can be installed in grid and off-grid heating and cooling systems, they perfectly fit the new smart cities and rural communities approach.

In addition, there is also an important role for shallow geothermal energy in connections with and management of smart electricity grids. Geothermal heat pumps can provide demand response services, thereby contributing to grid stabilisation, whilst UTES is an excellent storage solution.

Shallow geothermal technologies will be utilised in the next generation of district heating: Smart Thermal Grids.

Factsheets from:
http://www.heatunderyourfeet.eu

Public Awareness

Project Regeocities

http://regeocities.eu/

The campaign „The Heat under your Feet“ is intended to create more awareness of shallow geothermal technologies, and the solutions and advantages it can deliver

http://www.heatunderyourfeet.eu

More information

Visit www.egec.org

Visit www.geodh.eu

Aknowledgement: European Geothermal Energy Council