Deep Geothermal for District Heating and Spa resorts in Romania and Bulgaria

Christian Engel

Thermaflex International Holding bv, Veerweg 1, 5145 NS Waalwijk,NL

c.engel@thermaflex.com

Keywords: Geothermal District Heating, Otopeni, Separeva Banja. Pre-insulated pipes, Polybuten 1 (PB-1), Retrofit, Heating, Hot water, Spa

ABSTRACT

Romania and Bulgaria have rich resources of deep Geothermal on a temperature level that is suitable for direct use in District Heating. Existing systems that have been developed until the mid-1990th are up for renovation or even reactivation of the dwells. This paper and presentation will focus on concrete projects realized and in feasibility stage in both countries to show the opportunities and challenges.

Apart from the exploitation of the dwells the energy efficient distribution with sustainable solutions for the district heating network is key for the success of these projects. Piping solutions with over 40 years of lifetime in geothermal water transport are one part of the solution. The other success factor lies in the optimized design and selection of all components as well as in a realization by trained contractors. All that will be presented in two District Heating projects in Romania and Bulgaria.

1. INTRODUCTION GEOTHERMAL DISTRICT HEATING (GEODH)

GEODH has stated that of the “5,000 district heating systems operated today in Europe, more than 240 are Geothermal District Heating systems. The first regions to install GeoDH were those with the best hydrothermal potential, like Iceland, Hungary, Austria and Germany. Due to new technologies and systems, an increasing number of regions are developing geothermal DH. Systems can be small (from 0.5 to 2 MWth), and larger, with capacity of 50 MWth. Some new District heating schemes that utilise shallow geothermal resources are assisted by large heat pumps.

Installing GeoDH systems in areas of high urban density improves project economics, as both resources and demand need to be geographically matched. One considerable challenge in the current economic crisis concerns the financing and the development of new heat grid infrastructures. Retrofitting existing district heating systems is an alternative for developing the GeoDH market.”

With 2 examples of retrofitting – Otopeni in Romania and Sapareva Banja in Bulgaria – the project experiences will be shared from planning to realisation, showing some of the obstacles and achievements.

2. OTOPENI – DESCRIPTION OF THE PROJECT

Otopeni is a city located north and adjacent to Bucharest with a population of 11 thousands inhabitants. The main international airport “Henri Coanda” serving Bucharest is located in the city.

District Heating was originally provided from 7 boiler houses and rich geothermal resources servicing almost 2000 apartments until 1992. The hot domestic water supplies were stopped in 1987, because the steel system corroded rapidly due to the geothermal water. The 7 boiler houses in the city – 6 (CT1- CT6) on the right hand side of the main road (see Fig. 1) - and one on the opposite side of the road (CT 7) were not interconnected.

In 2010 the district heating (DH) network of 8,6 km supplied only 711 apartments, the rest of apartments decided to disconnect. Dalkia (today Veolia) started 2010 a concession contract for management of DH with the City Hall of Otopeni to operate and to modernize the system in order to win new customers.

Figure 1: Map of Otopeni showing the situation of the old boiler houses (CT1 – CT6)

2.1 Technical solution proposed for Otopeni

After analysing several scenarios the following solution was proposed to the municipality:

Step 1: Automatization of boiler plants.

Step 2: Interconnection between main boiler plants to enable central supply of hot water into the DH system.

Step 3: Installation of sanitary hot water modules.

Step 4: Connection of DH system to geothermal source of energy.

For the durability and efficiency of the DH in Otopeni the DH system will be ultimately equipped with geothermal source of energy. The geothermal wells exist (the city hall is currently in the process of taking over the wells from the previous owner) so the works to be made is to connect the wells into the main inter-connected DH network. In the meantime the promotion campaign will be carried out that will raise awareness of the introduction of sanitary hot water being supplied from DH.

The subsidies are important condition for connecting the DH system to the geothermal sources as without subsidies the project is not economically interesting.

2.2 Main risks for this project

The main risks identified for this project were:

- Client's behaviour – Clients seek greater independency and flexibility of heating – so they were choosing individual gas heating solutions. There is still a common thinking from the communist period that the DH is inefficient and poorly managed. This resulted in decreasing connection rate to the DH,

- Trend of disconnections continues (there is more disconnections than new connections especially for the non-residential clients who pay full price of heat without subsidies from city hall),

- Requirement of CAPEX for internal installations for owners of the buildings who usually do not have the necessary money is a big problem (risk of not getting necessary agreement among residents, time)

- Payback heavy dependant on the success of achieving high re-connection rate.

- Price of heat from DH system without subsidies is not competitive against individual gas heating.

2.3 The realization of the retrofitting

Between August 19th and October 25th 2013 the interconnection of heating stations and rehabilitation (repairs) of the worst parts of the heating network has been carried out with the following experiences.

The technical and commercial decision for the pipe material was based on the following key criteria for the new network.

- Life time 50 years
- Low operational cost (low friction losses over life-time)
- Minimized disturbance for the citizens
- Minimum life-time costs

The solution has been found with flexible pre-insulated plastic pipes with medium pipes made of Polybutene 1 (PB-1) in diameters of d40 to d225.

Lager diameters (d225, d160 and d110) have been used for the interconnection. The head to head butt-fusion welding procedure has been used for connecting the pipes homogeneously. The general contractor ACVATOT Bucharest, has conducted the installation works and has been trained by Thermaflex, the supplier of the piping solution.

For the retrofit pipes from d110 to d40 have been used and connected by electro-fusion welding.

Welding of semi-flexible sticks of 11,8 m was partly carried out outside of trenches, in sections of 3 up to 5 sticks /per line including elbows on each branch up-flow/down-flow. These flexible 30 up to 60 m sections have then been rapidly placed into the curvy trenches without the need of installing direction changing fittings, leading to a reduction of 75 % in installation time compared to pre-insulated steel pipe solutions.

Figure 2: Diameter d225 to d160 installation

It was also possible to avoid affecting some alleys, streets, parking spaces and green spaces through the use of the old concrete ducts created in the 80's for the transportation of geothermal water, through which 60m sections have been slid through a very narrow space. The sections slid on a concrete tile base of the ducts that had a width of merely 60 cm, the two sections of pre-insulated pipes both having an external diameter of 250 mm, totalling 50cm.

Figure 3: Diameter d225 to d160 installation into existing concrete ducts

Long and curvy trenches through green spaces and other zones uncirculated by citizens or automobiles have been effectuated gradually and have also been covered later in the same day after the placing sections of the pre-insulated PB pipes with minimal affecting of flowers, bushes or trees. Greatly reducing costs for the reconstruction of green spaces.

The Town Hall of Otopeni had been constantly consulted in establishing the optimal path of the trenches to avoid affecting trees, bushes or floral zones through the creation of detours and curves of the trenches without needing supplementary materials. In the same way manholes and vital points of other networks have been avoided.

The speed of installation of the pre-insulated PB pipes, 3 to 4 times faster than classical systems, greatly reduced the discomfort and the impact on the well-being of Otopeni citizens by greatly reducing time spent on works in traffic zones and zones of access to living spaces (areas of exposure to risks and discomfort), from a few hours to 1 or 2 days with the exception of weekends.

2.4 Economic and financial results

Due to the increase speed of installation (around 3-4 times faster than the classic system); the reduction of fuel usage for heavy machinery; polyfusion head to head welding or electro-fusion methods; reduction of necessary manpower and elimination of consumables unnecessary in the welding of PB pipes the total cost of INSTALLATION has been reduced to 25% compared to the classical installation costs of steel pre-insulated pipes.

Additional supplementary unforeseen costs have been avoided (fittings/ insulation kits/ supplementary pipe length) as obstacles have been avoided by taking advantage of the flexibility of PB pipes and simply placing them in curvy trenches.

Due to the support in design optimization, pipe sizes could be reduced, by taking the specific advantages of PB pipes into consideration, like low friction losses over lifetime. Elongation loops are unnecessary for PB pipes installations, and such supplementary costs that would have been necessary for classical solutions have been avoided. Hence total material cost could be reduced by 8%.

Costs for civil works execution (digging, filling, reconstruction of alleys and streets) have been reduced by around 40 % compared to the classic steel based system. In comparison, the required width and depth of trenches is smaller and extra holes for positioning and welding were not necessary for PB pipes.

Conveniently, the use of PB pipes permitted the changing of initial paths planned in the documentation with minimal costs, by using existing delivered materials! Supplementary materials were required solely for length extensions or growing the number of branches unforeseen in previous planning.

The total investment cost (taking into consideration materials, installation and civil works costs) has been reduced by 22% compared to the estimated total cost if the project would have been realized with a classical pre-insulated steel solution.

2.5 Connection of the Geothermal dwells

The project of recovering the geothermal wells has been prepared and the municipality has applied for subsidies in the Termoficare state funds already in 2014. Until today this application is waiting for green lights.

The complete renovation of the District Heating network and introducing geothermal energy will finally help to end the subventions on the heat prices from the municipally and to turn this system into a truly sustainable district heating.

Next to this benefit for the municipality, making the energy supply and distribution system energy efficient will lead to significant reduction of CO2 emissions and help to fulfil EU Energy Efficiency improvement targets.

3. BULGARIA – SEPAREVA BANJA – DESCRIPTION OF THE PROJECT

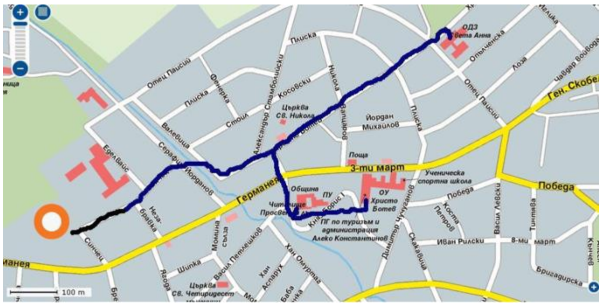
The city Sapareva Banja is located about 70km southwest of Sofia, near the town of Dupnitsa. In Sapareva Banja there is a thermal spring "Geiser" with water temperature of about 107 ° C

The source is located in the centre of the city and from there the thermal water is distributed to some spa hotels and by a heat exchanger also used for heating the city (only public buildings).

From there, the district heating network runs in the city and connects to

- A kindergarten
- A community center with Culture House next
- Two schools, one of them with swimming pool

Figure 4: scetch of the district heating network in Sapareva Banja



In 2003, the system was first put into operation and after 7 years there were major problems with the steel lines, which suffered very quickly from corrosion and as a consequence permanent leaking of the system. In the winter 2013/14 season, the system was constantly replenished with water, as it was no longer economical to eliminate the leak.

Another problem was that along the city network some private homes and hotels had illegally connected too (night actions with fast connections to steel pipe), these connection points were also potential weak points and need to be eliminated.

3.1 Technical requirements from the municipality

To renew the lines there were some important requirements of the community:

- High quality and durability of the lines
- Minimized heat losses
- Pipe material to which residents cannot easily connect on their own.
- Easy to install and space-saving, as the road was 3 years ago renewed under a EU program and all works are prohibited, or the EU subsidies must be repaid. All pipes should run under the sidewalks and no asphalt layers may be damaged.

3.2 Technical solution selected for Separeva Banja

The solution was to use flexible Polybutene 1 (PB-1) pipes that were slipped into the old steel pipes.

Flexible pre-insulated PB-1 pipes (Flexalen) were chosen, because the properties were fully in line with the requirements.

Financing was difficult and the green lights only came in late August, but the old heating system was no longer operational and the beginning of the heating season was very close.

Start of construction was September, and it was finished already mid-October. Built in lines were mainly d125 flexible pipes on coils (length 50m and 80m), d75 pipes (coil length 150m) and some d90 pipes. Very narrow trench for the pipes and a lot of communication lines need to be crossed. The pipes were partially pulled through the existing steel pipes. Connections to new house stations for all buildings had to be manufactured.

Figure 5: installation of the new district heating network in Sapareva Banja

The experiences during the installation were the minimum disturbance and the speed of the installation due to pipe in coils – saving 70% of connections.

3.3 Experiences in operation for Separeva Banja

After starting the heat network following improvements have been noted:

- The amount of water that was flowing through the heat exchanger is reduced to one-third

- The heat loss is reduced by seven times in the network itself.

- All the buildings are enjoying full power (previously in the last rooms of the buildings, the heat was not enough, so citizens used electric cookers to heat the rooms)

- The spa hotels enjoy better customer satisfaction

The community is very satisfied and has started to exchange their good experiences with other towns.

4. CONCLUSIONS

These two examples are demonstrating the potentials for Geothermal District Heating and show retrofitting with new pre-insulated plastic pipes that are supplied in coils and can be homogeneously welded. The installation time and thus the total cost over lifetime can be reduced by 22% as the project in Otopeni shows.

At the same time the operational performance is significantly improved as well as the service level and image of District Heating in this part of the world.

As we can see in Romania, but also in Bulgaria a need for improvements in the financing/subsidy schemes is necessary to gain all the advantages from the rich geothermal resources.

In the light of COP21 and the EU 2030 and 2050 targets also the legal framework for geothermal district heating has to be updated. The technical solutions are available as these projects have demonstrated.

REFERENCES

Philippe Dumas, Luca Angelino, Alexandra Latham, Valentina Pinzuti, *Developing geothermal district heating in Europe*, GEODH Report (http://geodh.eu/)

Gilles Hild, Florian Ionita, *Experiences of the renovation project in Otopeni, RO,* Evaluation of the installation and operation by Veolia 2015/16

Anton Tscholakov, *Experiences in the project Separeva Banja*, Evaluation with the municipality of Separeva Banja 2015