HOW TO DO GEOTHERMAL PROJECTS IN HUNGARY?
Dreams and realities

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ABSTRACT

Due to the abundance source of low temperature geothermal in Hungary hot waters are widely used for mainly heating purposes. The relative richness is, however, not in direct relationship with the success of geothermal projects being either before, under or after implementation. The article presents the almost 15 year long history of a geothermal project in the town of Szarvas, where a geothermal heating system has been running for 5 years without technical difficulties, but last three years have raised a number of legal and other kind of problems. The reader will also see how big influence have the purblind local policy into the field of geothermal and, how much political mind can block the possible future developments.

1. INTRODUCTION

Szarvas means deer in Hungarian. That is the name of a little town in the heart of the great Hungarian Plain. (See the map on figure 1.) Once there was in that town the geographical centre of the Hungarian Kingdom. Nowadays there are some 18.000 inhabitants in the city located on the banks of Körös dead channel. The basically agricultural town has, among others, two research institutes, two high schools, an interesting museum, and a famous arboretum.

2. GEOTHERMAL HISTORY IN SZARVAS BEFORE 1993

By the geothermal point of view Szarvas is very lucky: from the Upper-Pannonian sandstone reservoirs, laid at the maximum depth of 2200 m, almost 100ºC (outflow) low TDS water can be gained. The firs deep well for energetic use of geothermal was drilled in 1965 at Dózsa Agricultural Co-operative. After that 3 other wells were built for agricultural purposes.

The idea of space heating by geothermal arised only in 1985, when a national programme for replacing energy from fossil fuels by renewable energy sources started. The town council applied to the government for non refundable financial contribution to implement a geothermal heating system, and proved to be successful. Financial support had, however, been contracted to strict obligation for energy replacement. It was in 1986 when new production and reinjection wells were drilled, and surface equipment, pipelines, heat exchangers, etc. were installed. The operation start up was still at the end of 1986 with heat supply for three consumers: a camping and two holiday homes, which loaded the well capacity by only appr. 20%.

Why was it so and how could it be?
Well, the town council had a promise from the high politics to build up an immense health centre with spa hotel and thermal bath, which could have also been a consumer for geothermal energy. The site for well drilling was already subordinated to that totally unrealistic aim, as it become evidence during the coming years. Consequently wells were, unfortunately, placed rather far away from the city's large heat consumers. If the town council had not been forcing the idea of health centre, wells could have been drilled much closer to the possible consumers.

Anyhow, the geothermal heating system at very low capacity had already been running for three years when the political changes in Hungary swept away all the councils and, by the end of 1990, democratically elected self-governments were formed. The new Szarvas local government, as regards to geothermal, was confronted with the following difficulties:

- the idea of health centre was without any principle
- production well was utilised by low efficiency
- as the assign of the former town council, it would not be able to fulfil its obligation pertaining to the energy replacement, therefore
- it might have paid the financial support with interests back to the state.

To make matters worse, the biggest heat consumer, i.e. the camping disconnected from the geothermal system and begun its own heating supply by natural gas boilers. In order to solve the problems the self-government decided to establish a limited liability company called M. Thermal. It was the new firm's task to manage matters related to geothermal and seek for the proper technical and financial solution. Shortly afterwards a great number of crazy ideas and irresponsible offers to M. Thermal were sent by different natural and legal persons both from Hungary and abroad. Those proposals had, however, a mutual feature: all of them would have been at the response of the town while required the investment being financed by the local government. Having noticed that the self-government made a decision that it would not provide any financial contribution to any geothermal investment unless a professional company would take both technically and financially the risk of the investment. Our firm, the Porció Co. Ltd. undertook that condition.

3. IMPLEMENTATION OF THE FIRST HUNGARIAN GEOTHERMAL UTILITY

By May in 1993 negotiations between the local government and the future heat consumers on one side, and Porció on the other side had been finished, and all agreements were signed. The construction of agreements is showed in graphical form on figure 2.
There were basically two type of contracts between the local government and Porció:

A. agreement for the implementation of a geothermal heating system in Szarvas based on the well owned by the town.

B. energy supply agreements to heat three public buildings, i.e. Town Hall, Sport Hall and Town Clinic.

The contract "**A**" has the main topics as follows:
- Porció builds up a geothermal utility by its own financing without any financial contribution from the city.
- Local government allows Porció to utilise the production well free of charge for ten (10) years.
- After ten (10) years operation of heat supply system Porció will hand over it to the town without payment.
- Porció must lay down a larger diameter pipeline to the Town Hall in order to make the second part possible of investment to implement.
- Porció has the right to sell energy to any consumer where the supply system is constructed to.
- All the costs related to the geothermal system will be the duty of Porció within the first ten (10) years.

The "**B**" type contracts contained the followings:
- Porció installs the necessary equipment at the consumers heat centres by its own financing.
- Porció supplies geothermal energy at a 5-15% cheaper price than the cost of fossil fuel previously used (natural gas or oil) for ten (10) years.
- Consumer is obliged to take over the geothermal energy.

This type of agreement were signed with the other five (5) Porció's consumers, namely MOHOSZ, DATE, ÖKI, Pedagogical High School and 118 Private Flats.

Right after that Porció appealed to the water authority for a permission and prepared a feasibility study and, on basis of it, elaborated its application for a long term loan. In the meantime, Porció had a charge from M. Thermal to work out the feasibility study for a second phase implementation aiming at eight (8) more consumers.

After having the water permissions and loans from banks, in June 1994, the implementation started. Plans were designed by Porció, and implementation was carried out by local companies. All together more than four (4) km long transmission and distribution double pipeline was laid down for seventeen (17) geothermal substations in the existing heat centres. Each of the substations contained one or more heat exchangers, motor drive control valves, heat meters, pressure and temperature meters. The site plan of the whole geothermal utility shown on figure 3.

The system was, both financially and the operational point of view, separated into two parts. The first part was in the investment of Porció from the geothermal well till the Town Hall building (consumer No. 8), where the second part begun invested by M. Thermal. The main technical parameters for the heat consumers of both investors are listed in table 1.
Implementation lasted for four (4) months for the first part and the operation started on 1st of November 1994 and, as far as being implemented, consumers of the second part were step by step connected on to the geothermal network between November 1994 and January 1995.

The first Hungarian geothermal utility started to work in silence, without any puffery or fireworks, even politicians did not say speeches. It was only the mayor of Szarvas who pointed out: "The geothermal project has been a success story."

4. TECHNICAL DESIGN AND OPERATION EXPERIENCES

This chapter contains a brief technical description of the geothermal process and, review of system operation experiences.

4.1. Geothermal well

Main parameters for the production well are as follows:
- Production rate: 64 m^3/h (at 6 m wellhead pressure)
- Production type: artesian
- Outflow temperature: 98 ^oC (at maximum flow rate)
- Water chemistry: see table 2.
- Gas-water ratio (GWR): 0,83
- Gases in water: CH_4, CO_2, N_2.

At the time of well completion in 1985 the maximum outflow rate reached appr. 90 m^3/h at "0" wellhead pressure, which decreased slightly by the time of restart in 1994. Since then productivity of the well has practically not changed, or even, in the recent time, some increase was detected. Flow rate can easily be raised by additional airlift into the well as it became evidence during the last heating season.

4.2. Water treatment

Degassing

In accordance with the Hungarian laws all kind of waters containing methane over 0,8 Nl/m^3 must be degassed. Degassing at such a high temperature can be solved with no difficulty by an atmospheric water tank settled near to the wellhead. (Utilisation of the gas containing mostly methane is under examination.) The only problem may occur is scaling because of unavoidable removal of the CO_2 from the water.

Scaling

Calcite scaling might cause serious problems in geothermal systems. In the case of the Szarvas system very little amount of inhibitor is injected into the water still in the well. The inhibitor in use is that of Hungarian made and added to the water proportionally with the flow rate.

Sand

It is well known that geothermal waters from sandstone aquifers contain more or less sand. Diameter of particles in the Szarvas geothermal water is 200-300 μm by 90% in weight. So in the case of proper design and operation sand can practically subside in the degassing tank. After 5 years of operation the following experience have been collected:
- Sudden changes in the flow rate should be avoided
- Slow changes of the heating demand allow using relatively small capacity water tank
- Quantity of the sand settled down in the tank is quite insignificant while no sand has been observed in the system after the tank
- Amount of sand decreases year by year, so the well cleans itself.

Reinjection well is not in use - nor for reinjection, nor for production. The reason for it is that even in 1988 a reinjection test was carried out and results proved hair-raising. Although the well was very good at production, during the reinjection experiment the wellhead pressure was increasing unexpectedly rapidly. So, the well was pronounced out of ability for reinjection. At present cooled geothermal water is discharged into the river Körös through a five (5) km long pipeline.

The production well and the whole service system have been running without any serious problems since 1994. The only problem has been noticed is appearance of bacteria in the heat exchangers, which reduces heat transfer in them. Cleaning can be solve by using soft acids approximately twice in a heating season.

Concerning the heat selling to the consumers a general experience was observed, namely the rate of energy replacement did not reach the ratio that had been calculated down in the feasibility studies. The explanation for it is, however, quite simple. Due to the continuous operation and up to date control equipment installed in the substations consumers are able to save more energy than before. If energy consumption of the former "fossil fuel times" and geothermal times are compared than some 10-15% reduction can be detected.

A diagram for the energy sold by Porció Ltd. and M. Thermal Ltd. has been worked out and is showed on figure 4.

5. ECONOMIC RESULTS

In the case of proper technical design, good quality implementation and exact operation, economic results can only be depending on input economical conditions. This has so far absolutely true for the Szarvas situation.

In the heat supply contracts with the consumers Porció undertook to supply heat at a reduced price comparing those fossil fuels' prices that had been used before the geothermal system. Given discount rate by Porció to the consumers is, as an average, 10%. The company's revenues from selling the heat are, consequently, in direct correlation with prices of fossil fuels (natural gas and oil).

As mentioned Porció required for long term loan in order to finance first part of the Szarvas geothermal investment. Therefore, mainly in the first 3-5 years, the interest to be paid because of the loan has been the most significant cost. For example, in 1995 and 1996 it reached 87% and 71% of the total costs, respectively.

Focusing on the economic outcome of Porció from the Szarvas geothermal system there are two factors have main influence on it: energy prices and interest rates. Both have been increasing but not equally. As a percentage of the previous year energy prices reached 107%, and the interest rate 127% in 1995. (Prime rate was 22% at the beginning of implementation, and went in two steps up to 28% by middle of January 1995.) That effect caused considerable loss for Porció in 1995, although balance had previously calculated to "0" in the feasibility study. Situation has, fortunately, been changing and operation has been profitable since 1996.

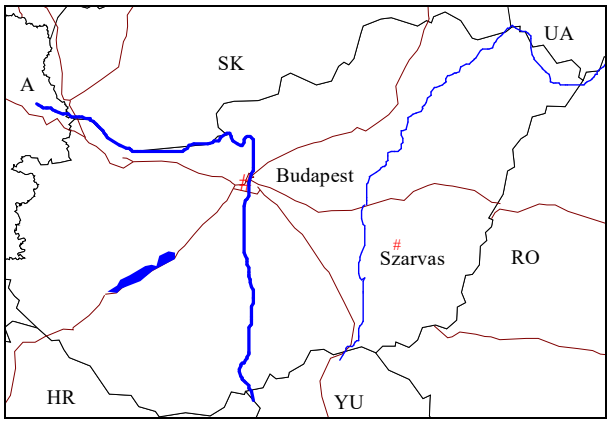

Figure 1. Location of the town of Szarvas in Hungary

It is no doubt that consumers are unambiguous winners of the project. They enjoy better energy service at lower price without any technical and financial risk. Good experiences after the second heating season lead DATE (consumer No. 3) to reconstruct its secondary heating system converting all the steam heating applications to hot water ones. In this way they could stop the low efficiency steam boilers and consume even more cheap geothermal energy.

6. LOST POSSIBILITIES

"When weapons are saying, muses are in silence", the proverb says.

Since May 1996 relationship between the self-government and Porció has gradually become worse and worse. This is, however, not typical as regards to Porció's other consumers, who have continuously been satisfying with geothermal service and its price. Occasionally, ideas of enlargement for the geothermal heat service in public and industrial buildings came up in the past three years, but neither of them has gone into materialisation.

Lost possibilities, i. e. the buildings where geothermal is not yet used, are as follows:

- Lutheran Church
- Székely Mihály Technical College
- Vajda Péter Grammar-school
- Sports field near the geothermal well
- Plastolus Plastic Works
- Szarvas Metallurgy Works

7. CONCLUSIONS

In full accordance with the opinion of former mayor of Szarvas we think that implementation of the Szarvas geothermal utility is really a success story. It has proved technically feasible and economically viable. It is a pity that legal actions have impaired the generally nice picture and additional developments have not been able to implement. Anyhow, the geothermal system has been running for already five (5) years without technical problems.

As the reader could, probably, notice, this paper has been sort of a sign of the times we live in. This example's message for us could be that solution of all the technical and economical

problems is still insufficient for our satisfaction. We, human beings, have to pay much more attention to each other with higher tolerance.

So, how to do geothermal projects in Hungary?
The same way we have done it so far.

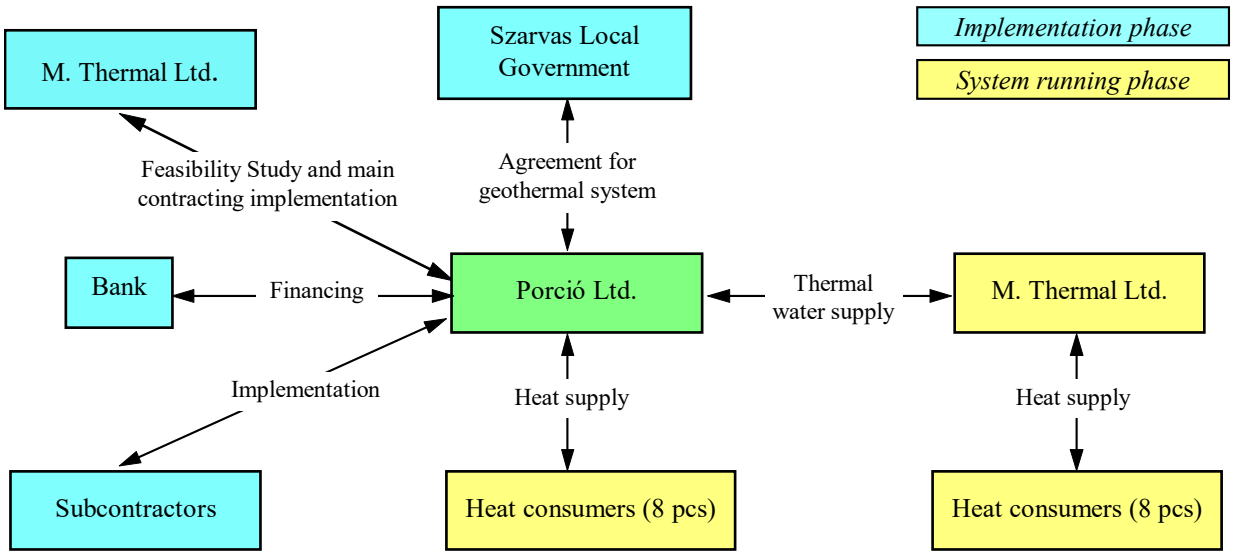

Figure 2. Construction of agreements for the Szarvas geothermal utility

Figure 3. Site plan of the Szarvas geothermal utility

Table 1. Main technical parameters of the heat consumers supplied by geothermal

No	Consumers	Heated volume	Heat demand	Previous
		m^3	kW	fossil fuel
	Porció's Consumers			
1	MOHOSZ Health Centre	3 900	100	oil
2	Sport Hall	14 000	310	oil
3	DATE, Agricultural High School	33 200	830	nat. gas
4	ÖKI, Research Institute for Irrigation	10 500	260	nat. gas
5	Brunszvik Pedagogical High School	38 200	950	nat. gas
6	118 Flats	19 300	620	nat. gas
7	Town Clinic	7 000	280	nat. gas
8	Town Hall	9 800	300	oil
	Total	135 900	3 650	
	M. Thermal's Consumers			
9	Primary School No. II.	14 100	535	nat. gas
10	Slovakian Primary School	8 100	240	nat. gas
11	Shops	4 400	180	oil
12	Culture House	7 100	290	coal
13	Hotel Árpád	6 400	260	nat. gas
14	Thermal Bath	3 300	135	nat. gas
15	Primary School No. I.	2 500	100	nat. gas
16	Szirén Clothing Co.	19 000	760	nat. gas
	Total	64 900	2 500	
	Grand total	**200 800**	**6 150**	

Table 2 Chenical composition of Szarvas geothermal water

Chemical component	Content mg/l
Sodium (Na^{+})	1 100,0
Calcium (Ca^{++})	8,0
Magnesium (Mg^{++})	3,3
Ammonium ($NH4^{+}$)	12,4
Ferrum (Fe^{++}) + (Al^{+++})	0,0
Chlorides (Cl^{-})	107,0
Hydro-carbonates ($HCO3^{-}$)	2 684,0
Sulphates ($SO4^{--}$)	53,0
Bromide (Br^{-})	0,4
Iodine (J^{-})	0,9
HBO_2	43,0
$H2SiO_3$	91,8
(K^{+})	26,0
(F^{-})	3,3
Total dissolved solids (TDS)	**4 133,0**
pH	7,6
Alkalinity (mg eq/l)	44,0
Total hardness (CaO g/m^3)	18,8
Variable hardness (CaO g/m^3)	0,0

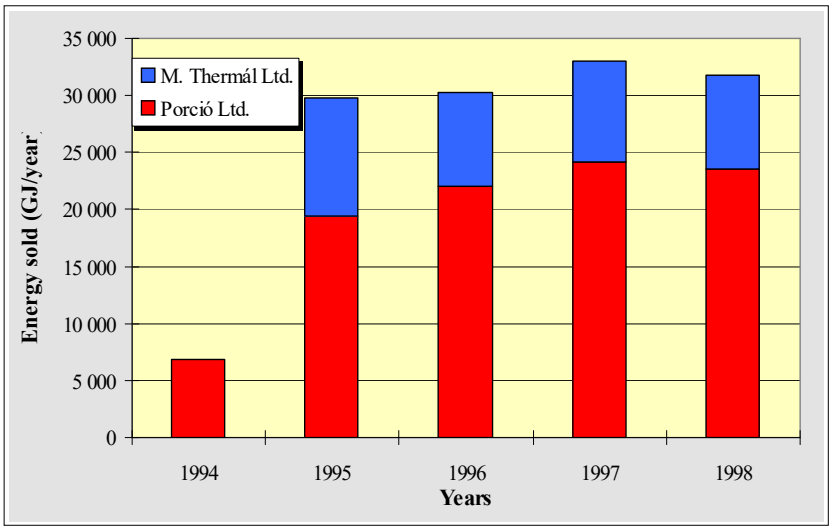

Figure 4 Energy sold through the geothermal utility (GJ/year)