THE SITUATION OF HARNESSING GEOTHERMAL ENERGY IN HUNGARY

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Due to the abundance of geothermal sources in Hungary, the thermal waters are used in great quantity for thermal baths and energy purposes. This paper gives a short overview of the present situation with a special emphasis on the results and experiences culled in the past four to five years in the field of energy utilization, i.e. the quality level of the uses, the situation of water disposal, reinjection experiments, the economic environment and the possibilities of financing of geothermal projects, and the changes in legal guidelines.

The history of utilizing geothermal energy

In Hungary, the major geothermal reservoir is the so-called Upper-Pannonian sandstone measures, the depth of which reaches 2500 metres. As a result of the very favourable geothermal gradient, the temperature of geothermal waters obtained from this reservoir, depending on the depth, could even be 80-100 ºC.

The dramatic development in harnessing of geothermal waters took place in the 1960`s and 1970`s, when a large number of boreholes were drilled exploiting geothermal water for use by agricultural facilities (green houses, poultry breeding farms, driers etc.). Geothermal waters coming from the almost exclusively positive wells are used directly without any special treatment. Then, the spent waters were drained into surface rivers, streams and canals.

The majority of geothermal energy utilization had taken place in the south-eastern part of the country and even today this is the most important area.

Current situation of harnessing geothermal water

By the 1980`s various consumers using geothermal energy had to face the following two main problems:

1. The yield of wells which have been used for ten to twenty years was gradually decreasing or perhaps their positive nature disappeared.
2. Scaling regularly damaged the equipment or required the operator to provide expensive maintenance.

The decreasing yield of the wells can be traced back to the reduction of stratum pressure. For operators, the only solution has been to install a pump in the production wells. However, only a limited range of reliable submersible pumps were available in the

European market. For a temperature above 80 ºC, practically no submersible pump could be obtained. A break-through in this field occured with the advent of longitudinal axle pumps. These pumps originally cold water BP series pumps manufactured by Grundfos, converted so that they could withstand the higher geothermal temperatures. After some initial difficulties, the operators have increasingly accepted this type of pump, and have perfected the facilities. Also about five years ago the first experimental Hungarian pump drive was introduced and has been followed by new ones. This is high significant from the aspect that well pumps fitted with Hungarian drive are much cheaper than foreign (USA) pumps operating reliably in the temperature range above 80 ºC. (For example REDA products are known also in Hungary, but because of their prices, they are mostly used in the oil industry). *So we can rightly say that the problem of water exploitation is practically resolved in Hungary.*

Most Hungarian geothermal waters are subject to scaling while only a few cases of corrosive water occur. Scaling arises from the CO_2 equilibrium being through free and dissolved gases including CO_2, coming to the surface. (Note: degassing cannot be omitted due to the generally high methane content, otherwise the risk of explosion is high). Initially, scaling was removed by subsequent acid treatment (or mechanically) from the well and from the surface equipment. But this process led to premature damage of steel structures, was expensive and environmentally polluting. Since the mid 1980`s, experiments with chemical water treatment have been conducted to prevent scaling. With the mutual efforts of foreign and domestic producers of chemicals and with the mutual exchange of experience *we are now in a position* that apart from one or two extreme cases, *scaling no longer hinders utilization.*

It is also to be mentioned that the efficiency of heat utilizations, that is the extent of cooling geothermal water (Δt) is left behind the desirable and even from the possible rate. This can be traced back to two reasons. One of them is that geothermal water has been relatively cheap for a long time, and so the operators were not really encouraged to save. The other reason is that control equipment were not available or could only be obtained with difficulty and at a high price. Thus, it is characteristic that 10 to 50 % more geothermal water than necessary is produced and used.
Since then, the situation has changed dramatically: the water fee to be paid on the exploitation of geothermal water has grown more than ten-fold and up-to-date equipment are now available, although they remain to be expensive. *Proliferation of the water and energy saving operations will be one of the most important challenges of the near future in Hungary.*

Disposal problems of spent geothermal water until recently reinjection initiatives

As mentioned in the introduction, disposal of spent geothermal waters have been almost exclusively through surface drainage with this situation only slightly changed in the last ten years.
In the meantime, the hydrostatic head of geothermal wells has decreased significantly. For example the hydrostatic head at the Szeged Clinic (in the south part of the Great Hungarian Plain) grater levels have dropped (while continuous production was carried out) from +35 m to 0 m in 15 years. Then during the following ten years, in spite of stopping production, it was stabilized at around –60 m. Because of the large-scale production, the water quality of surface reservoirs has also deteriorated substantially.

Consequently, reinjecting geothermal waters into the aquifers became a pressing task in order to:

1. halt the reduction of stratum pressure
2. prevent the contamination of surface waters.

Reinjection of water into sandstone reservoirs is a wellknown oil industry technology for reservoir boosting pressure. However, the well head pressures (110 bar!) used in the oil industry are unappropriate for current geothermal energy applications in Hungary, due to the initial and operating costs related to injection. Unfotunately reinjection experiments carried out so far could not provide reference results because of the primitive technology employed (Szeged, 1983-85) and the special well structure (Szentes, Hódmezôvásárhely 1985-87). Although reinjection is still being carried out currently, at the two experimental sites mentioned above, the measurements carried out there are not regular, and the condition of the instruments is doubtful, so there is no authentic information about the draining capacity of the wells.

In 1990, with PHARE's (European Community's) support, a geothermal project has been launched in Szeged, were a slanted pair of geothermal wells which have been unused for a long time will be operated as a doublet with one producing and one reinjection well for. After expert appraisal, a production and reinjection test was performed on the pair of wells in late 1992 by Porció Ltd. The twenty-day experiment was completed successfully from the aspect of reinjection, because the well head pressure associated with a maximum water drain of 45 m^3/h was stabilized at 10.5 bar by the end of the experiment (see Figure 1). On the basis of the experimented results, the experts decided to embark on the investment. The invitation for implementation bids was issued, and Porció Ltd was awarded the contract.

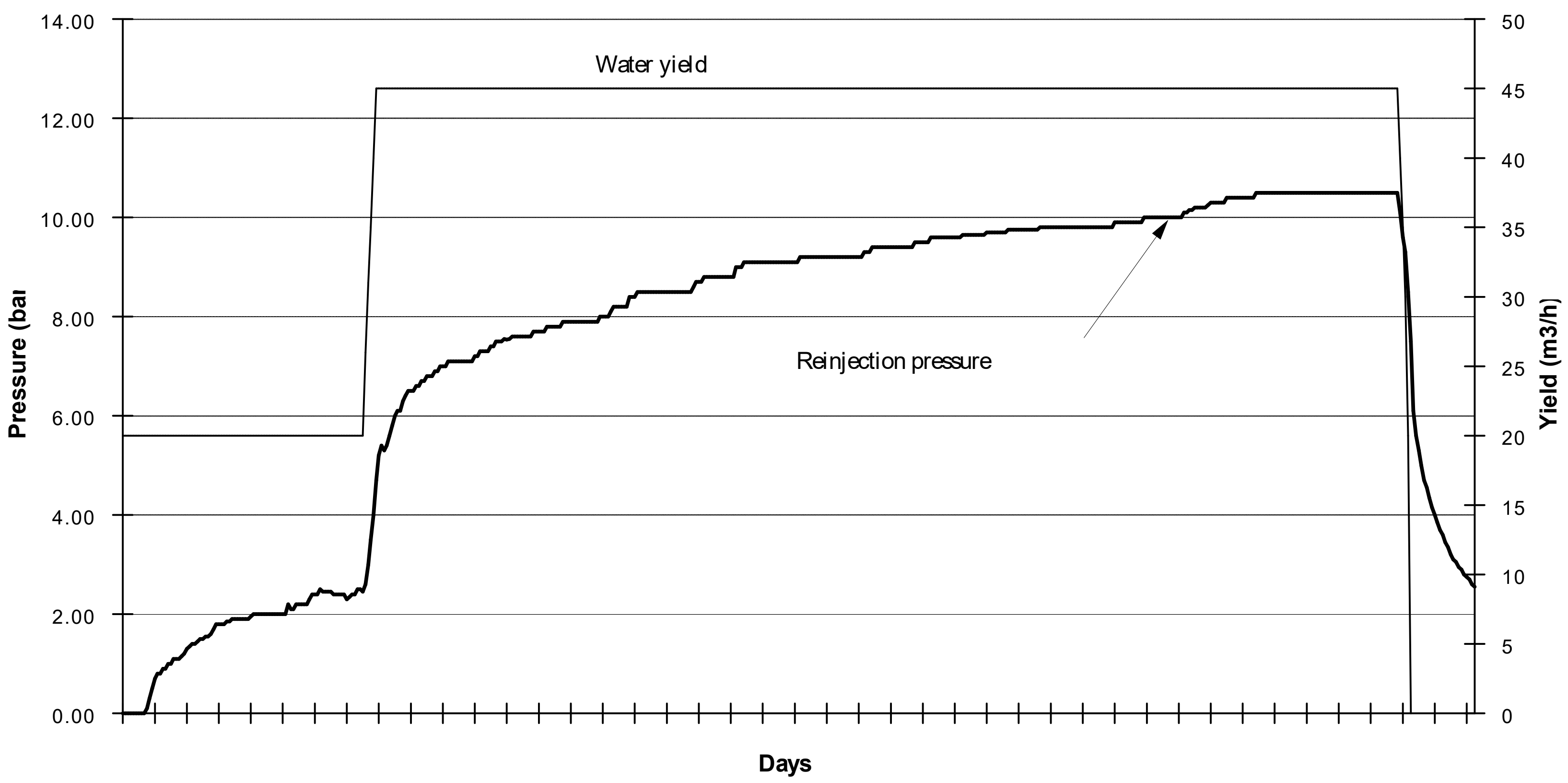

Figure 1: Reinjection pressure curve
(Reinjection experiment in in Szeged, 1992)

The crucial importance of the Szeged experimental investment is that finally a presumably prolonged continuously controlled reinjection project will be available to eventually supply valuable data for proliferating geothermal water reinjection projects.

Competitiveness and financing opportunities of geothermal energy

The economics for using geothermal energy purposes is fundamentally influenced by the price trend of fossil energy sources (natural gas, oil). In planned economy, the energy source prices were totally distorted by building various withdrawals and/or subsidies into them. Therfore, no information was available about how much something actually cost. After the political changes in 1989-90, one of the top priority tasks of the new government was to adjust energy prices in line with the conditions of a market economy. As shown by Figure 2 below, this has represented a price hike in most cases.

The price of light heating oil (topmost line) has grown substantially, practically reaching and even currently being around the world market level. (The same applies for the third consecutive year to engine petrols as well). It is evident from the figure that at the same time the price of natural gas, and in fact there are several prices (e.g. for the large and small consumers), is significantly lower than that of heating oil. This has caused many consumers in recent years to switch from oil fuel to natural gas fuel. By now, most of the large communities (housing estates, public institutions etc.) use natural gas as their primary source of energy. Consequently, geothermal energy must compete with the cheapest energy source with which natural gas.

The most characteristic feature today concerning the financing of geothermal energy project is that the earlier state contribution has been totally abolished. For example, the geothermal wells and surface equipment supplying the huge green house facilities established in the 1970`s were installed mostly by the state. The last state-funded geothermal project was completed in 1987, covering heat supply to approx. 4000 dwellings.

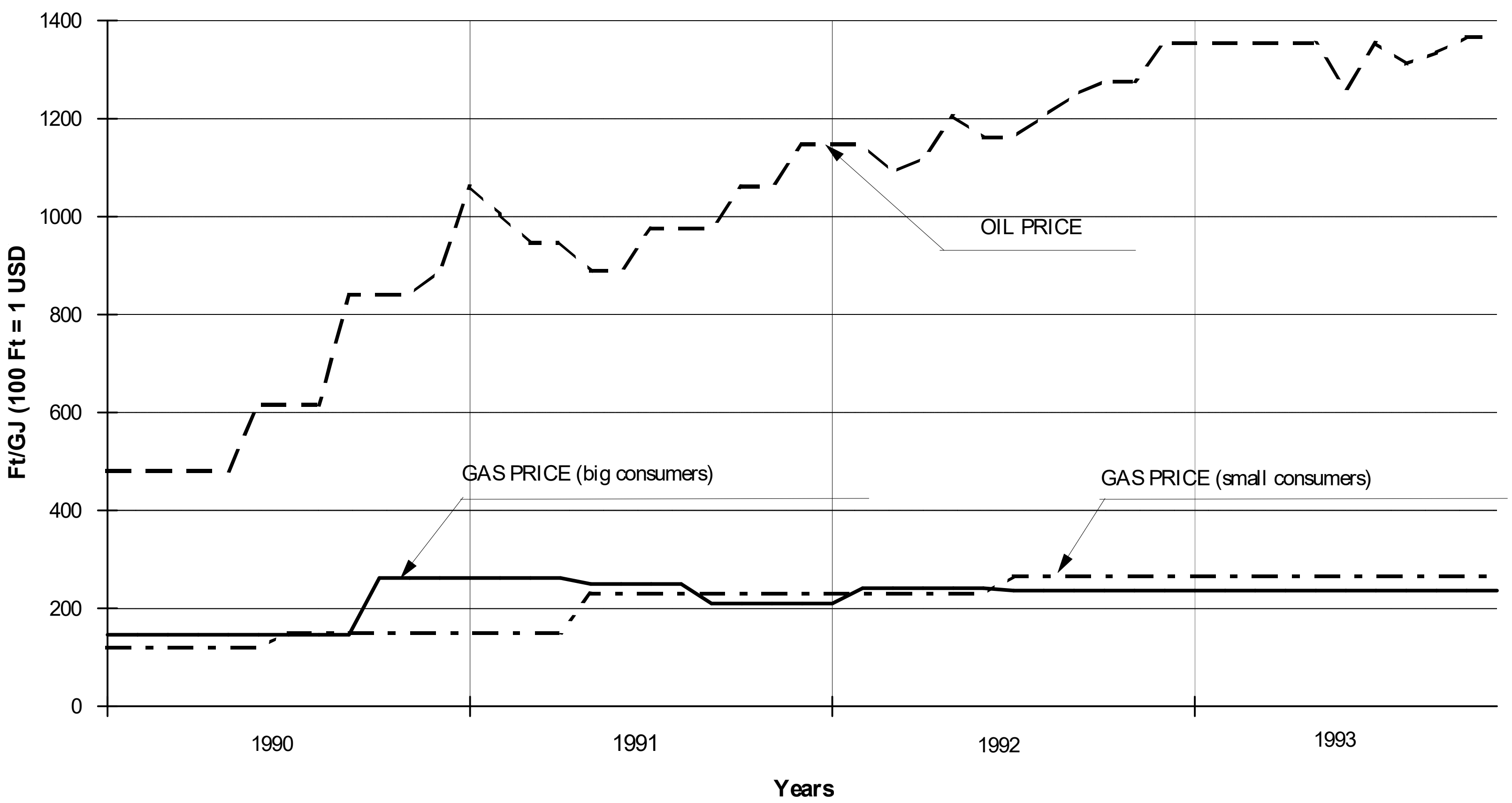

Figure 2: Energy source prices from 1990 until 1993

After the political and economic turn, the geothermal investments were primarily launched by entrepreneurs and to a lesser extent by local governments, strictly on the basis of cost criteria. Because ventures do not generally have sufficient resources, banks now play a major role in financing geothermal projects. Two types of long term credit is available for energy saving investments: the World Bank and the so-called "German Coal Aid" loan.

Credit conditions:	World Bank	"German Coal Aid"
Rate of interest:	Prime rate +4%	50% of the prime rate +3.5%
Maturity:	max. 10 years	max 8 years
Grace period:	max. 3 years	max 1 year

(The prime rate is 25 % in July 1994)

It is a well established bank practice in awarding the "German Coal Aid" loan that the maturity is determined to ensure the repayment of the credit as soon as possible. Therefore, the entrepreneur can pocket no or hardly any profits during the repayment of the capital and so this loan may only be used by companies with adequate capital.

An interesting picture is obtained about the economics of geothermal investments if the trend of gas price for large consumers, the bank prime rate, the average inflation rate and the devaluation of the forint is examined for the last three years. Figure 3 (next page) depicts these rates (percentage changes when set against the previous year and the absolute value of the bank prime rate).

The following factors act against geothermal investments:

- o the price of natural gas as capital energy source stagnates,
- o the implementation costs increase because of average inflation and forint (local currency) devaluations
- o the rate of interest on the credit remains high on an ongoing basis.

Another factor is that the so called water reserves contribution i.e. water fee has become a significant operating cost.

In summary, the financing of future geothermal investments will depend on the following:

- o that implementation costs are tied to a certain given technical standard, and cannot be arbitrarily reduced,
- o that gas prices increase, but this is a question of decision making by the government,
- o interest-free subsidies, low interest long-term credits or aviability of non-refunded subsidies for experimental or R&D projects (e.g. reinjection) designed to reduce the entrepreneur's risk.

Changes in the legislation

The Hungarian Parliament passed the Mine Bill and the Concession Bill in 1993. Both affect the harnessing of geothermal energy.

Under the Mine Act, a mine tax on thermal energy mined from the ground through any medium (e.g. natural geothermal water) of 2 % of the calorific volume utilized on the surface was enacted. This applies both to surface drain and to reinjection. However, a water management regulation encouraging reinjection was included exempted payment on any water volume reinjected into the permitted strata.

The Concession Act says that the exploiting of natural wealth owned by the Hungarian State may be carried out in the framework of the concession. The evaluation of the concession bids is carried out on an individual basis and the best bidder receives the concession rights.

It is also to be mentioned that although this is not regulated by an Act, the new geothermal investments may only hope obtaining permissions from the authorities if the geothermal circuit includes total water reinjection. This shows that the reinjection disposal of geothermal water must be dealt with very urgently and very seriously. To this end, however, the powers and risk-taking abilities of the entrepreneurs are not sufficient, and it is necessary for the state and/or international organizations to contribute.

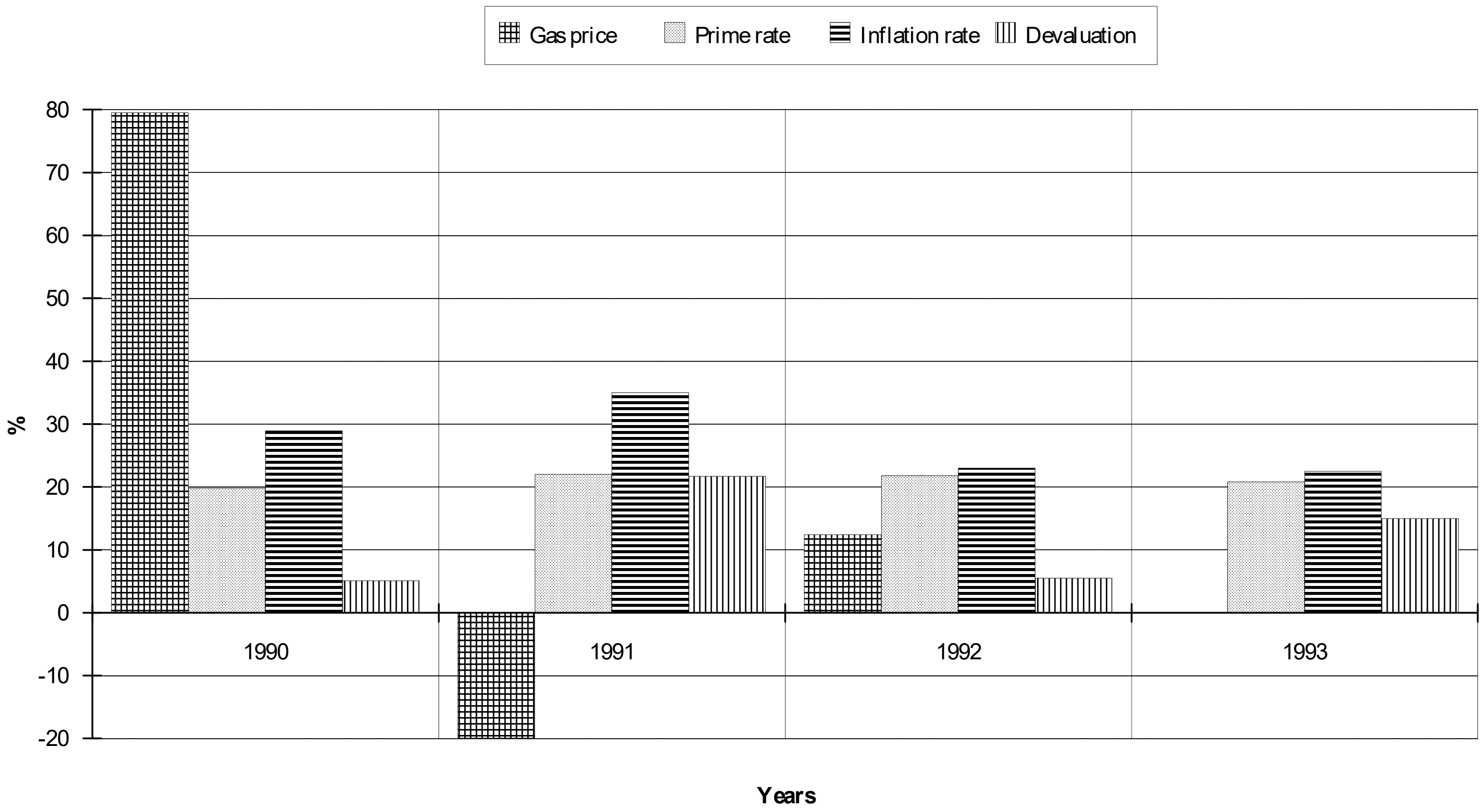

Figure 3: Changing of financial indicators in the last four years.