# GEOTHERMAL INSTALLATIONS IN RODIGO

Carlo Sordelli[1] and Vassilios Karkoulias[2]

[1] Cooperativa Sette Frati, Pozzo geotermico Rodigo 1, 46044 Sacca do Goito (MN) Loc. Mussolina, Italy
[2] OMEGA European Consulting Ltd, 20 Anat. Thrakis, Papagou, 156 69 Athens, Greece

Key words: Drying, Fish-farming, Geothermal, Greenhouses, Rodigo

## ABSTRACT

The Rodigo geothermal well, which was drilled in 1975 for oil exploration reaching a depth of 5 km, produces 80 $m^3/h$ of self flowing water at 59 °C temperature. The hot water from the well is utilised for heating of 10 acres of greenhouses, as well as for drying of 1,200 tons/year forage and 2,000 tons/year cereals. The waste water from the greenhouses and the driers, the temperature of which is around 25 °C, is used for farming of 45 tons/year eels in 3 acres of pools. The resulting energy savings from the project are 1214 toe annually, while the corresponding pay-back period of the investment amounts to approximately 3 years.

## 1. INTRODUCTION

Well Rodigo is located in the territory of Goito Community in the region of Mantova, Italy. It was drilled for oil exploration by AGIP S.P.A. in an agricultural area in 1975, and it was offered to the town of Rodigo in 1989. It is 5,000 meters deep and identified formation temperatures of 63 °C at 4000 m.

The hot water produced, which originates from a horizon at depths 3875-4170 m, has a temperature of 59 °C at the well-head, pH 7.16 and salinity 0.731 gr/lt NaCI. It can produce 72 $m^3/h$ of self-flowing water at 6 $kg/cm^3$ well-head pressure. For exploitation purposes the flow rate remains constant at 80 $m^3/h$. Other fluid characteristics are summarised in table 1. From these data a relatively high iron concentration (Fe total), as well as chlorides are evident.

Table 1: Fluid chemistry

| Species | g /l |
|---|---|
| Ca | 0.071 |
| $CO_2$ | 0.016 |
| Mg | 0.028 |
| $NH_4$ | 0.001 |
| Cl | 0.443 |
| $SO_4$ | 0.053 |
| Fe (tot) | 0.0006 |
| Na | 0.242 |
| K | 0.017 |
| $SiO_2$ | 0.02 |
| $H_2S$ | 0.0001 |

The exploitation firm owns 22 acres of land divided in greenhouses, driers and fish-farming pools as shown in figure 1.

## 2. GREENHOUSES

The greenhouses cover an area of 10 acres, almost half of the overall area of the installations. They are used for flowers cultivation (floriculture), partly imported and partly cultivated in the region. The most common cultivated flower types are shown in table 2.

Table 2: Most common flower cultivations

| Flower tvue | annual production (pieces) |
|---|---|
| indoor plants | 50,000 |
| seasonal flowers | 60,000 |
| cyclamen | 25,000 |
| "poinsettia" | 25,000 |
| geranium | 20,000 |

In addition, each year 200,000 vegetables are grafted and grown during the first season, which in turn are distributed to the nearby farmers and are further cultivated in an open field.

The greenhouses are constructed with steel/aluminium frame and "glass" or "corrugated methacrylate" cover (side walls and roof). The central heating system of the greenhouses, utilises the heat of the geothermal water through a variety of heat exchangers, air heaters for fast heating, finned pipes sidewalls and underground, heated benches and heated soil. In the last two systems, hot water flows through polyethylene pipes, which are located within the soil, or cross the perforated bricks of the benches.

The internal greenhouse temperature, as well as the other parameters affecting the plant growth, are controlled by a computer through windows openings and shading changes. For this reason sensors linked to the computer monitor continuously the changing external climatic parameters.

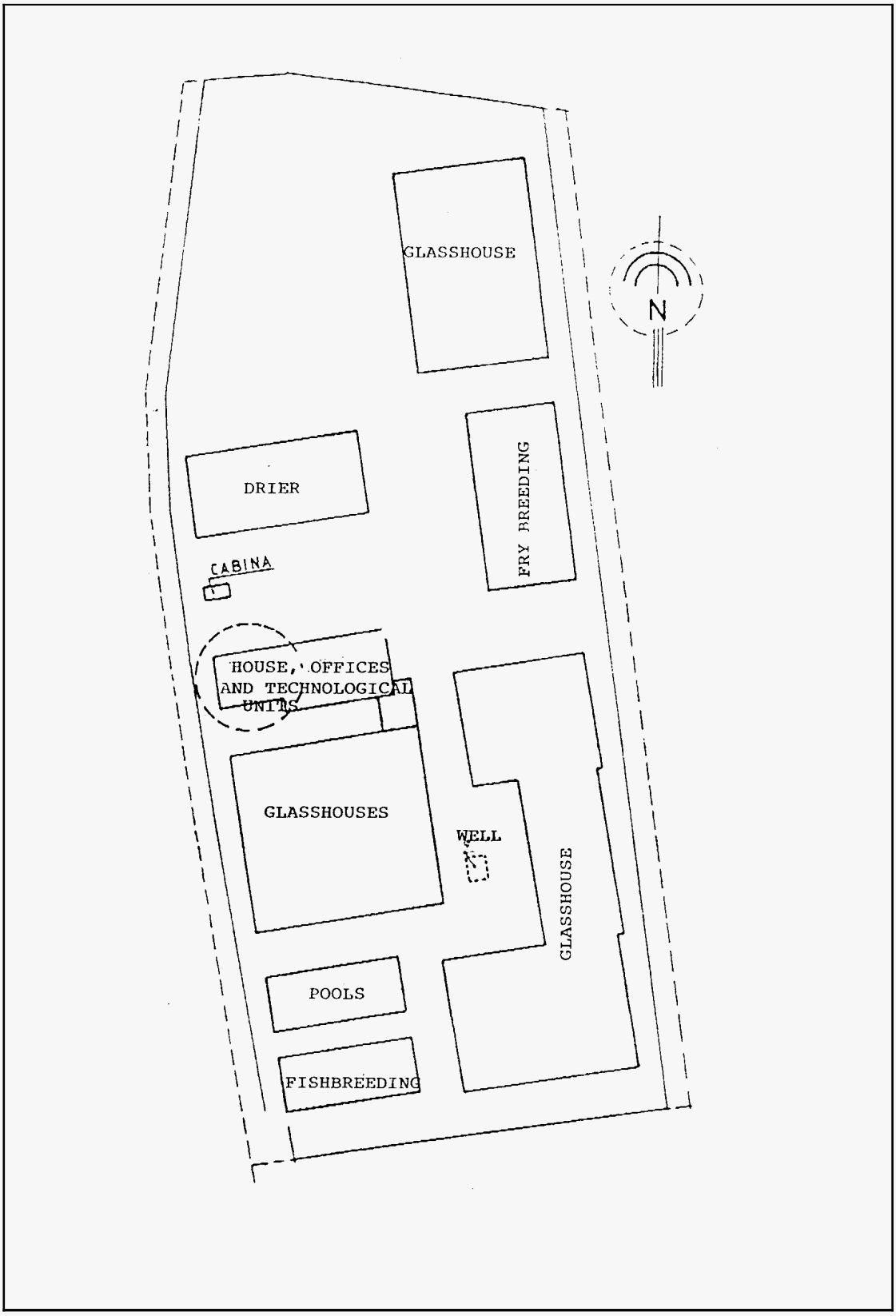


Figure 1: Layout of installations

## 3. DRIERS

The drying sector is divided into two areas: forage driers and cereal driers.

The forage driers consist of a tank with holes, through which hot air is blown. heated by the heat exchanger and collected by a proper subsurface piping network. The round bales of forage are put above the holes and are dried by the hot air passing through them. The drying capacity of the unit amounts at 43,200 kg/day or 1.200 tons annually.

The cereal drier consists of a silo with its proper funnel for loading and unloading of the cereals, and an arm mixing system with a vertical cochleae (screw). The hot air is blown from the base, passes through the mass of the cereal and leaves the drier from the top. The drying capacity of this unit is 40,000 kg/day or 2,000 tons annually.

## 4. FISH FARMING

The fish farming installations consist of the open pools for fattening of mature eels and the indoor pools for breeding of fry (newborn fish).

The total area covered is 3 acres. while the production capacity amounts at 45 tons of eels annually. The hot water necessary for fish-farming is the waste hot water from the greenhouses and the driers, the temperature of which is approximately 25 $^{o}$C. This water permits eels growth during the entire year.

## 5. ECONOMIC ANALYSIS

The overall energy saved by the project has been estimated at 1214 toe annually which corresponds to 668 millions of lire (1991). * (1 USD = 1619 lire ; 8.12.94)

The capital expenditures for the construction of the installations, excluding the drilling of the well, were approximately 2,000 million lire. Annual operation and maintenance costs amount at 40 million lire (1991) half of which correspond to energy costs.

The resulting payback time is around 3 years, which means that the use of geothermal energy in the above mentioned activities (heating of greenhouses, forage and cereal drying and fish farming) allows the recovery of the investment in a relatively short period of time.

Other side-advandages that resulted from the project are the following:

- geothermal dried products are of better quality than those dried by conventional energy sources
- regional development which would not be possible without the geothermal energy
- fuel savings
- environmental benefits arising from the use of a "clean" energy source

## 6. CONCLUSIONS

The Rodigo well and nearby installations, are an excellent example of geothermal low temperature hot water utilization. During the hot season, the geothermal water is used for forage and cereal drying, while during the cold season it is used for heating of greenhouses.

The waste heat of the water leaving the driers and the greenhouses, the temperature of which is around 25 $^{o}$C, is also used for eels breading throughout the year.

The project was successful in terms of both geothermal energy use and economic returns.

## ACKNOWLEDGMENTS

Ms Milena Guizzardi from OPET-ASTER is gratefully acknowledged for her assistance and Mr D. Mendrinos from OMEGA is also gratefully acknowledged for his contribution.

## REFERENCES

1. CEC-DG XVII (1993). *THERMIE Geothermal Energy Technology Projects,* 240 pp.

2. COOPERATIVA "SETTE FRATI" , THERMIE Demonstration Project GE/421/86/IT. *The Geothermal Unit in Rodigo.* Final Report for CEC, 31pp.