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Italian agricultural uses of geothermal energy

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ABSTRACT

Non electric uses of geothermal energy in Italy are mainly connected to the spa business, but a large share is also related, beside residential heating, to agricultural activities, including fish farming.

The main ongoing applications in agribusiness are greenhouses heating, the most important facilities being in ***Amiata*** (Tuscany) and at *Pantani* (next to Rome) and fish farming at ***Orbetello*** (Tuscany coast) and in Apulia shore.

A small but interesting integrated project, combining greenhouse and aquaculture heating is running in ***Rodigo*** (Lombardy).

Concerning the immediate future, some greenhouses are being built or planned near new geothermal power stations in Northern Latium.

Factors affecting the growth of geothermal use in Italian agriculture (as well as in other sectors) include the low price of energy, the mining risk, the technological hnow-how needed, bureaucratic hurdles, lack of information and insufficient support at the various Governmental levels, and, last but not least, the health status of the heat-assisted agri-industry as a whole.

KEYWORDS

Italy, agriculture, geothermal heat uses

Introduction

Non-electric uses of geothermal energy worldwide, with an installed capacity of **9,000 Mwt,** amounted in **1995** to 31,000 GWh/y, corresponding to a substitution of **2,4** million TOE/y. The agricultural share (including aquaculture) was **27%;** second only to residential beating **(34%)** (FREESTON **1996).**

In Italy, where direct uses amount to about 240,000 TOE/y, agricultural applications (60,000 TOE/y) represent 25% of the total, after balneological-spa uses (52%) but ahead of residential heating (16% of which 10% connected with spa hotels in the *Abano* (Veneto area).

The Italian floriculture industry is the third in the world as monetary worth and fifth in acreage. Greenhouses cover some 30,000 ha, of which about 30% are equipped with heating systems. Fuel use is almost 250,000 TOE/year.

Italy is the seat of two of the largest geothermal greenhouses in the world: *Amiata* (23 ha) and *Pantani* (18 ha). Even so, only a little over 50 ha (out **of** around 9,000 heated) use geothermal energy. But, while surface-wise the share is minimal (under 1%), energy use amounts to about 8% of total.

Almost all the Italian geothermal greenhouses are dedicated to flower and potted plant growing, with minor horticultural applications.

Italian fish farming industry is one of the most important in Europe. Some large operators in ***Orbetello*** (central Tyrrhenian sea shore) and in the Apulia coast grow fish with tepid near surface water, thus cutting drastically the time needed for species raising. The corresponding geothermal heat availability is around 40,000 TOE/year.

Over 100,000 TOE/y of fuel are used in crop drying, mostly in North Italy. A geothermal application in this field operated for some years in ***Rodigo*** (in the Lombardian Po Valley) in an integrated greenhouse and fish farm plant, but was recently discontinued because the equipment was not competitive with the large size conventional dryers.

The main Italian geothermal agriplants in operations are briefly described hereunder (for location see Fig. 1, while statistical data are in Table 1).

Galzignano (Veneto)

This is the first geothermal agricultural plant of commercial size to operate in Italy. The owner, a cooperative society, began its activities in the late Sixties and has been running since. The plant is located within the *Abano* high temperature area, whose resources are mostly dedicated to spa uses. The reservoir is in the Mesozoic limestone and the non-saline fluid has a temperature of 63°C with a flow on pump between 28 and 65 m^3/h/well. After circulating in plate heat exchangers, the geothermal water is discharged on surface at a temperature of 30-35°C. The 3 hectare glass and plastic greenhouses use the heat from three 200-300 m deep wells drilled between 1965 and 1984. Back-up boilers are installed and various hating equipment is used (fan coils, near ground pipes, etc.). Tropical potted plants are grown and a staff of about 40 people is employed. Utilized geothermal heat amounts to 1200 TOE/year.

Table 1: Italian geothermal agricultural uses

	area	temp. (°C)[1]		utilization flow rate	utilization time[2]	substituted energy
	(ha)	IN	OUT	(m^3/h)	(hours/y)	(TOE/y)
GREENHOUSES						
Amiata	23	90	50	1000	3000	13000
Pantani	18	5	35	1100	2000	3500
Galzignano	3	63	35	120	3000	1200
Rodigo	1	59	38	40	4000	400
Others	7					2900
Total	52					21000
FISH FARMS						
Orbetello		21	15	3600	4300	17000
Sannicandro/ Brindisi		25-19	15	6700	4300	15000
Rodigo		20-25	12	40	3700	1000
Others						6000
Total						39000
TOTAL						60000

[1] Outlet temperature applies to greenhouses.
Reference temperature is used for aquaculture and relates to the average temperature during the cold season of the nearest water body.
[2] For fish farms utilization time is all year round, but for energy substitution calculation only the period during which the water body is cooler than the geothermal water is considered.

Figure 1 : Italy – agricultural geothermal plants

Amiata (Tuscany)

In this area, located in the *Piancastagnaio* municipality, 23 hectares of greenhouses utilize residual hot fluids from a 8 MWe power plant fed by geothermal steam at 165°C and owned by the national utility ENEL.

Hot water at 90°C is recovered at a condenser installed near the electric plant and heat is transmitted via adjoining steel plate heat exchangers to water circulating in a two-way feeder, 3 km long, reaching a 350 m lower plain on which the greenhouses are located. A second set of shell and tube heat-exchangers is located at the greenhouse entrance and the plant is heated by fan coils and partly through underground piping. Peak load and emergency support is assured by conventional boilers. Temperature in the utilisation network drops from 80°C to 40°C and the spent fluid is reinjected near the condenser. Peak power is 35 Gcal/h and average yearly heat consumption , over a period of 3,000 hours, reaches 13,000 TOE/year. The greenhouses are fully automated. Both indoor plants and cut flowers are produced. About 250 people are employed, increasing to 500 in peak periods.

The plant, built and once owned by the then public ENI oil group, is presently privately controlled by the FLORAMIATA company. Its remote location is due to the fact that the project was originally developed to utilize locally available manpower after the closure of a mine in 1984.

Pantani (Latium)

Following the discovery by ENEL of shallow hot water in a 500 m deep well near *Civitavecchia* in 1960, a private flower growing firm (ALBANI & RUGGIERI) has developed, starting in 1984, a large and successful geothermal agribusiness. 18 hectares of glass greenhouses were built and 10 wells drilled to the depth of 350 to 500 m in a limestone Mesozoic reservoir. 5 to 6 well are producing on pump an average of 180 m3 of 3-4 g/l water at a temperature of 48 to 52°C. Spent water is reinjected in 4-5 wells at 35°C, mainly to mantain the pressure. No support boilers are installed but geothermal heat is integrated at times by 80°C water from a nearby ENEL power plant fed in a 1,200 m^3 reservoir. Steel plate heat exchangers transmit the geothermal heat to a secondary circuit consisting of underground and under-bench pipes and of fan convectors. The heating season is 5 to 6 months long, for a total of 1,800-2.000 hours. Substituted energy amounts to 3,000-3,500 TOE/year.

Flowers and potted plants (including succulents) are grown; staff includes ***55*** employees on a permanent basis and 150-200 part-time.

Location of the plant is quite favourable from the logistics point of view. During the over 10 year period of full activity the geothermal reservoir bas behaved very positively, with no decrease of temperature or flow-rate.

Orbetello (Tuscany)

A large geothermal aquaculture operation, consisting of 4 plants, is located on the central Tyrrhenian sea-shore in a lagoonal area where several conventional fish farms are active.

Some 45 wells, less than 100 m deep, tap an aquifer in karstified Mesozoic limestones with a flow rate on pump, 30 to 180 m^3/h each, of generally saline (up to 36 g/l) water at a temperature of 19 to 25°C (average 21°C). Species raised include sea bass, sea bream, mullet and eel. Total fish production is around 900 tons per year and personal employed is in the order of 60 people.

The use of warm water shortens very much the growth period, thus increasing the yearly income. Compared to conventional fish rearing in the adjoining unheated lagoon water (which has an average yearly temperature of 15°C) the use of the 21°C geothermal water corresponds to a benefit in energy terms of over 17.000 TOE/year.

The pumped geothermal water flows directly to the various ponds, spent water being in most cases channelled to the sea. Water in the ponds is oxygenated hy electrically driven mechanical shakers and/or by adding liquid oxygen.

The plants, built in the late Seventies-Eighties with EC and national financial support, operate the year around. The operators are presently completing a common handling and storage facility.

Rodigo (Lombardy)

The project was born because of the availability of hot water from a dry AGIP oil well drilled in 1975. The well was handed over free of charge of the Municipality of Rodigo which will bear all costs for abandoning the site at the end of operations. In turn the Municipality has a long-term agreement with a local cooperative society for the use of the resource.

The well taps a Mesozoic carbonate reservoir at about 4,000 m depth, with a free-flow of 80 m3/h of fresh 59°C water. The plant, which started operations in 1990, uses an average of 40 m3/h (with higher peaks) of geothermal fluid for integrated and cascaded heating of 1 ha greenhouses and a fish farm. Originally a crop drying unit was included, but it was recently removed because uneconomical due to its small size.

Geothermal heat, with a temperature drop from 59" to 38°C, is used in the greenhouses from November to April (about 4,000 hours), growing potted flowers and plants and nursery vegetables. Heating equipment includes suspended finned piping and under-bench tubing.

Eels are raised ponds all year around at the temperature of 20-25°C in geothermal water diluted with cold water from shallow wells and with the addition of liquid oxygen. Eel production is around 180 tons/year. Staff employed is 20 people, increasing to 30 during peak periods.

Overall energy substituted is around 1,400 TOE/y, of which 400 in greenhouses. To optimize the system and the use of the geothermal resource, there are plans to add a gas-fed cogeneration unit and to heat a new nearby swimming pool.

Other plants

A number **of** small size greenhouses, for an estimated total of 7 ha, are located mainly in Tuscany (where use is made of 70° to 150°C fluids are available near geothermal power stations) but also in the *Canino* (Latium) demonstration plant and between Venice and Trieste where a broad shallow geothermal anomaly is present (with 40-50°C fresh water at 300-5OOm).

A 3 ha greenhouses project is under development at ***Latera*** (Latium) which will use cascaded heat from the new ENEL geothermal power plant.

Concerning aquaculture, several large plants are operating in the Apulia coast (SE Italy) with geothermal water **for** an energy amount in the order of 16,000 TOE/year. Two plants are located at ***Sannicandro***, near Foggia, and use almost 1,500 m3/h of 25°C saline water from several shallow wells. One produces 500 tons of sea bass, sea bream and eels. The other grows decorative fishes. North of ***Brindisi*** a large hatchery-nursery uses 5,000 m^3/h of 19°C salt water pumped from several 250 m deep wells, while an important sea bass and sea bream culture (200 t/y) located at the Southern outskirts **of** Brindisi offtakes almost 400 m^3/h of 25°C saline water from 200 m deep wells.

Some smaller geothermal fish **farms** are developed in Tuscany and Veneto.

Comments

Development of agricultural uses of geothermal energy in Italy started only in the late Sixties (greenhouses at ***Galzignano*** near the long existing Abano spa facilities). The oil crisis and the related governmental and EC support measures enacted in the late Seventies and during the Eighties gave a strong impetus to new developments, but only where a local resource was available (warm water from springs or shallow water wells; hot fluids from abandoned oil wells or from unsuccessful drilling for high enthalpy resources; cascaded steam from geothermal power plants).

Amiata, ***Pantani***, ***Rodigo*** are the main greenhouses thus built and ***Orbetello, Sannicandro*** and ***Rodigo*** again the most important fish farms erected. In the Nineties the low oil prices (even though balanced in Italy by an almost equivalent increase in fiscal take) have contributed to a lessened interest in "Renewables" in all sectors including agriculture. However some important fish farming projects have seen the light in Apulia where suitable geothermal water was abundant and cheap.

Concerning the near future no sizable new developments are expected.

The outlined situation stems from a number of factors, aside from the already mentioned low oil prices:

- limited market growth in general of heat-assisted agribusiness, particularly greenhouses;
- large acreage of geothermal greenhouses as compared to the Italian traditional average size;
- high front-end investments (except for shallow wells), compensated however by low operating costs;
- existence in unproven areas of the mining risk (risk of not finding the resource with the required specifications);
- little or no knowledge of the local availability of already proven geothermal resources and of their way of use;
- existence of heavy bureaucratic and legal hurdles.

While these factors are critical and require appropriate actions *to* be overcome, there are some points which play in favour of a larger use of geothermal energy in agriculture.

The low-medium type of resource employed in agribusiness is available in many parts of Italy with the necessary characteristics of moderate cost and low risk.

There is an interest in agribusiness to limit the incidence of heating costs which represent a large portion of operating expenses even in the present favourable oil price situation.

The importance of the environmental aspects in any energy consuming industry, including agribusiness, is growing. Use of low-medium temperature geothermal heat, with its generally very limited pollution impact, can improve the image of greenhouse and fish farming business from the ecological point of view.

The recent (November **1998)** ITALIAN NATIONAL **ENERGY** CONFERENCE explored the ways and means *to* attain the Kyoto targets and it was decided that "Renewables" (including geothermal energy) should have a substantial role to play. In this light it can be expected that, provide adequate support measures are enacted, geothermal energy will find in the medium-longterm future more applications in Italian agricultur.

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