Proceedings World Geothermal Congress 2000
Kyushu - Tohoku, Japan, May 28 - June 10, 2000

GEOTHERMAL SPACE AND AGRIBUSINESS HEATING IN ITALTY

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Key Words: geothermal heat uses, Italy.

ABSTRACT

Non-electric uses of geothermal energy in Italy are mainly associated with the spa business, but a large share is also related to agricultural utilisation (greenhouses and fish farming) followed by space heating, including district heating (DH). The main existing applications in space heating are in the Abano area, Ferrara and Vicenza (in Northern Italy) and Larderello area (Tuscany). The most important agribusiness facilities include greenhouses at Amiata and Pantani (in central Italy) as well as the fish farms of Orbetello (Tuscany) and of Brindisi and Sannicandro (Apulia).

Concerning the near future, there is interest in geothermal district heating in Grado (on the North Adriatic coast) and in some Tuscany towns, and in greenhouse heating at Castelgiorgio (Umbria) near the Alfina geothermal field. In the longer term, moves to achieve the Kyoto environmental targets should favour the expansion of geothermal heat use in Italy.

1. INTRODUCTION

Non-electric uses of geothermal energy worldwide, with an installed capacity of 9,963 MWt, amounted to 36,910 GWh/y in 1997 (FRIDLEIFSSON, 1998), corresponding to a substitution of almost 2.9 million tons of oil equivalent per year (TOE/y). According to LUND (1996), space heating applications are prevailing (33%), followed by agribusiness including aquaculture (25%), balneology (19%), heat pumps (12%) and industry (10%).

The situation varies greatly from country by country. 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 (17% of which 10% is associated with spa hotels in the Abano area) (SOMMARUGA and VERDIANI, 1995; DICKSON and FANELLI, 1996; CARELLA and SOMMARUGA, 1999).

2. ITALIAN GEOTHERMAL RESOURCES.

Italy is one of the most important countries in the world with regard to the availability of geothermal resources. A long belt on the West side of the peninsula, from Tuscany to Campania, near Naples, is the seat of very high temperatures often exceeding 200°C at shallow to medium depth, associated with magmatic events. In the Northern half of this area several geothermal fields (generally in Mesozoic limestone reservoirs) are exploited for electricity generation with subordinate heating uses, often in the agricultural sector. The Po Valley, in Northern Italy, is underlain by a quaternary to Mesozoic sedimentary section with several aquifers at varying depth with moderate temperature, but occasionally (Abano, near Venice; Ferrara, north of Bologna) reaching relatively high values (70-100°C) at no great depth. A certain number of geothermal projects, mainly for residential heating and spas, but also for agricultural uses, are in operation.

Ground water is abundant in many Italian regions and, especially when tepid, is used for fish farming (Tuscany, Apulia).

Geothermal heat pump (GHP) uses of this resource are not common in Italy, contrary to Central and Northern Europe examples.

3. GEOTHERMAL HEAT USE IN SPACE HEATING

Even though medium-low temperature water is available in large quantities at reasonable depth in Northern Italy and Tuscany, few towns are geothermally heated.

Geothermal space heating in Italy, including use in hotel facilities in the Abano area amounts to the equivalent of 40,000 TOE/year. Energy from currently operating geothermal DH systems (12,000 TOE/y out of the 15,000 available) represents 2.3% of energy from all existing DH plants (AIRU, 1998 mod.). The main geothermal space heating plants are briefly described hereunder.

3.1 Abano area (Veneto).

The largest direct use of geothermal heat occurs in the Abano area and consists in the individual heating of a large number of spa hotels and of a spa centre. It represents one of the most important examples of integrated use of geothermal energy for health purposes, space and recreational heating in Europe (DAINESE, 1992, CARELLA, 1992).

The Abano area extends for some twenty km^2 at the eastern edge of the Berici-Euganei volcanic ridge in Veneto (NE Italy). Several resort towns are located in this sector, famous for its numerous hot springs, with many hotels dedicated to the health and relaxation business. Abano is the most important spa town with about 80 hotels, almost all of which produce their own geothermal water. In all, including other neighbouring resort towns, some 120 hotels are fitted with their own geothermal facilities. Approximately 230 wells at an average depth of 400 m are currently producing, by pumping, 3,600 m^3/h of water from fractured Upper Mesozoic limestone. Temperature ranges from 65°C to 87°C and salinity between 2.5 and 6 g/l. The main tourist season is in spring and autumn. Average water production throughout the year is about 2,500 m^3/h. Most hotels have two producing wells and are connected with spa facilities. The utilisation scheme is quite simple and includes a set of heat exchangers which pass the geothermal heat to a separate fresh water circuit for space heating and sanitary water needs. Hot and cold water storage tanks are common but a back-up fuel boiler is seldom provided, and emergency needs are taken care of by withdrawing heat from nearby wells. A large proportion of the geothermal fluid is used directly, after filtering, for health treatments and to supply the swimming pools. The exhausted thermal water, with a temperature of about 40-45°C, is discharged at surface. The total heated space is about 2.5 million m^3, in addition to 200 swimming pools. Substituted energy is estimated to be 25,000 TOE/y for space heating and 90,000 TOE/y for therapeutic and recreational uses.

3.2 Ferrara (Emilia-Romagna)

The Ferrara geothermal field, in NE Italy, was discovered following oil and gas exploration carried out by AGIP. In

1956 the well *Casaglia 1,* drilled to the depth of 3,379 m on a large structural high without finding hydrocarbons, intersected a 100°C aquifer starting at about 1,100 m depth in fractured Mesozoic carbonates. *Casaglia 1* was re-entered in the late seventies and tested in 1981 under a joint-venture with ENEL, the Italian national utility, with AGIP acting as operator. As exploitation of the resource required reinjection of the spent fluid, a new well (*Casaglia 2*, about 1 km from *Casaglia 1* and 1,960 m deep) was completed in 1981. This well has a high productivity (up to 400 m^3/h when pumped) of 100°C water with salinity of 65 g/l.

After signing a preliminary heat sale contract with the Ferrara municipality in 1983, the project developed slowly on the downstream side until 1990 when the first geothermal heat delivery took place. The initial mining facilities consisted of *Casaglia 2* well used as producer (at rate of 200 m^3/h when pumped) and *Casaglia 1* acting as reinjector. In 1995, a second producer (*Casaglia 3*) was drilled, parallel to and a few metres from *Casaglia 2,* to a depth of 2,000m, doubling the flow-rate from the field.

The surface equipment operates in closed circuit at 18 bar. Anticorrosion additives are injected in the producing wells. At the production site a filtering unit, followed by a set of three titanium plate heat exchangers pass the available heat to a fresh water circuit feeding the district heating system, owned by the Ferrara Municipality and operated by its company AMGA. A pre-insulated steel double feeder line, 2 km long, carries the hot fresh water to the heat plant and conveys back the cooled fluid to the AGIP-ENEL heat exchangers. The heat plant is composed of: the feeder terminal; two hot water and two cold water storage tanks, each of 1,000 m^3 volume; and four peak-load and back-up gas boilers with a total capacity of 36 Gcal/h. A 150 ton/day solid waste incinerator with a potential of 36 Gcal/h provides additional heat. The district heating network covers an extensive central area of the town starting from the NW outskirts. Input temperature of the hot water is 90-95°C and pressure varies from 9 to 19 bar; return temperature averages 60°C. A grid of 26 km of pre-insulated double steel pipes connects 250 substations for a total of 2.5 million m^3 of residential and tertiary heated space. Geothermal energy provides 5,000 TOE/y (almost 60% of total needs) as compared to about 25% from the incinerator and 15% the gas boilers.

During 1999 a 3.3 MWe cogeneration unit has been installed at the central heat station and the DH network is being extended to adjoining town quarters with a target of 0.5 million m^3 additional heated space. Another action will involve optimisation of the central heat station and of end users equipment (ARDIZZONI and ARTIOLI, 1999).

3.3 Vicenza (Veneto)

Warm fresh water from Mesozoic limestones was discovered in 1977 in well *Villaverla 1*, located 14 km North of the town of Vicenza (NE Italy) in the course of AGIP's oil and gas exploration. Subsequent studies led to conclusion that the same hot aquifer should be present under Vicenza.

After signing a preliminary sale agreement with the municipal company of Vicenza. A.I.M., AGIP and ENEL in joint venture drilled a well in the town in 1983. *Vicenza 1* was completed in Mesozoic age limestones at 2,150 m, producing when pumped up to 125 m^3/h of 67°C fresh water. After signing a final sale contract for the hot water between the parties, A.I.M. developed the whole district system starting in 1988 and geothermal heating began in the second half of 1990.

The heat plant (LEONI, 1995) consists of a stainless steel plate heat exchanger; three heat pumps (for a total of 7 Gcal/h) with connected cooling towers; three peak and back-up gas fuelled boilers (for a total of 15 Gcal/h) and one geothermal water storage tank (capacity 200 m^3). The district heating network includes a 7 km one-way domestic hot water line supplying directly about 20 m^3/h sanitary hot water to the end-users. Space heating is provided by a parallel 7.4 km double line in pre-insulated steel pipe. Inlet network temperature is 90°C and outlet 60°C. Air conditioning is through cold water (inlet 6°C, outlet 12°C) in the same line. After heat extraction, the geothermal water is discharged in the town drainworks at 20-25°C. The system services 74 main users, heating a volume at 1.33 million m^3. Energy substituted is around 2,700 TOE/y and savings amount to 3,300 TOE/y. Use of geo-heat has been suspended in recent years, due to a dispute over the geothermal water price.

3.4 Acqui Terme (Piedmont)

Another geothermal plant using heat pumps is that of Acqui Terme, in NW Italy (PREZIUSO, 1989). Acqui is a spa town with a single hot spring (*La Bollente*) with a temperature of 70°C and a free-flow of 33 m^3/h. The geothermal plant owned by Acqui Terme municipality was designed to use the spring water when spa facilities are closed (spring, autumn and part of winter). The heat station consists of a plate heat exchanger; two gas fed heat pumps and two back-up gas boilers (total capacity 3.6 Gcal/h). The district heating network is a two-way preinsulated steel line, 2.2 km long, with input temperature of the water 80°C and output 60°C. It serves 11 substations, all in public buildings, with 130,000 m^3 of heated space. The spent geothermal fluid should have a temperature of 35°C. Energy from the geothermal source should be 300 TOE/y. The system was built in 1986-87 and started in operations in 1989. Because authorisation to use the spring water has not yet been granted the district heating network is fed provisionally by conventional fuels.

3.5 Bagno di Romagna (Emilia-Romagna)

Bagno di Romagna is a small spa town in the northeastern Apennines, with 45°C springs. The Municipality developed on its own, between 1983 and 1986, a geothermal district heating system, which went on stream in 1987 (CANESTRINI *et al*, 1990). The resource availability was confirmed by some very shallow wells (up to 130 m depth). Over 200 m^3/h of 30 to 40°C geothermal water with around 1 g/l salinity were located in fractured sandstones of Miocene age. Presently use is made of well n.*3*, 50 m deep, which produces when pumped 90 m^3/h of 37°C water. Although the well is located only 400 m from the main spring, no interference has been noticed. The heat plant consists of: two gas-electric heat pumps with heat recuperator (total capacity 1.3 Gcal/h); two cogeneration units which generate heat (0.9 Gcal/h) and electricity (0.6 MWe) and three back-up boilers (gas and gasoil fed) with a total capacity of 4.4 Gcal/h. The network consists of 9 km of two-way preinsulated steel pipes. Inlet temperature of the hot water is 80°C and return 60°C. Several hotels and houses are served with a heated space of 220,000 m^3. Spent geothermal water at 20 °C is rejected in a nearby river. Excess electric power is exchanged or sold to ENEL. Geothermally derived energy is about 500 TOE/y.

Ongoing expansion of the grid will double the connected space by the end of 1999.

3.6 Tuscany

ENEL is the only producer of electricity from geothermal energy in Italy, with plants located predominantly in Tuscany, SW of Florence. In several small towns direct use is made of part of the steam available for power generation and/or of steam unsuitable for electricity production (BURGASSI *et al,* 1995). Part of such fluid is used in district or centralised heating. Thermal power available for operating district and centralised heating in the ENEL area in Tuscany is about 30 Gcal/h. Consequent energy use amounts to about 6,500 TOE/y.

The largest operation is in the **Pomarance** municipality where DH is installed in four suburbs (Larderello, Montecerboli, Serrazzano and Lustignano) with a total capacity of 21.1 Gcal/h. In **Larderello** offices and living quarters of ENEL are served directly, while the other systems are owned by the Municipality. The main fluid used is power-plant grade steam at 160-200°C, tapped from steam-lines, while **Lustignano** employs 170°C steam from a dedicated well. Heat is transferred from the steam to the district heating water circuit in shell-and-tube heat exchangers. Return temperature is 70 to 95°C. Another small district heating network serves **Monterotondo Marittimo** using 95°C steam (return temperature 70°C). Installed power is 1.5 Gcal/h.

The **Castelnuovo V.C.** municipality employs geothermal district heating in its centre and in the Sasso Pisano suburb. The Castelnuovo heat plant (5.4 MWt), completed in 1987, was fed with high-grade steam tapped from the pipeline to the Castelnuovo power station. The plant was recently refitted to use low-pressure 105° C steam from shallow wells and a separate distribution line for hot domestic water was laid down. Steam from the power station network is used only in peak periods. Space heated is 200,000 m^3. An expansion plan is under way to heat additional 80,000 m^3.

The **Sasso** heat plant owned by ENEL (while the district heating network belongs to the Municipality) was completed in 1998. With its 1.8 Gcal/h it serves 150 buildings with a volume of 50.000 m^3. Steam, at low pressure and with temperature of 105°C, from existing refitted shallow wells is fed to a shell-and-tube heat exchanger to cover base load needs of the district heating system. Peak demand is satisfied by steam tapped from the line feeding the Sasso Pisano power station, through a second shell-and-tube heat exchanger. The heat plant has a gas disposal unit. Spent geothermal fluid, with a temperature of 70°C, is reinjected.

A proposed DH project, designed to heat the National Geothermal Research Centre (I.I.R.G.) and some residential suburbs at **S**. **Cataldo** near Pisa was abandoned after a well drilled by ENEL in early 1999 to an inclined depth of 1,044 m into very friable Mesozoic dolomites with a temperature around 50°C was considered uneconomic to complete.

3.7 Possible developments

Beside the reviewed plants, few new geothermal DH projects may be enacted in the near future. ENEL has proposed to the local Tuscan authorities to make available geothermal heat from existing power plants or unused productive wells for DH systems in the towns of **S. Fiora** (already under bidding) and **Piancastagnaio.** Space heated would be around 1 million m^3 and energy savings nearly 7,000 TOE/y. On the NE Adriatic coast, the resort town of **Grado** is interested in a geothermal DH heating involving also spa uses to connect some hotels a tourism centre and a new holiday village. The system would be fed by water (at an estimated temperature of 50-60°C) from 1,000 m well to be drilled to a Mesozoic carbonate reservoir on a large structural high.

4. GEOTHERMAL HEAT USE IN GREENHOUSES

Use of heat in agriculture is limited to high revenue products, whose sale can recoup the relatively high costs of the process. One of the main applications is flower-growing. The Italian floriculture industry is the third in the world in monetary worth and fifth in acreage. Greenhouses cover some 30,000 ha, of which about 30% are equipped with heating systems.

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 ha heated) use geothermal energy. The share is minimal (about 0.5%). A similar situation occurs in the rest of the world, where only 850 out of over 200,000 ha of greenhouses are geothermally heated (POPOVSKI, 1998). Almost all the Italian geothermal greenhouses are dedicated to flower and potted plant growing, with minor horticultural applications. A brief description of the main plants is given hereunder.

4.1 Amiata (Tuscany)

In this area, located in the Piancastagnaio municipality (Tuscany), a 23 ha greenhouse complex utilises geothermal residual hot fluids from a nearby 8 MWe power station owned by the national utility ENEL. The greenhouses, once belonging to the then public ENI oil group, are presently privately controlled by the FLORAMIATA company. The project was originally developed to utilise locally available manpower after the closure of a mine in 1984. Hot water at 90°C is recovered at a condenser near the electric plant, and heat is transmitted via adjoining steel plate heat exchangers (2,000 t/h of 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 (in glass and fibreglass) is heated by fan coils and partly through underground piping. Temperature in the utilisation network drops from 80°C to 40°C and the spent fluid is reinjected near the condenser. Peak load and emergency support is assured by conventional boilers (ENEL, 1995). Average yearly heat consumption, over a period of 3,000 hours, is estimated 13,000 TOE/year. Both indoor plants and cut flowers are produced. About 250 people are employed, increasing to 500 in peak periods.

4.2 Pantani (Latium)

Following the discovery by ENEL of shallow hot water in a 500 m deep well near Civitavecchia (Latium, North of Rome) in 1960, a private flower growing firm, ALBANI & RUGGIERI, has developed 18 hectares of glass greenhouses (CARELLA, 1992). Ten wells were drilled to the depth of 350 to 500 m in a limestone Mesozoic reservoir, of which five to six produce, when pumped, an average of 180 m^3/h each of 3-4 g/l water at a temperature around 50°C. Spent water is reinjected in the remaining four or five wells at 35°C. No support boilers are installed but geothermal heat is supplemented at times by 80°C water accumulated in a reservoir fed irregularly by a nearby ENEL conventional power plant. Steel plate heat exchangers transmit the geothermal heat to a secondary circuit of underground and under-bench pipes and to fan convectors. Heating hours are around 1,800-2,000/y. Substituted energy amounts to 3,000-3,500 TOE/year. Flowers and potted plants are grown. Staff includes 55 employees on a permanent basis and 150-200 part-time. During the over 10 year period of full activity the reservoir has behaved very positively, with no decrease of temperature or flow-rate of the geothermal water.

4.3 Galzignano (Veneto)

This is the first geothermal agricultural plant of commercial size installed in Italy (MARTINO, 1989). Owned by a cooperative society, it began its activities in the late Sixties and has been successfully operating since. The plant is located in Veneto (NE Italy) within the *Abano* high temperature anomaly, whose resources are mostly dedicated to spa related activities. The 3-hectare glass and plastic greenhouses use the heat from three shallow (200-300 m deep) wells drilled between 1966 and 1984. The reservoir is in Mesozoic limestones and the non-saline fluid has a temperature of 63°C with a total flow when pumped of around 120 m3/h. After circulating in steel plate heat exchangers, the geothermal water is discharged at a temperature of 30-35°C. Back-up boilers are installed and various heating equipment is used (fan coils, near ground pipes, etc.). Tropical potted plants are grown and a staff of about 40 people is employed. Utilised geothermal heat amounts to 1200 TOE/year.

4.4 Rodigo (Lombardy)

The project (CARELLA, 1992) which features the only cascaded use of direct geothermal heat was originated by the availability of hot water from a dry AGIP oil well drilled in Lombardy Po Plain in 1975. The well was handed over free of charge to the Municipality of Rodigo which will bear all costs for abandoning the site at the end of operations.

The reservoir is a Mesozoic carbonate 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 half of this quantity for integrated and cascaded heating of 1 ha greenhouses and a fish farm. Geothermal heat, with a temperature drop from 59° to 38°C, is used in the greenhouses to grow potted flowers and plants and nursery vegetables from November to April (about 4,000 hours). Heating equipment includes suspended finned piping and under-bench tubing. Eels are raised in ponds all year around at the temperature of 20-25°C in geothermal water diluted with cold water from shallow wells with the addition of liquid oxygen. Eel production is about 180 tons/year. The system is owned and operated by a local cooperative society. A staff of 20 people are employed, increasing to 30 during peak periods. Overall substituted energy is around 1,400 TOE/y, of which 400 is in greenhouses.

4.5 Other plants and possible developments

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 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 up to 40-50°C fresh water at 300-500m in Quaternary clastics). A 3 ha greenhouse project has been completed at **Latera** (Latium) and will use, from the end of 1999, cascaded heat from the new ENEL geothermal power plant. Other greenhouses have been proposed at **Castelgiorgio** (Umbria), near the Alfina geothermal field.

5. GEOTHERMAL HEAT USE IN FISH FARMING

Italian fish farming industry is one of the most important in Europe. It employs 15,000 people and is a high-growth sector especially for what concerns sea fish species (mainly sea bass and bream) whose present-day production is around 10,000 t/y, third in Europe after Greece and Turkey. Of this amount nearly 2,000 tons are geothermally raised. Some large operators in Orbetello (Tuscany seashore) and in the Apulia (South Adriatic coast) grow fish with tepid near surface geothermal water, thus cutting drastically the time needed for market-ready specimens. The corresponding geothermal heat availability is nearly 40,000 TOE/year.

The main operations are described hereunder.

5.1 Orbetello (Tuscany)

A large geothermal aquaculture operation consisting of three main plants (COSIMA, VIGNETO, ITTIMA) and a minor one is located on the Tuscany Tyrrhenian sea-shore, in a lagoonal area where several conventional fish farms are active (CARELLA, 1992). Some 45 wells, less than 100 m deep in karstified Mesozoic limestones tap generally saline (up to 36 g/l) water at a temperature of 19 to 25°C (average 21°C). Total flow rate on pump is 7,200 m^3/h. Species raised include sea bass, sea bream, mullet and eel. Total fish production is around 900 tons per year and personnel employed are of the order of 60 people. The use of warm water considerably shortens 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 all year around directly to the various ponds and is oxygenated by mechanical shakers or by adding liquid oxygen. A common handling and storage facility has been recently completed.

5.2 Apulia

Several large privately owned fish farms installed in the Apulia coast of SE Italy utilise tepid 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 m^3/h of 25°C saline water from several shallow wells. One farm (AGROITTICA) built in 1985, produces 500 t/y of sea bass, sea breams (80% of total) and eels (20%). The other (EUROQUALITY) grows decorative species (mainly redfish). North of **Brindisi** PANITTICA PUGLIESE owns a large hatchery-nursery which uses 4,900 m^3/h of 19°C salt water pumped from several 250 m deep wells. Beside fry, some market size fish are also produced. At the southern outskirts of Brindisi ITTICA SUD raises sea bass and sea breams in a plant using almost 400 m^3/h of saline water, at a temperature of 25°C, from 200 m deep wells. Production is 200 ton/year.

5.3 Other plants

Some smaller geothermal fish farms exist in Tuscany and Veneto-Friuli.

In Tuscany, near the town of **Castelnuovo V.C.**, steam at 110°C is used via heat exchangers to warm fresh water of a fish farm at the temperature of 25°C to raise up to 20 ton/y of elvers. The plant (partly experimental), on stream since 1993, is privately owned by COSVIG, while the geothermal fluids is provided by ENEL. In coastal Friuli and Veneto (on the same thermal anomalous area where some greenhouses are geothermally heated) several shallow wells with individual free-flow rate of up to 40 m^3/h are used for aquaculture: 24°C water feeds a farm in **Carlino** municipality (Friuli) to raise 50 t/y of sea bass and eels. On the Veneto side, in the **Caorle** and **S. Michele al Tagliamento** municipalities, some fish farms use 25°C to 34°C water from 400-500 m deep wells within a Quaternary clastic reservoir.

6. GEOTHERMAL HEAT PUMPS (GHP)

This conditioning technique is widely used in neighbouring countries (Switzerland, Austria, Germany), mostly in small house units but very limited developments have occurred in Italy, even if this country was a forerunner in the field (GHP in Milano, since 1935). Compared to the over 20,000 Swiss units, existing Italian GHP are guessed to be a few hundred.

The prospects for growth in this sector in Italy are attractive, especially in the Alpine and Appennine sectors not yet reached by the natural gas network. The market potential for medium-large GHP units is being studied by ENEA (Agency for Renewables) together with ENEL and others under a program supported by EC (DA DALT *et al,* 1999).

7. COMMENTS

Development of direct uses of geothermal energy in Italy, except those connected with another main applications (heating in Abano hotels related to balneological activity and space heating in Larderello area tied to geothermal power production), started after the oil crisis and consequent governmental and EC support measures enacted in the late Seventies and during the eighties, mainly where a local resource was available or could be inferred. In the nineties the low oil prices have lessened interest in geothermal direct uses, even though some important fish farming projects have been developed where a suitable resource was abundant and cheap.

Concerning the near future few sizeable new developments are expected. Building of new geothermal plants in Italy is conditioned by a number of factors, apart from low oil price situation: mining risk; poor knowledge of existing resources; high front-end costs compared to conventional systems; bureaucratic and legal hurdles; preference for individual heating and small-size greenhouses; limited market growth of DH and of heated greenhouses, with natural gas dominating the market.

While these factors are critical, the increased attention to environmental problems (Kyoto targets) favours a larger use of renewables, including geothermal energy, as indicated by the November 1998 National Energy and Environment Conference. It can thus be expected that, provided adequate support actions are undertaken, geothermal direct energy uses, with their limited pollution impact,will increase in the medium-long term future.

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Table 1 ITALIAN GEOTHERMAL SPACE HEATING AND AGRICULTURAL USES

	VOLUME or AREA	TEMPERATURE (°C) In – Out (1)	UTILIZATION Flow rate (m^3/h)	Time (hours/y) (2)	ENERGY OUTPUT (TOE/y)	POWER (4) (MWt)
SPACE HEATING -Volume (x$10^6 m^3$)						
Abano area	2.50	65/80 - 40/45	1,500	3,600	25,000	61.0
Ferrara	2.50	95 - 60	400	2,500	5,000	16.3
Vicenza (3)	1.33	67 - 25	125	2,500	2,700	6.1
Acqui T.(3)	0.13	70 - 35	33	2,500	300	1.3
Bagno Romagna	0.22	37 - 20	90	2,500	500	1.8
Tuscany (several towns)		95/180 -70/95			6,500	34.5
Heat pumps			*(m i n i m a l)*			
					40,000	**121.0**
GREENHOUSES - Area (ha)						
Amiata	23	90 - 50	2,000	3,000	13,000	93.0
Pantani	18	52 - 35	1,100	2,000	3,500	21.7
Galzignano	3	63 - 35	120	3,000	1,200	3.9
Rodigo	1	59 - 38	40	4,000	400	1.0
Others	7				2,900	14.0
	52				**21,000**	**133.6**
FISH FARMS						
Orbetello		21 - 15	7,200	4,300	17,000	50.2
Sannicandro		25 - 15	1,500	4,300	6,000	17.4
Brindisi		19/25 - 15	5,300	4,300	10,000	43.1
Rodigo		38/59 - 12	40	5,700	1,000	1.7
Others					5,000	20.0
					39,000	**132.4**
				TOTAL	**100,000**	**387.0**

References:.
1) Reference temperature is used for aquaculture and relates to the average temperature during the cold season of the nearest water body.
2) Aquaculture utilization time is all year around, but for calculation of energy output only the period during which the water body is cooler than the geothermal water is considered.
3) Temporarily operating with conventional fuel.
4) Power (MWt) = Water flow rate (kg/s) x (inlet temp. – outlet temp) (°C)) x 0.004184.

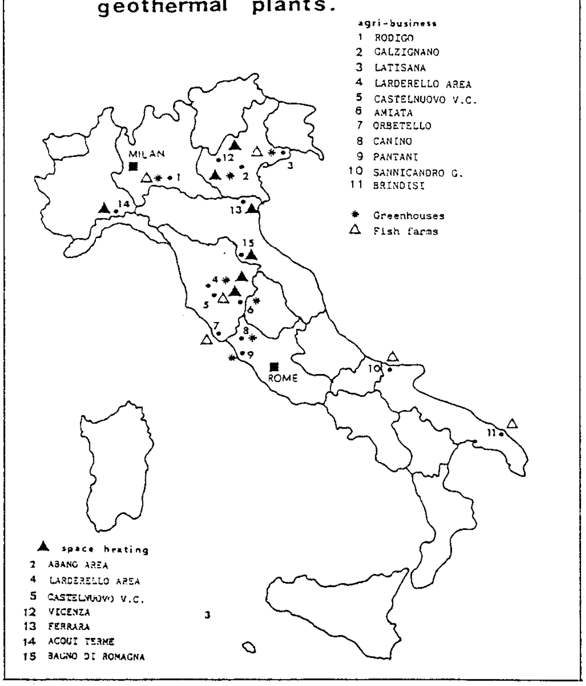

Fig.1 - Italy- space heating and agricultural geothermal plants.