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Direct Uses of Geothermal Energy in Italy 2000–2004 Update Report

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ABSTRACT

Direct uses of geothermal energy in Italy have remained almost stable over the last five years.

New developments include Pomarance district heating and refurbishing of the Floramiata greenhouse plant (Tuscany), as well as some activities in the GHP sector in northern Italy.

Considering fluids above 30°C, the prevailing use is related to health spa and well-being treatments (almost 2,700 TJ/yr), followed by civil heating, including spa hotels and resorts, (around 1,700 TJ/yr), and greenhouse uses (about 1,100 TJ/yr). The total, including minor industrial applications and two small fish raising plants, amount to over 5,600 TJ/yr.

As concerns geothermal energy below 30°, very large volumes of low-temperature water are used in fish farming, for a heat amount of over 1,400 TJ/yr, while heat pumps are still a minor, but growing development.

In total, over 7,000 TJ/yr of terrestrial heat produced and utilized for non-electrical generation purposes.

1. INTRODUCTION

Italy is famous worldwide for the presence of high enthalpy geothermal resources that have been developed and utilized mostly for electricity generation. There are also several non-electric applications that make Italy one of the leading countries in Europe for the direct uses of geothermal heat. The steady development of geothermal heat pumps (GHP) in central and northern Europe has increased the direct uses in countries like Germany, Switzerland, Sweden and Austria, strengthening also France ranking. Italy, however, makes a large use of low temperature water for fish farming and employs a very sizable quantity of geothermal heat in spas.

Overall, the present Italian situation can be described as nearly stagnant, notwithstanding the large available resource and the granting of economic incentives for some uses of geothermal heat (which, however, are fixed in the annual budget law, thus encompassing the risk of non-renewal of the benefits).

On preparing this paper the authors have reviewed and analyzed previous data and updated the information on plants in operation from several years as well as data relevant to new developments, both by means of direct contacts and personal estimates.

The results thus indicates a 487 MWt capacity for the year 2003, and a 7,054 TJ/y production, of which 408 MWt and 5,814 TJ/y from fluids above 30°C, and the rest from lower temperature waters used in fish farming.

The data relevant to the plants in operation are presented in Table 3 and the share of the main categories of direct heat applications is show in Table 5.

The importance of the spa industry in direct uses of geothermal energy is quite evident. This activity is in evolution, with a growing sector dedicated to well-being, while the curative sector is stagnant.

The spa business employs some 70,000 people, with over 300 million Euro turnover, which reaches 2,140 million Euro if dedicated suppliers are also included.

2. ITALIAN GEOTHERMAL HEAT PLANTS

With reference to the previous papers presented at the WGC 2000, where the main plants and applications were described (Carella et al. 2000, Cappetti et al. 2000), in this paper an update of the major variations occurred in these last five years are presented.

Leisure and health uses

Spa treatment uses are the ones which cover the largest share of geothermal heat in Italy, with two prevailing resort areas: the Abano district (Euganei Hills) and Ischia island. Respectively, these locations have an estimated annual energy output of 1,684 and 576 TJ/y dedicated to spa recreational and curative purposes.

As for the Abano district, the previously indicated data (Carella et al. 2000) have been reviewed after a thorough discussion with the operators: the maximum flow rate has been progressively reduced to a value closer to the natural recharge, to avoid the depletion of the resource, while the utilization has been improved. Upstream activities carried out in these last five years in the Abano district include the drilling of some replacement wells, and of a new production well in an undrilled area.

Spa uses in the Ischia island, where around 80 hotels have geothermal wells and cure facilities, are also very important. The revised estimate is based also on recent studies carried out by the Campania Regional Authority and the “Federico II” University of Naples.

A small leisure and sport facility has been recently installed in Rodigo (Lombardy), complementary to the existing geothermally heated greenhouses, for an energy use of 14 TJ/y.

Taking also into account 400 TJ/y that can be attributed to the other unlisted facilities (the most important of which have been already described in Carella et al. 2000) the total amount of energy use for spa is 2678 TJ/y.

Residential space heating

This important sector (which includes sanitary water) accounts for 1,711 TJ/y of direct heat uses, 1,009 of which for individual plants in the Euganei Hills and Ischia island areas, plus 100 TJ/y for unlisted spas.

The largest share of this amount is utilized in the Euganei spa district, where some 120 hotels are heated and sanitary water is provided for. The related value (907 TJ/y) is lower than that indicated in WGC 2000, because of a re-evaluation of the data relevant to the space heating in Abano hotels.

Ischia island, which is the second largest spa resort area in Italy, has limited heating needs for the hotels, about 102 TJ/y, thanks to its mild climate, but even so ranks third after the large and most important Italian geothermal district heating of Ferrara, with an annual utilization of 279 TJ/y.

A new district heating plant was put in operation at the end of 2002 in Pomarance, a small town north of Larderello. The plant will provide heat for the equivalent of 55 TJ/y.

Vicenza and Aqui Terme district heating plants, the first of which operated for some years with geothermal energy and the second designed originally as geothermal, are now operated by burning gas and are therefore not included in our statistics.

The application of GHP in Italy is still limited, but gradually growing, albeit at slow pace. A few operators have entered the field, and important heat pump manufacturers do exist. GHP (water-fed heat pumps) are marketed in Italy at the rate of 500 units/year (in 2002 and 2003). Around 6,000 units have been installed up to now, some hundreds of which are of the closed loop type. Commercial applications include a large GHP unit conditioning a 4,000 sq m mattress factory in Pocenia (NE Italy). Adopting the criteria used by Lund and Freeston (WGC 2000) the capacity estimate for the Italian GHP sector is some 120 MWt, and the energy amount 500 TJ/y.

Fish farming

Because of the high volume of produced fluid, and notwithstanding the low temperatures involved, this sector represents an important contribution to Italian direct uses of geothermal energy.

To calculate the heat available the authors have used, as outlet temperature, a reference value which corresponds to the average temperature of the nearest water body during the cold season. Even though utilization time in aquaculture is all year around, the energy output is calculated only for the period in which the reference water body is cooler than the geothermal water.

The main plants have already been described in Carella et al., 2000. There has been a limited reduction of fish production, and consequently of heat extracted in some of the farms. Heat output is estimated 1,318 TJ/y for the listed plants, to which some 170 TJ/y have been added added to account for smaller unlisted plants in operation in Italy.

Greenhouses

The use of geothermal heat in the greenhouse sector is fairly stable. The large Floramiata plant in Tuscany is being refurbished and will be connected to the Piancastagnaio 3 power station. Two previously unlisted greenhouses in the Euganei area (Galzignano FLORIDA and Baone) have been included in Table 3. The small demonstration plant in Canino (Latium) has been closed. Rodigo has doubled the amount of geothermal water used and provides heat to a new sports resort centre.

The total amount of heat used in greenhouses is estimated 1000 TJ/y, plus for 130 TJ/y small unlisted plants.

Industrial uses

A new project for the utilization of geothermal fluids as process heat started recently the operation in the S. Martino cheese factory at Monterotondo Marittimo (Tuscany). On the other hand, the ECOMILK project (Tuscany) is not more operational, and the industrial applications in the Larderello area have been reduced to 47 TJ/y. Production and sale of carbon dioxide from a geothermal well of the Torre Alfina geothermal field is still in operation.

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Table 3- Utilization of geothermal energy for direct heat as of 31 December, 2004

[1] I = Industrial process heat
C = Air conditioning (cooling)
A = Agricultural drying (grain, fruit, vegetables)
F = Fish farming
K = Animal farming
S = Snow melting
H = Individual space heating (other than heat pumps)
D = District heating (other than heat pumps)
B = Bathing and swimming (including balneology)
G = Greenhouse and soil heating
O = Other (please specify by footnote)

[2] Enthalpy information is given only if there is steam or two-phase flow

[3] Capacity (MWt) = Max. flow rate (kg/s)[inlet temp. (^{o}C) - outlet temp. (^{o}C)] x 0.004184 (MW = 10^{6} W)
or = Max. flow rate (kg/s)[inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg)] x 0.001

[4] Energy use (TJ/yr) = Ave. flow rate (kg/s) x [inlet temp. (^{o}C) - outlet temp. (^{o}C)] x 0.1319 (TJ = 10^{12} J)
or = Ave. flow rate (kg/s) x [inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg)] x 0.03154

[5] Capacity factor = [Annual Energy Use (TJ/yr)/Capacity (MWt)] x 0.03171
Note: the capacity factor must be less than or equal to 1.00 and is usually less, since projects do not operate at 100% of capacity all year.

Locality	Type[1]	Maximum Utilization					Capacity[3]	Annual Utilization		
		Flow Rate	Temperature (^{o}C)		Enthalpy[2] (kJ/kg)			Ave. Flow	Energy[4]	Capacity
		(kg/s)	Inlet	Outlet	Inlet	Outlet	(MWt)	(kg/s)	(TJ/yr)	Factor[5]
Bagno di Romagna	D	19,4	40	20			1,62	2,1	5,5	0,11
Brindisi Ittica Sud	F	500,0	25	15			20,93	250,0	329,8	0,50
Castelnuovo V.C.										
Comune	D	5,3	120	80	2600	360	11,87	1,3	90,7	0,24
Isolver	D	0,0	117	70	2600	300	0,07	0,0	0,6	0,29
Guppy Italia	F	0,5	105	70	2580	300	1,14	0,3	22,9	0,64
La Boracifera	G	1,1	120	80	2600	360	2,46	0,4	26,1	0,34
Civitavecchia (Pantani) - Albani	G	305,6	52	25			34,54	69,8	248,4	0,23
Euganei										
Abano Terme		409,5	* 78	35			73,73	273,0		0,67
	B								1006,4	
	H								541,9	
Baone	G	8,2	52	35			0,59	5,5	12,3	0,67
Battaglia Terme		19,7	70	35			2,88	13,1		0,67
	B								39,3	
	H								21,2	
Galzignano		69,8	70	35			10,23	46,5		0,67
	B								139,6	
	H								75,2	
EUGANEA FLORIC.	G	33,3	63	35			3,90	22,2	82,0	0,67
FLORIDA	G	16,3	63	35			1,91	10,8	40,0	0,67
Montegrotto		236,0	* 72	35			36,56	157,3		0,67
	B								499,1	
	H								268,8	
Ferrara	D	111,1	95	60			16,28	60,4	278,8	0,54
Ischia Island		500,0	* 65	35			62,80	171,2		0,34
	B								575,9	
	H								101,6	
Monterotondo M.mo										
COMUNE	D	5,8	95	70	1000	300	4,06	1,4	31,1	0,24
LA BORACIFERA	G	0,8	125	80	2600	360	1,79	0,3	18,3	0,32
Orbetello **	F	1550,0	21	15			38,94	775,0	613,3	0,50
Piancastagnaio FLORAMIATA	G	17,5	97	50	2200	200	35,00	8,4	529,6	0,48
Pomarance										
COMUNE ***	D	10,7	160	80	2640	360	24,37	1,1	76,3	0,10
Larderello villaggi	D	1,4	160	80	2640	360	3,19	0,3	23,6	0,23
Larderello industriale	D	5.6	160	80	2640	360	12,77	1,3	96,3	0,24
ENEL Larderello imp. sport.	B	0,3	200	80	2720	360	0,71	0,1	4,2	0,19
SCL Larderello	I	4,3	200	80	2720	360	10,15	0,6	46,7	0,15
Radicondoli PARVUS FLOS	G	0,6	120	80	2580	360	1,33	0,2	13,4	0,32
Rodigo SETTEFRATI	G	18,2	60	38			1,68	10,0	29,0	0,55
	F	18,2	38	15			1,75	18,2	55,3	1,00
	B	4,0	60	25			0,59	3,0	13,9	0,75
Sannicandro AGROITTICA LESINA	F	100,0	25	16			3,77	50,0	59,4	0,50
Torre Canne PANITTICA PUGLIESE	F	900,0	19	15			15,07	450,0	237,4	0,50
Others							50,00		800,0	
TOTAL							486,68		7053,7	

* average temperature of several tens of wells
** includes COSA, IL VIGNETO and ITTIMA plants
*** includes the following separate nteworks: Pomarance town, Larderello INACASA, Lustignano, Montecerboli, S.Dalmazio, Sasso

Table 5- Summary Table of geothermal direct heat uses of 31 December, 2004

[1] Installed Capacity (thermal power) (MWt) = Max. flow rate (kg/s) x [inlet temp. (^{o}C) - outlet temp. (^{o}C)] x 0.004184
or = Max. flow rate (kg/s) x [inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg)] x 0.001

[2] Annual Energy Use (TJ/yr) = Ave. flow rate (kg/s) x [inlet temp. (^{o}C) - outlet temp. (^{o}C)] x 0.1319 (TJ = 10^{12} J)
or = Ave. flow rate (kg/s) x [inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg) x 0.03154

[3] Capacity Factor = [Annual Energy Use (TJ/yr)/Capacity (MWt)] x 0.03171 (MW = 10^{6} W)
Note: the capacity factor must be less than or equal to 1.00 and is usually less, since projects do not operate at 100% capacity all year

Use	Installed Capacity[1] (MWt)	Annual Energy Use[2] (TJ/yr = 10^{12} J/yr)	Capacity Factor[3]
Individual Space Heating[4]	57,58	1108	0,61
District Heating [4]	74,22	603	0,26
Air Conditioning (Cooling)			
Greenhouse Heating	94,21	1130	0,38
Fish Farming	91,55	1488	0,52
Animal Farming			
Agricultural Drying[5]			
Industrial Process Heat[6]	10,15	47	0,15
Snow Melting			
Bathing and Swimming[7]	158,8	2678	0,53
Other Uses (specify)			
Subtotal[8]	486,51	7054	0,46
Geothermal Heat Pumps	120	500	
TOTAL	606,51	7554	