

Geothermal Energy Use, Country Update for Italy

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1. INTRODUCTION

This summary paper reports the most relevant information from two detailed and exhaustive papers, presented at this conference, focused on direct uses and electricity generation.

- Walter Grassi, Raffaele Cataldi and Paolo Conti: **Country report on geothermal direct uses in Italy 2005-2010**, (from Unione Geotermica Italiana),
- Massimo Montemaggi, Paolo Romagnoli and Ruggero Bertani, **Geothermal Electricity, Country Update for Italy**, (from Enel Green Power).

For all the details and comments please refer to the quoted papers.

2. CURRENT STATUS OF GEOTHERMAL ELECTRICITY

All the plants in operation are located in Tuscany, in the two productive poles of Larderello/Travale and Mount. Amiata (see figure 1); all the plants are owned and operated by Enel Green Power

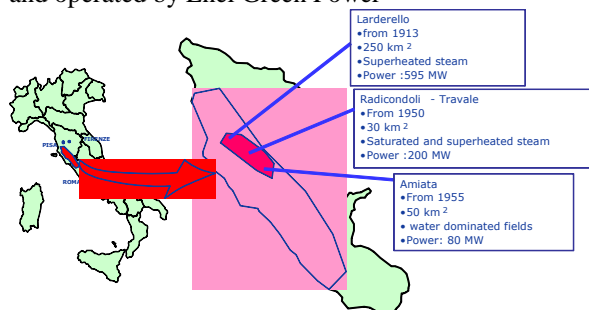


Figure 1: geothermal areas in Italy
(from Geothermal Electricity, Country Update for Italy)

After more than 100 years of exploitation Larderello field is still able to provide a sustainable development (see figure 2).



Figure 2: Historical trend of Electricity production in Italy, (from Geothermal Electricity, Country Update for Italy)

As of 31 December 2012, the following figures have been achieved:

- **Wells in Operation:** 308 for production, 69 for reinjection and 107 as reserve or field control; 96 wells have depth greater than 3 km.
- **Gathering Systems:** 207 km of steam lines, 298 km of reinjection pipes.
- **Power Plants:** 34 power units, 4 of 60 MW, 3 in the range 20-40 MW, 3 old units below 15 MW, and the majority (24) is with the standard unified design of 20 MW.
- **Capacity:** the installed capacity of 875 MWe is unevenly split in the two poles: Larderello/Travale with 795 MWe of dry steam units, and Mount Amiata, where in the water dominated field 80 MWe of flash plants have been installed. The total operating capacity is 766 MWe, achieving a production of 5235 GWh in 2012.

2. CURRENT STATUS OF GEOTHERMAL HEAT UTILIZATION

To facilitate comparisons with the data published in past years, or with those that will be published in future years, UGI decided to group direct uses in Italy in the following main sectors of utilization:

- space conditioning (heating & cooling);
- thermal balneology ¹;
- agricultural uses (greenhouses, pasteurization of milk products, and other agricultural uses);
- aquaculture (fish farming and other animal breeding, and hydroponics); and
- industrial processes, plus other minor uses.

With other minor uses in the last group we mean all those uses that, though having had little or no application in Italy so far, might however find a certain development in the future, such as: snow melting and de-icing of urban roads and sidewalks, snow melting of cycle-tracks, defrosting of highways, seasoning of valuable timber, sterilization of textiles by natural steam, washing carpets with thermal water, and other possible minor uses related to industrial activities. Data for 2005 and 2010 are presented in tables I and II.

Table 1: Direct uses in Italy 2005
according to data revised by UGI
(from Country report on geothermal direct uses in Italy 2005-2010)

Sector of application	Total thermal energy consumed (TJ/year)	Fraction obtained by GHPs (TJ/year)
Space heating & cooling	2100 (26%)	700 (82%)
Thermal balneology	3400 (41%)	//
Agricultural uses (greenhouses, etc.)	1140 (14%)	100 (12%)
Aquaculture	1360 (17%)	//
Industrial processes and other	200 (2%)	50 (6%)
Total energy (TJ/year)	8200 (100%)	850 (100%)
Total installed capacity, (MW_t)	650	215

¹ Beauty care centers or beauty farms, fitness clubs, and other facilities not using hot natural fluids are excluded.

Table 2: Summary of direct uses in Italy 2010,
according to data revised by UGI
(from Country report on geothermal direct uses in Italy 2005-2010)

Sector of application	Total thermal energy consumed (TJ/year)	Fraction of obtained by GHPs (TJ/year)
Space heating & cooling	4750 (38%)	1450 (85%)
Thermal balneology	4200 (33%)	//
Agricultural uses (greenhouses, etc.)	1500 (12%)	150 (9%)
Aquaculture	1800 (14%)	//
Industrial processes and other	350 (3%)	100 (6%)
Total energy (TJ/year)	12,600 (100%)	1700 (100%)
Total installed capacity, (MW_t)	1000	500

For aquaculture too, just as for balneology, both thermal capacity and energy consumption are related to the temperature drop between the inlet and outlet temperature of pools or ponds.

Capacity (MW_t) depends on the maximum flow rate of water that can be supplied by wells or springs.

Energy consumption (TJ/y) depends on the total volume of water used during a given year.

The inlet temperature level is taken to be that of the average outlet temperature of the feeding water at well head or spring mouth.

On the contrary, for the outlet temperature, it is assumed that the water remains in the relevant pool or pond for a relative long span of time, so that it is possible to approximate its outlet temperature with the average annual air temperature of the site concerned (for Italy, in general, such average annual temperature is 15 °C).

Table A: Present and planned geothermal power plants, total numbers

	Geothermal Power Plants		Total Electric Power in the country (2011)		Share of geothermal in total	
	Capacity (MW _e)	Production (GWh _e /yr)	Capacity (MW _e)	Production (GWh _e /yr)	Capacity (%)	Production (%)
In operation end of 2012	874.5	5,235	118,443	302,570	1%	2%
Under construction end of 2012	41					
Total projected by 2015	915					

Table B: Existing geothermal power plants, individual sites²

Locality	Plant Name	Year COD	No of units	Status	Type	Total inst. Cap (MW _e)	Total run. Cap. (MW _e)	2012 product. (GWh _e /y)
Larderello	Nuova Larderello	2005	1	O	D	20	15	115.2
Larderello	Farinello	1995	1	O	D	60	46	399.6
Larderello	Valle Secolo	1991	1	O	D	60	57	436.0
Larderello	Valle Secolo	1992	2	O	D	60	57	417.1
Larderello	Nuova Castelnuovo	2000	1	O	D	14.5	14	122.0
Larderello	Nuova Gabbro	2002	1	O	D	20	19	139.6
Larderello	Nuova Molinetto	2002	1	O	D	20	17	94.8
Larderello	Sesta 1	2002	1	O	D	20	17	46.7
Larderello	TOTAL		8			274,5	242	1,771

² In the case of major renovation of the plant, in the COD column there is the indication of a second year.

Locality	Plant Name	Year COD	No of units	Status	Type	Total inst. Cap (MW _e)	Total run. Cap. (MW _e)	2012 product. (GWh _e /y)
Radicondoli	Travale 3	2000	1	O	D	20	19	6.7
Radicondoli	Travale 4	2002	1	O	D	40	39	309.2
Radicondoli	Pianacce	1987	1	O	D	20	18	98.3
Radicondoli	Rancia 1	1986 2012	1	O	D	20	18	86.9
Radicondoli	Rancia 2	1988 2012	1	O	D	20	18	90.6
Radicondoli	Nuova Radicondoli	2002	1	O	D	40	38	288.7
Radicondoli	Nuova Radicondoli	2010	2	O	D	20	17	153.7
Radicondoli	Chiusdino 1	2010	1	O	D	20	18	147.3
Radicondoli	TOTAL		8			200	185	1,182
Lago	Selva 1	1999	1	O	D	20	19	102.6
Lago	Nuova Lago	2002	1	O	D	10	10	80.5
Lago	Monteverdi 1	1997	1	O	D	20	16	143.6
Lago	Monteverdi 2	1997	1	O	D	20	16	100.9
Lago	Cornia 2	1994	1	O	D	20	14	98.8
Lago	Nuova Monterotondo	2002	1	O	D	10	8	40.1
Lago	Carboli 1	1998	1	O	D	20	19	96.7
Lago	Carboli 2	1997	1	O	D	20	19	86.6
Lago	Nuova San Martino	2005	1	O	D	40	36	308.9
Lago	Nuova Lagoni Rossi	2009	1	O	D	20	15	72.2
Lago	Nuova Sasso	1996	1	O	D	20	15	85.5
Lago	Sasso 2	2009	1	O	D	20	17	116.9
Lago	Le Prata	1996 2012	1	O	D	20	15	93.7

Locality	Plant Name	Year COD	No of units	Status	Type	Total inst. Cap (MW _e)	Total run. Cap. (MW _e)	2012 product. (GWh _e /y)
Lago	Nuova Serrazzano	2002	1	O	D	60	47	341.4
Lago	TOTAL		14			320	266	1,768
Bagnore	Bagnore 3	1998	1	O	1F	20	20	160.9
Bagnore	Binario	2013	1	N	B-ORC	1	1	N/A
Bagnore	Bagnore 4		1		1F	20	20	N/A
Bagnore	Bagnore 4		2		1F	20	20	N/A
Piancastagnaio	Piancastagnaio 2	1969	1	R	1F	8	6	N/A
Piancastagnaio	Piancastagnaio 3	1990	1	O	1F	20	19	134.3
Piancastagnaio	Piancastagnaio 4	1991	1	O	1F	20	17	116.9
Piancastagnaio	Piancastagnaio 5	1996	1	O	1F	20	17	102.0
Piancastagnaio	TOTAL (in operation)		4			80	73	514
TOTAL (in operation)			34			874,5	766	5,235
Key for status:			Key for type:					
O	Operating	D Dry Steam				B-ORC	Binary (ORC)	
N	Not operating (temporarily)	1 Single Flash				B-Kal	Binary (Kalina)	
R	Retired	F Double Flash				O	Other	

Table C: Present and planned geothermal district heating (DH) plants and other direct uses, total numbers

	Geothermal DH Plants		Geothermal heat in agriculture and industry		Geothermal heat in balneology and other	
	Capacity (MW _{th})	Production (GWh _{th} /yr)	Capacity (MW _{th})	Production (GWh _{th} /yr)	Capacity (MW _{th})	Production (GWh _{th} /yr)
In operation end of 2010	80.7	168	298	1000	400	1200
Under construction end of 2010						
Total projected by 2015			474	1600	420	1250

Table D: Existing geothermal district heating (DH) plants, individual sites

Data courtesy of: Enel Green Power, AIRU, Soggetel, A2A Calore & Servizi

Locality	Plant Name	Year commiss.	Is the heat from geothermal CHP?	Is cooling provided from geothermal?	Installed geotherm. capacity (MW _{th})	Total installed capacity (MW _{th})	2010 geothermal heat prod. (GWh _{th} /y)	Geother. share in total prod. (%)
Castelnuovo V.C. (PI)		1986			7.3	7.3	23.1	100 %
Sasso Pisano (Castelnuovo V.C. ,PI)		1996			2.3	2.3	5.9	100 %
Montecastelli Pisano (Castelnuovo V.C. ,PI)		2010			2.9	2.9	1.4	100 %
Monterotondo M.mo (GR)		1994			2.3	2.3	9.7	100 %
Larderello (Pomaranze, PI)	(Ina Casa?)	1988			0.7	0.7	1.2	100 %
Lustignano (Pomaranze, PI)		1996			0.7	0.7	1.0	100 %
Montecerboli (Pomaranze, PI)		1995			3.5	3.5	6.6	100 %
Pomaranze (PI)		2003			11.6	11.6	13.2	100 %
San Dalmazio (Pomaranze, PI)		1999			0.7	0.7	1.1	100 %
Serrazzano (Pomaranze,PI)		1996			2.0	2.0	3.3	100 %
Pomaranze (PI)					3.3	3.3	2.6	100 %
Pomaranze (PI)							0.7	100 %

Locality	Plant Name	Year commiss.	Is the heat from geothermal CHP?	Is cooling provided from geothermal?	Installed geotherm. capacity (MW _{th})	Total installed capacity (MW _{th})	2010 geothermal heat prod. (GWh _{th} /y)	Geother. share in total prod. (%)
Santa Fiora (GR)		2005			15.1	15.1	27.0	100 %
Morbegno (SO)		2006			2.8 (3.7)	31.7	1.8 (2.4)	3.6% (5%)
Bagno di Romagna (FC)		1983			1.4 (1.6)	7.6	2.3	41.8%
Milano	Centrale Canavese	2007 (Geo DH since 2010)		YES	10.0 (15.0)	73.2	2.8 (4.1)	6.4%
Ferrara		1987		YES	14.0	154.5	66.2	35.1 %
Total					80.6	319.4	169.9	44.2%

Table E: Shallow geothermal energy, ground source heat pumps (GSHP)

	Geothermal Heat Pumps (GSHP), total			New GSHP in 2012		
	Number	Capacity (MW _{th})	Production (GWh _{th} /yr)	Number	Capacity (MW _{th})	Share in new constr. (%)
In operation end of 2010		500	472.2			
Projected by 2015		835	737.5			