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Direct Uses of Geothermal Energy in Italy 2005-2009: Update Report and Perspectives

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ABSTRACT

Italy is widely known for the strong expertise in field of geothermal electricity production. Despite the presence of such industrial know how, previous analysis reveal a huge untapped potential in geothermal direct uses. This paper, based on qualitative and quantitative information and expert evaluations, aims at giving an overview of market achievements in the last five years. The situation of direct uses of geothermal heat in Italy, compared with the situation of 2005, appears widely evolved and is rapidly moving to reach significant targets set for 2010.

The global growth of direct use of geothermal heat at the end of 2009 in Italy is expected to reach an amount of 1.2 times more than the values of the previous update: 850 MWth and 10,000 TJ compared to UGI-2006 values of 650 MWth and 8000 TJ. This larger contribution, in terms of installed power, is mainly due to the wide development, principally in northern areas of Italy, of geothermal district heating (5-15 MWth unit power) and, in terms of numbers of installations, to single household applications, which are widely applying heating & cooling equipment with geothermal source of small unit power. Analyzing the heating and cooling systems in civil buildings, and in particular the ones that use middle depth or shallow geothermal resources, a relevant impulse to the growth of geothermal industry has certainly been obtained by the large increase of geothermal heat pumps systems, fed by ground heat with horizontal or vertical exchanger, or by hot water extracted with shallow depth wells both in open or closed loops. At the moment, the number of companies which provide HPGS in Italy is growing very fast and thus, in the near future, a continuous growth of the geothermal direct uses is foreseen.

The market development is driven by challenging applications as the ones, characterized by a high level of technology integration, in progress in Grado (Udine) and Milan. In the past five years, the geothermal direct uses reached a greater interest than in the past also from the designers' community. Hence, as a consequence of the market dynamics, the unitary cost of the geothermal installations is decreasing and, at the same time, the need of new and specific regulations, both regarding performance and environmental preservation, is increasing. The lack of shared databases of authorized plants and of shared rules for their classification represents the main barrier for further research. For this reason, new investigation and acquisition of detailed multidisciplinary information are required so as to support the development of public policies and private strategies.

1. INTRODUCTION

Compared to the previous papers presented at the WGC 2005, where the main plants and applications were described according to Borghetti et al. (2005), in this paper an update of the major variations which have occurred in these last five years are assessed on the base of the available information. The lack of both a shared databases of authorized plants and of shared rules for their classification makes it difficult to gather comprehensive information about the state of the art and perspectives. As a consequence, the analysis is based on the assessment of interviews with the major technology providers, designers and geothermal operators. Afterwards, a discussion within expert communities has taken place. In fact, since Italy does not have an official collector of data from direct uses, such organizations as Unione Geotermica Italiana (UGI) and Centre of Excellence for the Geothermal energy of Larderello (CEGL) have intensified their networking activities (e.g. meetings, workshops, conferences, etc.).

On the basis of the information gathered, it is possible to estimate that the global growth of geothermal heat direct use at the end of 2009 in Italy would be about 1.2 times more than the values of the previous update: 850 MWth and 10,000 TJ, referred to UGI (2006) values of 650 MWth and 8000 TJ. AT the present growth rate, about 900 MW_{th} and 11,000 TJ may be foreseen by the end of 2010. The increase is due both to the wide development of geothermal district heating (5-20 MWth unit power), mainly in northern areas of Italy, and to single household applications, which are widely implementing their heating and cooling equipment with geothermal sources of small unit power. The following figures show the share of the main categories of direct heat applications in Italy in 2006 (Figure1) and 2009 (Figure 2).

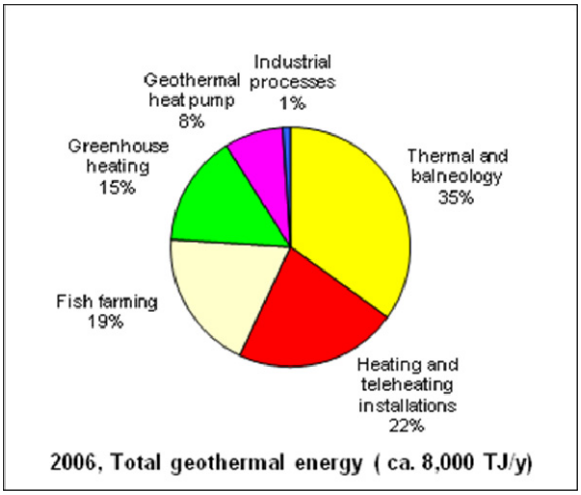

Figure 1: Geothermal direct uses in Italy in 2006.

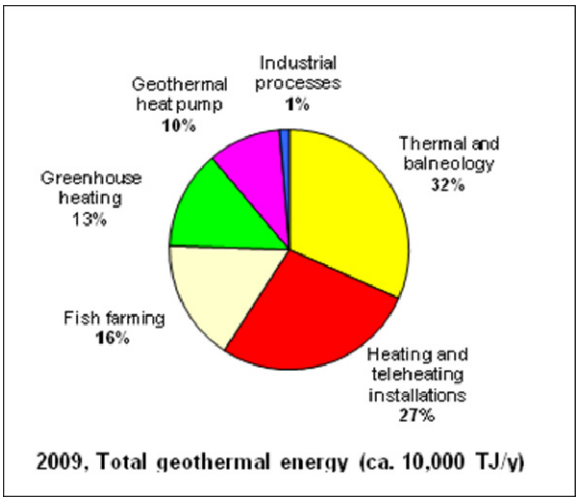

Figure 2: Geothermal direct uses in Italy in 2009

2. ITALIAN GEOTHERMAL DIRECT USES

2.1 Leisure and health uses

For centuries Italian people have largely used thermal waters for bathing, medical cures and relaxation. Nowadays, the importance of the spa industry in direct uses of geothermal energy is always evident, even if tourism investors display a decreasing importance of the presence of natural geothermal resources for the definition of siting strategies. At present, the use of mineral baths (balneology) still continues to cover the largest share (32%) of the geothermal heat use in Italy thanks to the major and most important spa areas of Italy, in Veneto (Euganei Hills) and the isle of Ischia (Campania). These activities (well-being and curative sectors) are growing in relevance as side offering of core tour packages. For this reason, the capability to attract capital investments mainly relies on multi-disciplinary integrations in tourism attractions (e.g. food, sport, culture, etc.) and not only on thermal ones.

2.2 Residential and industrial space heating

A noteworthy number of district heating plants, significant in terms of both dimension and technology intensity, has been developed in Italy. Based on favorable territorial planning and on state-of-the-art technology providers (especially regarding pipelines and heat exchangers), large urban areas in the northern part of Italy have used the opportunity to supply thermal energy using local geothermal resources.

At present, the heating and teleheating installations represent the 27% of the total amount of the direct uses in Italy. It is valued that in the next future these heating applications may assume the predominant share of the direct uses.

The most important district heating plant in operation so far in Italy is the one in Ferrara, in Emilia Romagna, where the local important geothermal source is coupled with an efficient waste disposal plant. Heat is derived from combined energy sources, including urban solid wastes, geothermal heat and a co-generating plant (Maroni, 2008). The hot fluids, present in a structural highs of the geothermal reservoir made of fractured Mesozoic carbonate rocks, are produced from two wells, 1.3 and 2 km deep, at close distance. A total of 400 m3/h of water, at about 105 °C is pumped from the wells; the exhausted water is reinjected in a third well 1000 m away, down in the original geothermal aquifer. The heat exchanger input and output temperatures are 95°C and 65°C. Geothermal energy provides 14 MWt (74 GWh/y), corresponding to a 100% of energy in 1990, but since the pumped water has grown less than the network has increased, it now represents about 45% of the total need. Gas (49%) and an incinerator (6%) thermal plants supply the complementary need. The sole use of geothermal energy allows for a saving of fossil fuels in the order of 6,600 OET/yr, avoiding CO2 emissions by about 15,000 tons per year (26,700 tons/year for the whole system).

In Tuscany the application of the direct uses of geothermal heat has increased. Other district heating systems are running in some villages in “traditional” geothermal areas in Tuscany using high enthalpy geothermal steam thanks to the presence of (but not to their integration in the downstream process of) electric power plants. Nowadays, a specific interest in the expansion of the teleheating network is evident. Beside the use of high enthalpy geothermal steam, future projects make a point also of medium enthalpy geothermal resources and integration with other renewables (e.g. solar, biomasses, etc.) (Lentz 2006).

District heating is in operation in Pomarance, Castelnuovo V.C., Monterotondo Marittimo (Larderello Geothermal field) and Santa Fiora (this one near to the geothermal field of Bagnore – Monte Amiata). In the last three years, depending on the seasonal weather conditions, the average annual total energy use has been about 107.000 Gcal/y (445 TJ/y).

With the geothermal steam applications nowadays present only in Tuscany, according to the data from Cosvig[1] and GES[2], the direct use of steam for direct thermal uses is about 149.000 Gcal/y (630 TJ/y), used for greenhouses (88%), industrial processes (10%), fish farming (1%) e food and creamery (1%) (Figure 3).

Main applications: *Food production, fisheries, mechanical and chemical industry, greenhouses, cheese factories*	Consumption (Gcal/year)	Avoided TEP	Avoided CH_4 (m^3/year)	Avoided CO_2 (tons/year)
	149139	14915	19885048	46215

Figure 3: Geothermal direct uses in Tuscany

In Italy at present, some projects are underway to realize district heating plants with the geothermal contribution, and among these, the ones that perform an extension of already existent networks and the ones with the contribute of the heat derived from geothermal heat pumps.

The district heating project for the town of Grado, in the north-east of Italy, is a representative example under development. Here, the producing well, 1.1 km deep, with a tested flow rate of 100 t/h and a temperature of 48°C, has already been drilled.

Beside that, it is also important to notice that a large number of geothermal applications are nowadays promoted through the regional regulations on Ecologically Equipped

1 Consorzio per lo Sviluppo delle Aree Geotermiche, public organization operating in Tuscany for promoting the geothermal direct uses

2 Geo-Energy Service, public organization operating in Tuscany for the management of the geothermal teleheating networks and renewable energy projects.

Productive Areas (APEA). Here, in fact, the use of geothermal heat seems to play a relevant role in local energy management strategies. Thus geothermal pipe-network heat plants will provide soon a large number of companies with hot water in areas as Scarperia (Firenze), Mirandola (Modena) and Pomarance (Pisa) and, in prospect, it is estimated by insiders that between 30 and 50 APEAs will use local geothermal resources by 2015.

2.3 Geothermal heat pumps applications

While globally the geothermal heat pumps market is driven by small scale and household applications, in Italy big installations (2-5 MW) have played an important role. Notwithstanding more than one decade of delay, they have been able to spread the interest in this technology among designers and small installers.

Nowadays, both public and private investors are aware about the great untapped potential in terms of energy saving of this technology and, also, agree on the need for specific regulation. The regulation which is in force, in fact, was mainly made for big geothermal power generation plants and, thus, does not provide a detailed framework for promoting the uniform and sustainable development of geothermal heat pumps applications all over Italy. As a consequence, even though a large number of small scale household installations have been developed, no adequate monitoring tools and capabilities have been developed.

Various geothermal actors report that, during previous years, as an indirect consequence loop, the lack of clear market rules has implied the lack of investors, which is the most important requirement in order to facilitate the required integration between different competences (e.g. designers, thermal engineers and geologists).

With regard to geothermal heat pumps, the total capacity estimated at December 2009 is in the order of 240 MWt, with about 1000 TJ/y of thermal energy produced, corresponding to about 30% of the total installed thermal capacity, and to about 10% of the national geothermal direct uses: these values are still much lower than their full potential. The use of this technology is, however, now growing fast, as proved by the projects completed or underway in several towns in northern and central Italy. The most significant are two urban district heating projects using heat pumps supplied by phreatic or surface waters at a temperature of less than 15 °C. The first of these projects is being implemented in Milan (Sparacino et al., 2007), and the second in Bergamo (Mangili et al., 2006), both in Lombardy. The project for the new headquarter of the Lombardy Regional Administration, that is destined to be one of “the symbols” of Milan, will include the use of geothermal heat pumps too.

The city of Milan has been one of the first cities in Italy to use the geothermal heat pump technology (GHP); in fact, since some years one installation of 3 MWt is operative for the conditioning of the Bocconi University. The energetic company A2A has promoted a particularly significant project for the district heating of the city of Milan that will allow repeating in other 4 installations that one already existing in the Centrale Canavese (Sparacino et alii, 2007). This is constituted by a GHP plant with two units of 15 MWt each, that supply the 50-60% of the thermal energy distributed, integrated with other contributions coming from cogeneration and the so called “trigeneration plants” (the simultaneous on-site generation of electric energy, heat and cool from the same plant). The GHP system consists of a open loop system, using ground water at 14°, discharged at 6°in the network of superficial canals. The total saving of primary energy is of 35%, corresponding at the moment to 8200 OET/y (340 TJ/y). In the city of Milan, the only projects actually in progress before 2010 will be able to supply power of about 100 MWt, that may become 200 in the 2015; the capability of the ground water as heating source can arrive up to 300-400 MWt (Puppini 2008).

To confirm that the GHP technology in Italy is nowadays in big expansion, in the province of Milan during 2007 and 2008 respectively 80 and 100 requests of authorization for wells associated to GHP have been presented. Generally, authorizations have been presented for big urban areas and units having an indicative power of about 500 KWt each; that implies a potential growth of many dozens of MWt a year.

The strong growth of GHP in Lombardy will allow this Region to become part of the league with the highest utilization of natural heat, together with Veneto, Tuscany, and Campania.

The application of GHP in Italy will see a strong increase, estimated to be more than 15% per year. A number of operators have entered the field, and important heat pump manufacturers do exist now, able to cover a great part of the Italian market. For the year 2020 a GHP power value of 2500 MWt has been estimated, corresponding to more than 40% of the 6000 MWt total power (Figure 4).

2.4 Fish farming

Because of the large volume of produced fluid, and notwithstanding the low temperatures involved this sector still represents an important part (about 16%) of the Italian direct uses of geothermal energy.

Beside such naturally predisposed areas as Orbetello (Grosseto), where there is a very important geothermal fish farming cluster, the typology and the siting of new farms seem to depend more on the market needs and trends (e.g. entire and fresh fish vs. finished and semi finished products) rather than on the energy efficiency of farming processes. Therefore, at moment, no relevant variations in numbers of fish farms occur nor are they foreseen.

2.5 Greenhouses

As in the case of fish farming, the use of geothermal heat in greenhouses is still steadily applied. With the only exception of Pantani plants (Civitavecchia, Rome), Italian geothermal greenhouses are mainly related to the integration as downstream process in electric power generation. The larger running plant is currently sited in Tuscany, which may be considered as useful side project for safeguarding the sustainable development of geothermal areas (Sanyal 2004). In terms of perspectives, the increasing confidence of designers with regard to geothermal heat pumps is expected to give a new impulse to the development of low and medium enthalpies applications.

In the greenhouse sector, the most important geothermal realization is in the Monte Amiata region, about 3 km to the South of Piancastagnaio. Here, the exhausted steam by the local power station is condensed in order to obtain water at 90°C which, before reinjection, feeds a heat-exchanger with a fresh-water loop in order to supply heat (> 500 TJ/y) to a large greenhouse complex (230,000 m2). Greenhouses fed by geothermal heat can also be found in other parts of Tuscany, and in Veneto, Latium, and other Italian regions. The total amount of heat used in greenhouses is estimated 1300 TJ/y (about 13% of the total geothermal heat).

3. GEOTHERMAL DIRECT USES IN ITALY: CONSTRAINTS, OPPORTUNITIES AND PERSPECTIVES

With regard to the future, the whole direct uses in Italy can grow at a much faster rate than in the last years. Forecasts of geothermal growth until 2020 can be made using two development scenarios (I and II): the first in the light of the present economy and technology, and the second in the light of an ecologically driven economy and energy policy and with the encouragement to apply strongly innovative technologies. According to these two scenarios values of 4,000 to 6,000 MWt and 50,000 75,000 TJ may be reached. According to the European and national frameworks, a particularly remarkable growth of geothermal heat pumps (see Figure 4) is expected (Buonasorte 2007).

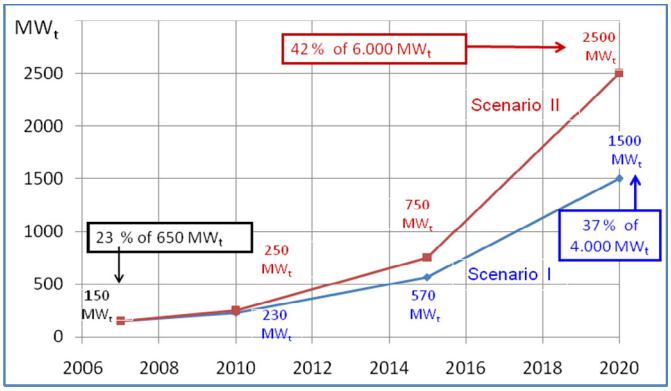

Figure 4: Estimated development of GHP by 2020, according to Growth Scenarios I and II

The use of geothermal heat could be based on mature and worldwide available technologies (Bertani 2005 and Lund 2005).

At European level, the EU's Climate and Energy Policy (Climate Action & Renewable Energy Package) is expected to have an impact on the geothermal market. In fact, it sets ambitious targets for 2020: cutting greenhouse gases by at least 20% of 1990 levels (30% if other developed countries commit to comparable cuts), increasing the use of renewables[3] to 20% of total energy production, cutting energy consumption by 20% of projected 2020 levels by improving energy efficiency.

The EU's Climate Action & Renewable Energy Package and the proposal of Renewable Energy Directive (RED) state also that geothermal and hydrothermal heat energy captured by heat pumps shall be taken into account for "the gross final consumption of energy from renewable sources for heating and cooling" and that no later than 1 January 2013 the Commission shall establish guidelines on how Member States shall take into account the RES fraction. Beside that, member States shall also ensure that certification schemes or equivalent qualification schemes become available by 31 December 2012 for installers. Finally, national action plans shall assess the necessity to build new district infrastructure for heating and cooling.

In Italy, according to these commitments, several Regional Administrations (which are the designated competent body) have set their targets to contribute towards the national agenda. These targets are ordinarily part of the Regional Energy Plans.

For example, the current Energy Plan in Tuscany sets a target of 10% of thermal energy from RES by 2020 considering that the present annual thermal demand (household and industrial) is around 20.000 GWh (mainly technically consistent with the presence of geothermal resources). In particular, the target in terms of low enthalpy use in household applications is to prevent a consumption of 18 kTep by 2020. For this purpose, since local companies have a relevant experience in high enthalpy teleheating[4] (TH) that is expected to be useful for future low enthalpy geothermal TH development, a renewed attention is paid to those resources that are not of primary interest for electric applications. Similarly, analyzing different administrative domains, it is possible to find an increasing number of requirements in terms of geothermal provision within urban planning, building regulations and industrial regulations (e.g. the so called "ecologically-equipped production areas").

This "green new deal" also reflects in a broader scientific debate. In fact, the increasing number of geothermal conferences and workshops and the increasing number of researchers involved in geothermal projects prove the renewed scientific interest in geothermal sciences.

Unfortunately, despite this interest, the Italian low-enthalpy market, which seems to be ready for a booming development, is at the moment still an immature market compared to most other European markets. In fact, the absolute number of running plants is still low compared to the huge presence of natural resources[5] and the demand-side potential in terms of aggregation of users.

From a technical and economic point of view, a reliable analysis of the dynamics of small and medium enterprises (SMEs) is made difficult by a lack of shared rules for the classification of the applications. For this purpose, a preparatory technology assessment[6] based on interviews with relevant actors and stakeholders has been launched. According to the early results, different success drivers reflect the complexity of the system.

First of all, the lack of available and certified geological information seems to be a first barrier for new market players due to the costs of explorations and the trade-off between specialization of SMEs and needs in terms of integration of non core capabilities (e.g. geological ones). From this point of view, no technical gap is revealed between Italian firms and foreign ones[7], but a fragmentation of chain of competences exists indeed.

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3 "Wind, solar, geothermal, aerothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases" as defined in Article 2 of European Parliament legislative resolution of 17 December 2008

4 As it is seen in e.g. Larderello, Brescia and Ferrara cases

5 Drilling costs increase non-linearly with depth (Tester 2006), therefore geothermal anomalies allow to reduce the cost of high and medium enthalpy applications

6 The Center of Excellence for the Geothermal energy of Larderello (CEGL) has launched in May 2009 a technical and economic research on national geothermal SMEs system

7 On the contrary, Italian technology providers feature several points of excellence, e.g. in heat-exchangers, compressors, anti-corrosion pipes.

The role played by large applications as "starter" of the Italian geothermal heat pumps market derives from the large amount of capital involved. In fact, the major complexity in terms of project management and development naturally encourages the removal of the barriers in networking and integration of competences, leading up to the development of multidisciplinary teams.

Apart from the lack of structuring observed in small scale technology providers, the household applications play the role of follower also due to the complexity of the average Italian urban structure and architectural heritage, which represent a constraint for the wide spread application of small private plants. The revision and further development of a specific, clear and uniform regulation is expected to have a positive impact on the market. Nowadays, in fact, the different approaches adopted by the regional or provincial competent authorities, together with the different climatic conditions in Italian regions, contribute to the "jeopardization" of the low enthalpy market. Hence, even if Tuscany is widely recognized as one of the most important geothermal regions in the world, the larger number of low enthalpy industrial actors are sited in the northern part of Italy. This difference can be doubtlessly be explained by a stronger tendency to traditional mindedness of the small enterprises in Tuscany and to a grater openness to new markets in the north. Here, in fact, there is a higher concentration of SMEs which are open to the diversification of the business and disposed to such approaches as open innovation and co-development partnership.

The geothermal market in Tuscany, being driven by the unequaled presence of the geothermal electric plants, is characterized by the abundance of significant experiences in terms of industrial chain integration (e.g. food industries, cheese farming, fisheries and other industrial activities supplied by waste geothermal fluids).

De facto, earlier evidence indicate a relationship between the local business environment and the local major intensity of SMEs inclined to reactive rather than proactive business intelligence and, consequently, to execution rather than innovation.

At the national level, looking at low enthalpy geothermal development, the best market opportunities are expected in geothermal heat pumps, district heating and industrial applications. Different stakeholders point out the need to implement further tools in order to attract larger capitals and become more competitive in the global arena. Coherently with European policy, these tools are mainly referred to the qualification and certification schemes and to the development of environmental and performance risk management approaches.

In terms of medium term prospects, as a consequence of the implementation of such tools, the improvement of reliable investment profiles should cause a down-scaling and proliferation of household installations. Hence, once again, a multidisciplinary effort has to be made so as to ensure that the sustainable geothermal development will really benefit from the presence of the above mentioned tools.

For all these reasons, currently and for the next years, geothermal energy in Italy offers a field of great interest for both investors and technological and socio-economic research.

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