Geothermal development in southern Italy and the contribution of VIGOR Project

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ABSTRACT

VIGOR, a three year Project launched at the end of 2010, is dedicated to a comprehensive geothermal assessment of geothermal energy and its technological applications in four regions of southern Italy. It refers to any kind of geothermal use, from air conditioning by means of ground source heat pumps (GSHP) to direct uses for industrial processes to power production, depending on the natural resource and the economic and social aspects of the reference territories.

In the two years of activity VIGOR has provided eight feasibility studies for geothermal resources in a wide range of temperatures, proposing eight different kinds of exploitation technologies, which have been chosen on the base of the resource as well as on the energy demand of the area. Geothermal potential has also been evaluated, both at surface and at depth, and mapping of geothermal potential is under development. Economics and regulatory aspects have also been considered and described.

VIGOR wants to be an example of a truly comprehensive geothermal assessment, to be followed in other regions, to answer energy demand and for the future benefit of society.

1. INTRODUCTION AND MAIN AIMS

Many uses have been defined for geothermal energy, from direct exploitation of geothermal heat to power production. Investors and public seldom know them, and the geothermal potential remains unhindered. Indeed, Italy's need of energy and the dependence from imported fuels are very high, and a better exploitation of geothermal resources may provide an important contribution, increasing the produced electricity from the actual 5.4 TWh to 12 TWh and the heat production from the estimated actual 12600 TJ/year to 90000, following recent forecast (UGI).

The role of geothermal energy is crucial also considering that most of the uses of energy in Italy are thermal, and 30% of them are related to low-medium temperature (Fig. 1).

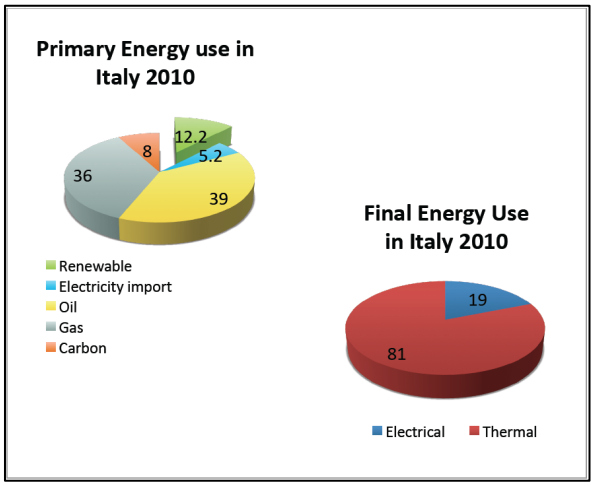

Figure 1: Distribution (in percentage) of primary and final energy use in Italy on 2010.

To partly answer the demand for a better knowledge of geothermal potential and geothermal technologies, VIGOR Project was launched at the end of 2010. The VIGOR project (Evaluation of the geothermal potential of Regions of Convergence) derives from an operative agreement between the MiSE DGENRE (Directorate General for Nuclear Energy, Renewable Energy and Energy Efficiency, of the Ministry of Economic Development) and the CNR DTA (National Research Council of Italy, Department of Earth and Environment), and is aimed at the implementation of innovative use of geothermal resources in the Convergence Regions (Campania, Apulia, Calabria, Sicily, Fig. 2) under the line of activity 1.4 of Interregional Operative Program "Renewable Energy and Energy Conservation 2007-2013".

VIGOR considers any kind of geothermal application that can be recovered in the four regions, therefore balancing the knowledge and potential of them, creating the base for a wide involvement in terms of occupation, market, business. In the target areas the amount of energy produced from geothermal source is irrelevant today, despite the interesting perspectives, assessed in relation to new ways of widespread use of

geothermal energy, with innovative technologies capable of triggering a thermal cycle even with small temperature differences.

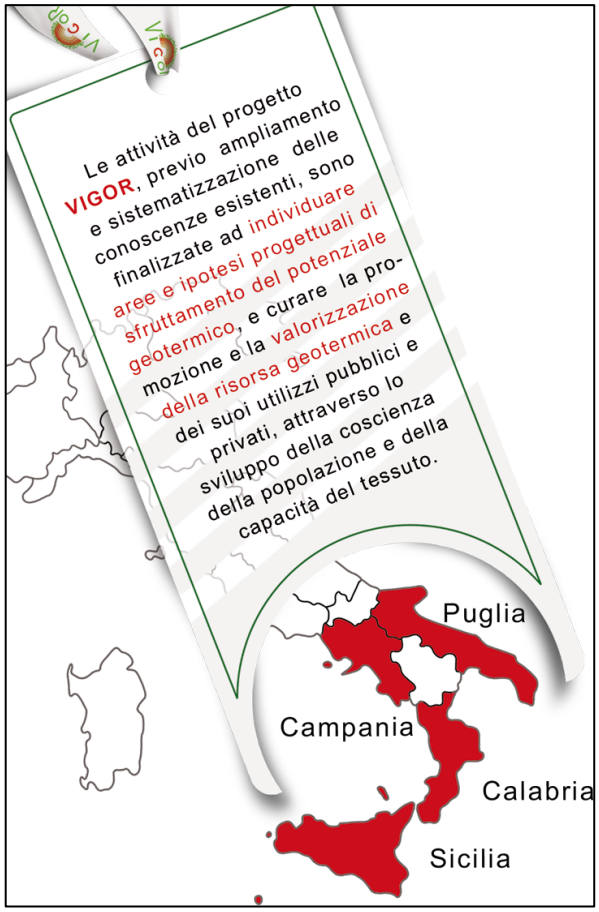

Figure 2: A graphic display of VIGOR targets, and in red the four Convergence Regions of Italy to which VIGOR is dedicated.

VIGOR inherits the aims of the Structural and Cohesion Funds that contribute to its existence: to reduce disparities between regions in terms of opportunities and to help all regions build economic, social and innovation capacities corresponding to their situation and priorities. For this reason, VIGOR is particularly focused on geothermal resources that can be exploited using technologies having a widespread utilization, in particular direct uses that may cover wide sectors of the territory, creating the required wide involvement in terms of occupation, market, business.

The VIGOR Project is aimed at:

- providing to potential future users of the geothermal source analytical information useful to engage in exploration and exploitation of geothermal energy, to broaden the knowledge of the natural potential and the real possibility of exploitation of geothermal resources in the Regions of Convergence;
- defining for the Ministry of Economic Development - DGENRE a number of feasibility studies to be used for the formulation of specific calls to fund demonstration projects.

2. GEOTHERMAL ENERGY EXPLOITATION MADE CLEAR FROM EXAMPLES

2.1 Case studies

In order to start the evaluation of different uses and technologies, four demonstration geothermal projects were studied, defining their resource characteristics, and their technological and economic parameters.

The chosen applications span the whole spectrum of resource temperature (Fig. 3) and apply to processes that could be of interest for the four Convergence Regions: power (Unterhaching, Germany; heat for space conditioning (Unterhaching, Germany, and Heerlen, The Netherlands); heat for milk and cheese production (Monterotondo, Italy), controlled temperature for wine production (La Rioja, Spain). The studies are part of the booklet (final version in preparation, a draft version already available), dedicated to geothermal direct uses.

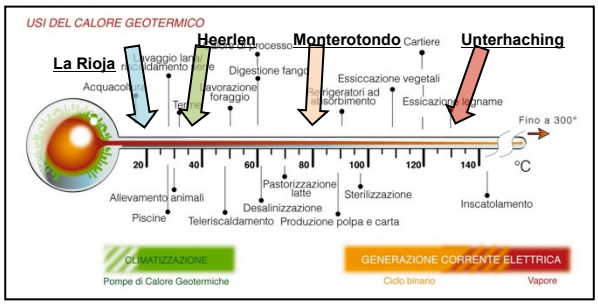

Figure 3: Reference temperature of the four case studies considered in VIGOR with respect to the VIGOR geothermal thermometer (a graphic representation of the classic Lindal diagram of geothermal uses declined with VIGOR logo and colours).

2.2 Feasibility studies

On the base of schematic description of various known geothermal resources prepared by the CNR Team for each region, the regional authorities and the Team chose two areas for each region where a detailed assessment of the resource and a design of geothermal plant to exploit were conducted. The choice was made considering the territory vocation and trying to present many different kind of uses that could be taken as examples for demonstration projects not only in the eight areas, but wherever similar geothermal condition could be found.

The resulting eight feasibility studies refer to resources of different depth and condition. Two areas were chosen for designing low-enthalpy geothermal energy for heating and cooling purposes of residential units, therefore requiring shallow exploration. In three areas the resource of interest is at depth of a few hundred meters, whereas in other three the target geothermal reservoir is located at depth of more than 1

km (Fig. 4). The proposed geothermal plants of the eight areas are listed in Tab.1.

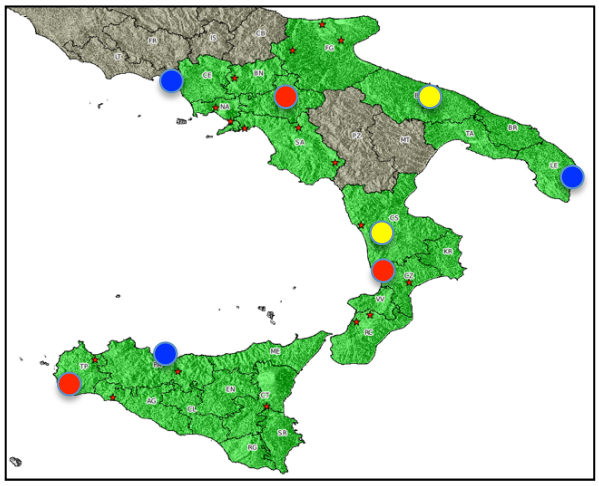

Figure 4: Area location of feasibility studies. The colour of the eight circles describes the different exploration depth: yellow for shallow exploration (GSHP plants), blue for medium depth exploration (down to 400 m) and red for deep exploration (2-3 km).

Table 1: List of plants proposed in VIGOR. Colours are matched to those of Fig. 4.

Area Name	Region	Proposed plant
Mondragone	Campania	Swimming pool, district heating
Guardia Lombardi	Campania	Power production
Bari	Apulia	Air conditioning by GSHP, open circuit
S. Cesarea Terme	Apulia	Pasta production
Rende	Calabria	Air conditioning by GSHP, closed circuit
Terme Caronte	Calabria	Wastewater treatment
Termini Imerese	Sicily	Desalination
Mazara del Vallo	Sicily	District heating

Each feasibility study describes the results of the assessment, including conceptual model of the resource, temperature and hydraulic condition at depth. Down-hole data are also provided, either from wells already available at the beginning of the project (some of them courtesy of ENI), or from exploration wells drilled for the occasion (still on-going). Each assessment shows also the location for the wells or ground source heat exchangers necessary to the proposed geothermal plant.

The feasibility then describes the proposed plant, which is designed taking into account the geothermal resource and the energy demand it wants to satisfy. The proposal is completed by the evaluation of the costs and the economic analysis, as well as the description of the documents and procedure required for the authorization. Each feasibility is described by a report and all the useful maps and diagrams.

3. GEOTHERMAL MAPS

All the cartographic products of VIGOR can be accessed on the web through a webmapping service. Thanks a service developed by CNR, the maps can be viewed, searched, zoomed easily and quickly, as well as downloaded and printed.

3.1 Local maps

The collection of available maps on the local scale are those produced for the feasibility studies, and comprehend geological, hydrogeological, geophysical maps and sections (see Fig. 5 for some examples).

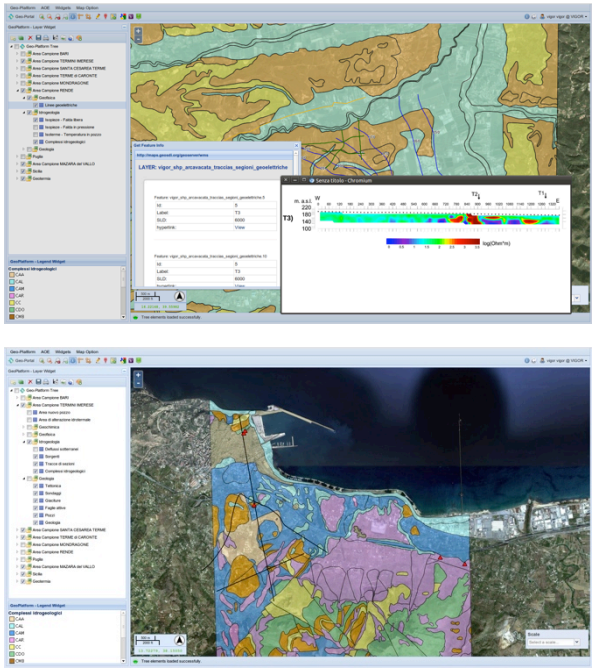

Figure 5: Examples of produced maps and profiles available on the web for two areas studied within VIGOR: geological map and electrical resistivity profiles in the Rende area (top) and hydrogeological map of Termini Imerese (bottom).

3.2 Regional maps

Regional maps of geothermal potential are going to be released soon, both for low enthalpy resources (described in Destro et al., 2013) and medium-high temperature resources (Trumpy et al., 2012). The medium-deep geothermal potential maps are obtained by evaluating the heat in place computed on the base of temperature distribution at depth, and then defining the theoretical, technical and economic capacity by considering rock permeability and thermal conductivity, reservoir geometry, required temperature of the technology and economic parameters (Fig. 6).

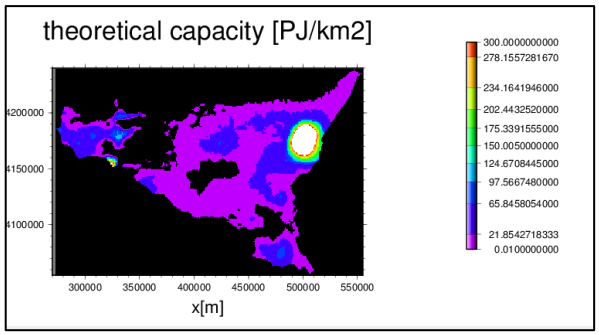

Figure 6: A draft Sicily theoretical potential map for binary plant power production.

Other regional maps are also available, such as the heat flow map, the temperature distribution at surface and at various depths, the thermal conductivity distribution at surface (Fig. 7).

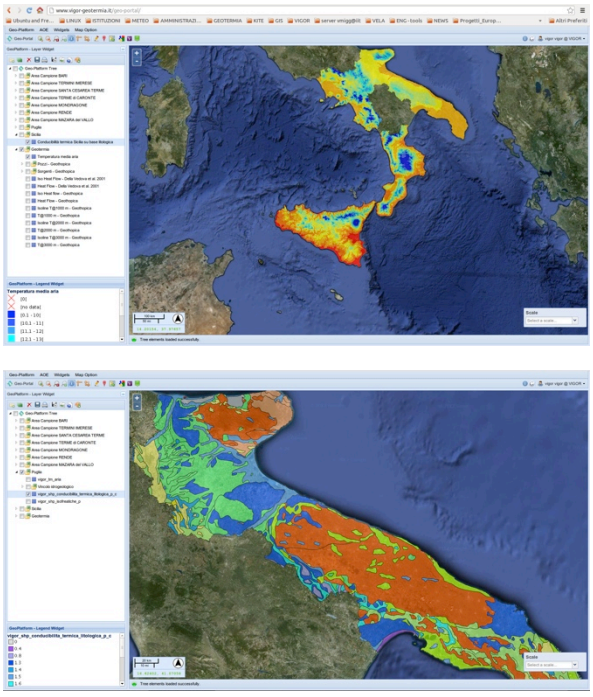

Figure 7: Some examples of regional maps: temperature distribution at surface in the four regions (top) and thermal conductivity in Apulia region (bottom).

3. DISSEMINATION

Geothermal energy and its benefits, as well as VIGOR results have been described in eight seminars (two per region) and two national conferences held in Rome every year.

VIGOR is producing many documents, which can be accessed on the project website http://www.vigor-geotermia.it, together with a general description of the project and the access to the webmapping service.

Beside the flyer and a brochure available in pdf format on the website and distributed in printed version at the seminars and conferences, and the feasibility reports that are being published on the website, a series of booklets are being released, describing various aspects of geothermal energy. Three books are related to technical aspects, one to regulation and authorization issues of geothermal plants and one on social aspects.

Italian is the only language used for disseminating the project products, since VIGOR's main audience is Italian, and too little is nowadays available in Italian language regarding geothermal energy. For this reason many figures that are shown in this paper, derived from VIGOR's flyers and booklets, have Italian words.

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