Geothermal Communities

demonstrating the cascading use of geothermal energy for district heating with small scale RES integration and retrofitting measures

Montieri (IT)

demonstration site

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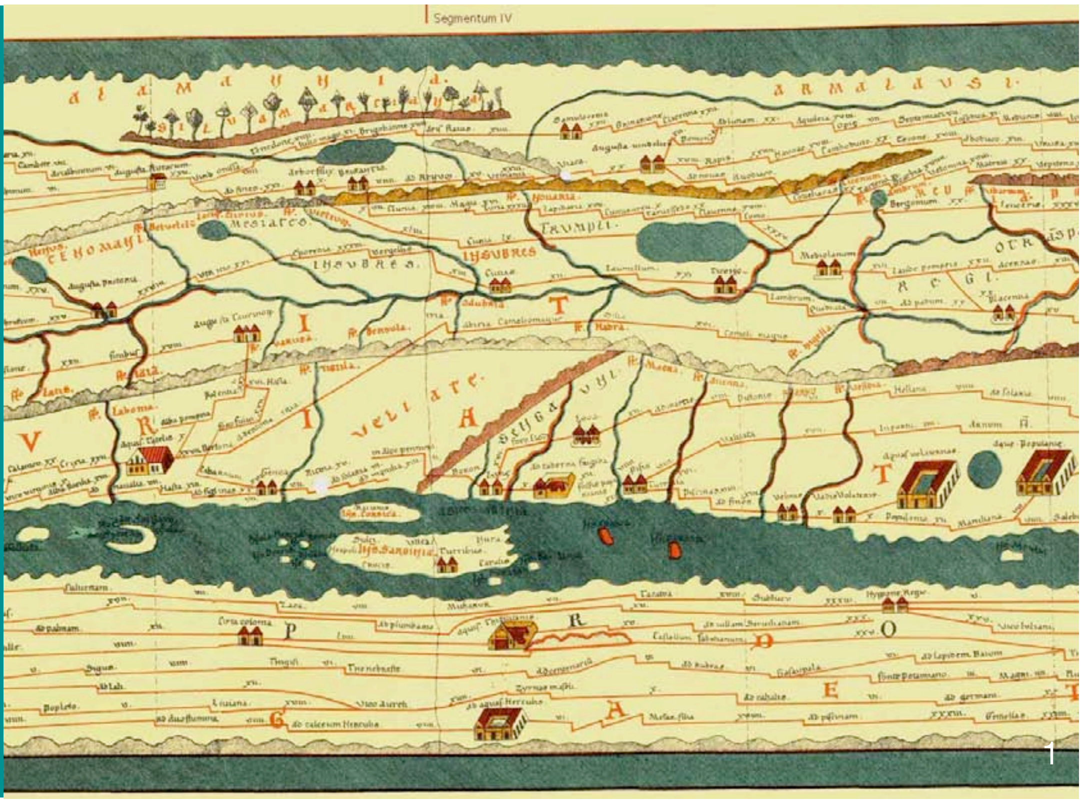
For more information about CONCERTO GEOCOM please visit the project's website

www.geothermalcommunities.eu

GEOTHERMAL ENERGY RESOURCE

Img.1

The Tabula Peutingeriana is a document of 13th century that reproduces an original document from 3rd-4th century about the itineraries of the Roman Empire. It is made up of 11 sections that show all Roman settlements, mountain rivers of all the Empire. In Larderello area the document shows a many thermal baths



Historical notes on the discovery and development of geothermal resource in Larderello (Tuscany Region, IT)

Text by Pierdomenico Burgassi
Scientific Director of Museum “Le Energie del Territorio” in Larderello (IT)

The discovery of geothermal phenomena

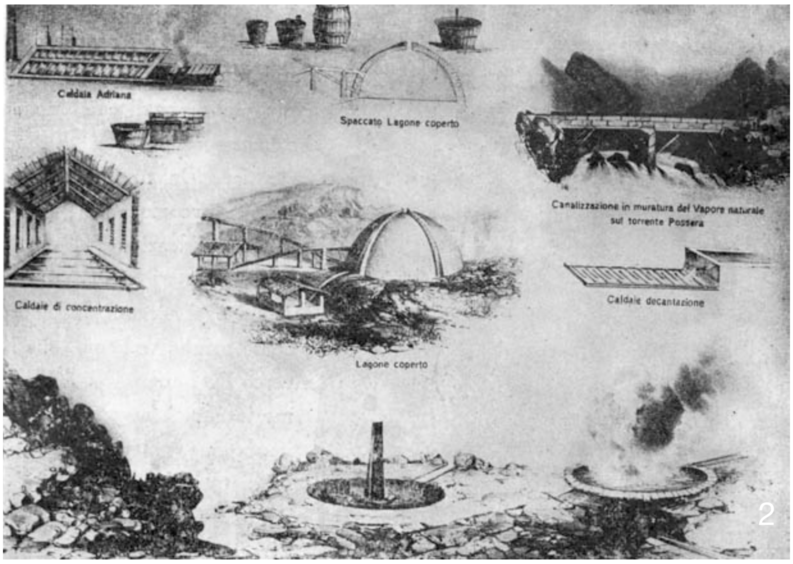
The first exploitation of geothermal phenomena in southern Tuscany is referred to Etruscan-Roman period, but other discoveries, as prehistoric handmade objects and a sepulchre of Bronze Age, demonstrate that geothermal phenomena were well known since the presence of first men in this area. Prehistoric men approached geothermal phenomena by fear and respect seeing in them the expression of underground divinity.

It is proved that Etruscan knew very well the therapeutic benefits of warm water springs: in the area there were many thermal baths whose ruins are still visible today.

Romans, as their usual custom, inherited the habits of subdued population, from Etruscan (and Greeks as well) they learned to use thermal baths not only for therapeutic benefits but also as a meeting place.

In Tabula Itineraria Peutingeriana, that is a copy from 13th century of a Roman document of 3rd century a.C. (considered the 1st road map), are drawn the main thermal baths of the area and among these Aquae Populoniae and Aquas Volaternas, one of which corresponds to archeological site of Bagnone in Sasso Pisano.

It is possible that the two “Aquae” were also pharmaceutical laboratories, as seems to be proved by archeological excavations in Bagnone, where many medications were prepared using geothermal fluids to supply heating for the



Img.2

The picture shows “lagoni coperti” (covered big lakes of geothermal hot fluids) and the most important devices of early borax production.

At the bottom of the picture are shown the main natural phenomena,in the centre the Lagone coperto, and at sides different kind of boilers and pipelines.

process. In archaeological site of Roselle excavations gives evidence that at the same age of Bagnone’s laboratories, geothermal hot fluids were used here for indoor environmental heating.
The substances present in water were Sulphur, Nitrum Volaterranum (boric acid) used both for medicine and preparation of protective sheath for pottery and for soldering of metals.
Some substances, already present in nature, were artificially prepared in laboratory, as “Vetriolo Azzurro” or “Vetriolo from Cipro” that is a copper sulphate useful as disinfectant, and “Vetriolo Verde o Romano”, a iron sulphate useful as pesticide.
These products were traded also as “palle da cani” (balls for dogs) that were small amount of clay collected on the borders of warm springs, enriched of boric acid and sulphur, and dried, they were known all over Roman territory. Once those little balls were melted in a bowl of water, they were useful to cure skin diseases common to men and dogs, and also as beauty care mask with the addiction of olive oil, to stretch wrinkles on the face. During Middle Ages there was a reduction in communication and a technological regression that lead to decline of thermal baths and a more local use of product from geothermal water springs. People feared these phenomena again: for instance the whole valley of Larderello was called Valle del Diavolo (Evil’s valley) and the nearest village to the geothermal phenomena, Montecerboli derives its name from Latin Mons Cerberis, that means the mount where Cerbero, the three-headed dog who watches the gate of hell, lives.
However, as a mark that the activity was carried on, some agreements between the Bishop and the merchants of Volterra can be found in the town’s archives, needed to allow the use of “lumaie”, the heat sources, for exploiting heat in different processes.
At the beginning of Renaissance geographers and doctors as Falloppio, Ugolino da Montecatini, and Girolamo Savonarola, expressed great interest for thermal baths of this area, and this therapeutic activity restarted, above all with the development of Bagni ad Morba, the favourite thermal baths of Lorenzo De Medici and his Family.
Benoccio Capacci from Siena discovered the presence of Alum, essential item for processing wool in Florence’s factories. Many quarries were opened in the area and two wars were fought between Florence and Volterra to control them.

18th an 19th century developments

In the second half of 18th century, by the will of Granduca of Tuscany, Giovanni Targioni Tozzetti, after a thorough analysis of resources of territory, begun the first studies on the nature of Geothermal phenomena. In 1777, Uberto Francesco Hoefer, who was the manager of pharmacy of Granduca, discovered boric acid in Lagone Cerchiaio of Monterotondo and Lagone of Castelnuovo. Few years before, one of the main scientist of that age, Paolo Mascagni, from Pomarance, began to study geothermal phenomena. He visited those sites many times and he examined both waters and mud found around the big lakes. In two diaries (“Commentari”)of 1779 and 1799 he confirmed the discovery of boric acid in all natural phenomena of the area and theorised about the possibility of extracting it from water using the same natural heat by burying boilers in the

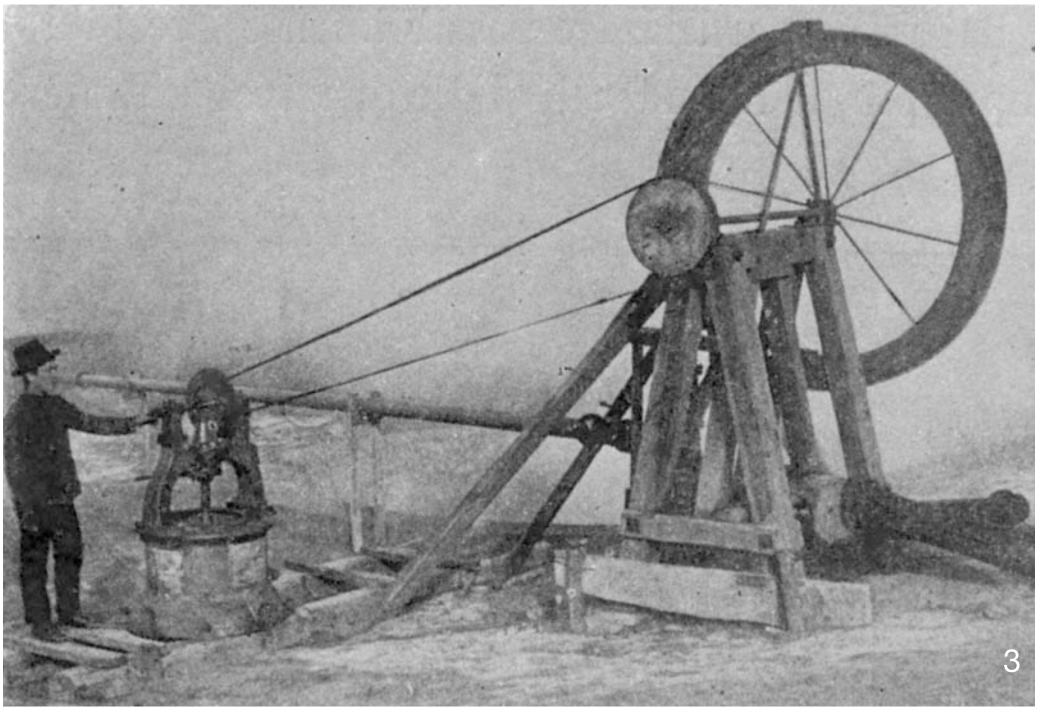
terrain. In 1810 he obtained a patent right for processing the borax.
Mascagni's suggestions were used in 1812 by dr. Santi Tastoni together with his company who tried to produce boric acid and borax from big lakes of Montecerboli and Monterotondo, but the company was terminated in few years. In 1815 a second company improved the production process and exported 3555 kg of boric acid to France between 1817 and 1818.
In the same year, Pomarance Municipality let the two big lakes to a group of French businessmen, who created a company called "Ved. Chemin Prat, Lamotte, Larderel e Comp".
The company set up many factories in Montecerboli, Monterotondo, Castelnuovo and Lustignano that at the beginning had a great production up to 50 tons of boric acid per year, but later came up against almost insurmountable problems. The extraction of boric acid from geothermal water needed a large amount of heat that was supplied by wood. When the level of production increased the surrounding woods were not enough and became necessary buying more wood from other areas. Moreover the Granducato (the main local authority) set higher taxes and the initiative almost failed. By common decision the company was terminated in 1827, and the young De Larderel bought it all by himself.
The new idea of De Larderel was an improvement of Mascagni's theory: he proposed to use the geothermal heat piping the steam of natural emissions. He invented a cover for big lakes ("lagoni coperti") and a system to pipe steam through insulated pipes towards boilers. At the same time he thought about using natural steam as driving force and how to find it by drilling.
In 1836 the famous French chemist Payen advised Larderel against drilling activity because he had been struck by the result of small wells few meters deep.

De Larderel innovations

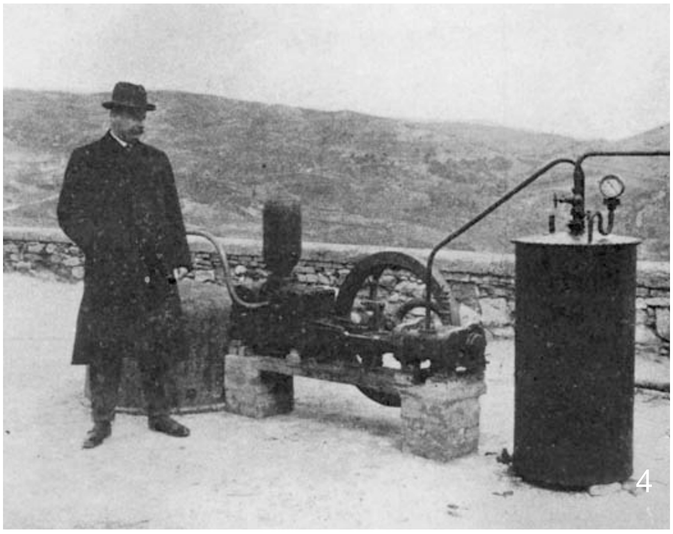
Only after 1840, when perforation technology had been experimented for years by other engineers, Francesco Larderel came back in this activity. After 1850 the method was innovated by the use of raised worktop, winch supplied by natural steam, and other technologies that few years later were adopted in petroleum drilling.
The invention of Caldaia Adriana, that allowed a faster collecting of boron, lead to an increasing of production.
In 1850 the Factory of Boric Acid ("Fabbrica dell'Acido Borico") was made up of 9 buildings in an area of 300 m^2 with 108 employees, but thanks to satellite industries there were many more people employed by that factory.
De Larderel received the title of Conte di Montecerboli and the right to name by his own name the area where the 1st factory was borne, that he called Larderello.
In Larderello a General Regulation of work was established in 1849, to protect workers and their families as a kind of welfare state. Every worker received health care and a pension when he

Img.3

De Larderel was the 1st who studied the use of geothermal steam as driving force around 1836. But at his time the technology of drilling wasn't ready for this purpose. By the end of 19th century, thanks to the care of Prince Piero Ginori Conti the technology to use geothermal steam as driving force was fully developed



wasn't able to work anymore. Sons were sent to school and had the opportunity to inherit the father's job. If the worker died at work widows were employed in the factory. Someone defined those measures as a romantic paternalism, but this contract had a big value at that time.
By the end of 19th century, thanks to innovations due to the care of Prince Piero Ginori Conti, son-in-low of Florestano De Larderel, chemical production was diversified in different products as boric talc, the use of steam as driving force was strengthen and some civil buildings were heated by geothermal energy. The 4th July 1904 were switched on the first bulbs using natural steam to activate a piston engine connected to a dynamo. This was the beginning of electricity production by geothermal energy, defined as geothermal electricity.
In 1906 and 1908 two piston engines were installed in the first electrical power station to supply electricity to factories and civil buildings.
In 1912 all small companies that produced boric acid were grouped together in "Società boracifera di Larderello" and the first Tosi-Ganz turbine of 250 kWp with indirect production cycle was installed.
After the 1st World War a Geological Office was created to do geophysical test bore in order to allow a better development of drilling activity. This led to a great increase in steam production, many other power station were built in the area increasing the electricity power up to 12150 kWp and boric acid production to 4800 tons/year.
In 1939 was built the big power station of Larderello 2, also with indirect production cycle, made up of 6 groups of 10 MW. In 1943 the company Larderello SpA was created and other power stations were activated leading to an electricity power of 132 MWp and 6500 ton of boric acid per year.
In 1950 there were 6 power stations and 211 MWp installed, in 1957 started the 1st drilling on Monte Amiata, leading to a new power station in Bagnone two years later.
In 1963, when Enel bought Larderello SpA, there were 11 power stations and 311 MWp of power installed.
To face the oil crisis of the 70s there was a new push on geothermal energy by drilling wells even more deep and by enlarging geothermal sites. The reinjection of fluids was started at first to obey to new local laws then to reactivate no more productive wells. Thanks to years of experiments and chemical checks to study a process to refuel the reservoir and regenerate the geothermal resource, scientific bases to define geothermal energy as renewable source were created.
Today there are 33 power plants with a total power installed of 882,5 MWp and an energy production of more than 5 billion kWh per year.



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Img. 4

In 1904, the Prince Piero Ginori Conti switched on the first bulbs using geothermal energy. This event set the birth of geothermal electricity

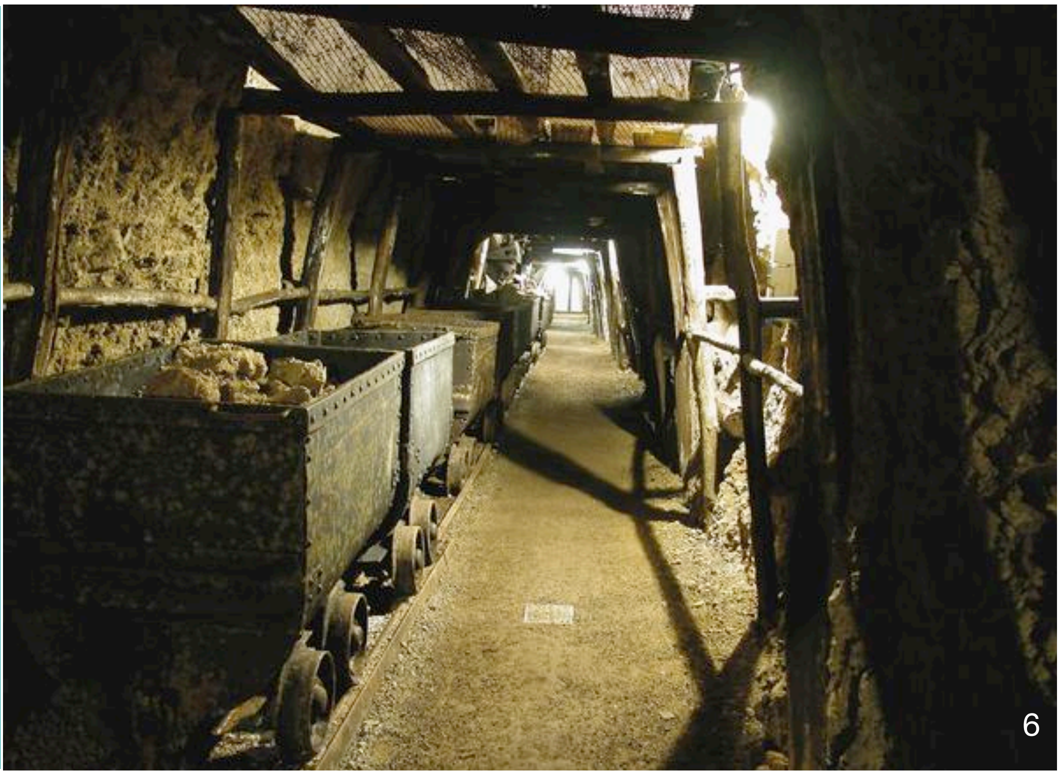
Img.5

During the 70s, due to oil crisis, the production of geothermal energy was increased and the 5th January 1972 the Travale well n. 22 started its production.

RESOURCES OF THE TERRITORY

Img. 6

One of the tunnels of the archeological mining park of Montieri.
This site is part of the National Technological and Archeologcal Park of Colline Metallifere, that “was born to preserve history of metallurgy and mining activities carried on during 3 millenniums in territory”*
[*www.parcocollinemetallifere.it]



From mining past to geothermal future through GEOCOM project

Montieri in history

The territory of Montieri enlarges upon Colline Metalifere area, famous for the rich underground patrimony that was represented by important mineral deposits well known also to people of antiquity, who always exploited them for their activities. The presence of these deposits conditioned the history of these places for long time, and created a close relationship between population and territory.
In Colline Metallifere area lead, iron copper and silver could be found. The Montieri zone was particularly famous for its copper and silver mines, indeed the town owes its name to Latin “*Mons Aeris*” that means Copper Mountain. This resource was already known at Etrurian time and around it great conflicts arose later in Middle Age in order to obtain the right for mineral exploitation. Between 1100 and 1300, Siena and Volterra fighted to exploit the silver and copper mines of Montieri, and in this age the medieval castle of Montieri, Gerfalco Travale and Boccheggiano were built to protect mineral deposits and extraction and processing activities.
The depletion of mineral deposits led to a general decay of the whole Colline Metallifere area and from 15th century economic activities were decreasing and mainly linked to the exploitation of forests.
During the second half of 18th century a series of administrative and institutional reforms favoured investments and repopulation. Some of the mining excavations were resumed together with agricultural activity, but then abandoned again during the 20th century. The importance of the mining activities in this area is still visible today thanks to the traces of the urban development due to the exploitation of these resources.

Img. 7

The Roste are old mineral deposits of copper processing dated back to the end of XIX and the beginning of XX century. These deposits, nowadays part of protected landscape, characterises the area visible from the road between Massa Marittima and Siena, beside Merse river.

Img. 8

The Poggio di Montieri rises 1051 meters a.s.l. On is north-east side lays the town of Montieri

Indeed the territory of the Colline Metallifere consists of ancient towns, “borghi” [medieval type villages] and castles, with a patrimony made up of centuries-old traditions and immersed in a landscape of considerable naturalistic interest.

Montieri nowadays

Montieri together with its three villages counts 1250 inhabitants (Montierini), an area of 108.61 km^2 and a population density of 11.50 inhabitants per km^2. The inhabitants are distribuited in four villages Montieri, that is the chief town,with its 435 inhabitants, Boccheggiano (498), Gerfalco (139) e Travale (178). They are distributed in 616 families with an average per household of 2.03 members.

The 2001 census showed a variation percentage of inhabitants -16.68% during the years 1991 – 2001.

Although for twenty years Montieri’s population decreased consistently, since the last five years this fenomenon has been slightly stabilizing thanks to immigration of people from the eastern Europe.

The total working population amounts to 803 individuals, 281 pensioners and 165 unemployed equivalent to 64.29%, 22.50% and 13.21% of the inhabitants, respectively. Moreover the trend of demography shows an increasing number of old population and a decreasing of young one, which can also be read as a reduction of the workforce.

The local inhabitants prefer to invest their resources on buildings and land rather than on economic activities.

It is common to see residents making small agricultural and forestry activities on their own land to satisfy personal need. Recently few tourism and reception activities are settling in the territory.

To rise economic and social liveliness of the area strategic actions are needed, above all those aimed at improving infrastructures and valorization of Montieri’s territory from historical cultural and environmental point of view.

The municipality of Montieri together with Massa Marittima, Monterotondo Marittimo and Roccastrada represents the Comunità Montana delle Colline Metallifere (Mountain Community of Colline Metallifere).
The whole territory of the municipality lays between 335 and 1060 meters a.s.l. and the town of Montieri is located at 704 m a.s.l.
The landscape is mainly made up of high-hills, with steep slopes characterised by many phenomena of instability (movements, landslides, erosions, etc.)
The territory is delimited on all sides by small rivers, the most important of these is the Merse, that flows into Ombrone river. There is also a small pond called lake of Montieri that gathers waters from northern slope of Poggio di Montieri.
The 86% of the territory is forested, the rest are arable lands (grass, olive trees, vineyards and fruit trees) or pastures.

Montieri demosite for GEOCOM project

The Geothermal Communities Project is part of CONCERTO initiative co-funded by the European Commission within the FP7.
The GEOCOM project aims at demonstrating the best available technologies in the use of geothermal energy combined with innovative energy efficiency measures and integration of other renewable energy sources in three different pilot sites (Hungary, Slovakia and Italy).
GEOCOM project in Montieri demonstration site has three main objectives:

- The realisation of a highly innovative geothermal district heating network and power generation system by using high enthalpy fluid
- The energy retrofit of selected dwellings among the building estate of Montieri town centre with materials and methods in conformity with their historical value
- RES integration: 8.5 kWp of PV panels and 42,5 m^2 of solar collector for sanitary hot water production

A preliminary investigation highlighted the feasibility of a geothermal district heating network, exclusively devoted to the city of Montieri, for a total of 425 residential units to be served by the system, with a total heated volume of 110,000 m3 and a value of energy required that can be estimated in 5,500 kW (20,000 GJ). The GEOCOM project will fund the cost of buildings' connection to district heating network and the upgrading of the existent heating system of private homes.
Montieri also represents a challenging site for defining and testing a qualitative architectural integration of retrofitting measures because in such an architectural heritage, the potential for intervention at the building envelope level is quite limited. Only natural materials and methods are acceptable that are in conformity with the medieval city structure. The building refurbishment will be matched with eco-measures to improve by the 50% the 2006 Italian new code for heating demand. Moreover these buildings will make use of geothermal heating to get a 100%

Img. 9 and 10

Examples of traditional buildings in Montieri's town centre.

Features of traditional architecture are massive walls of stone and bricks, horizontal structure made of timber beams and small openings


9


10

free fossil fuel. The retrofitting demonstration will take care of the town high cultural and artistic value. The GEOCOM project, besides developing a research project on this topic, will fund part of the energy retrofit cost for renovation of private and public buildings.

Img.11

The path of geothermal district heating net through streets of Montieri

Img.12

View of Montieri city centre

Img.13

Geothermal hot steam phenomena

11


12


13

GEOTHERMAL DISTRICT HEATING NET

Img. 14

Geothermal power plant of Travale. This is the nearest well to Montieri. This well will supply geothermal hot steam and water to the two exchange plants that lead the hot fluid to geothermal district heating net in Montieri

A demonstrative project with innovative solutions and technologies

System innovation

The Montieri pilot site will be setting a new, ambitious example for Central-Eastern European countries, where higher temperature fluids (medium/high enthalpy) may also be recovered. The feasibility of tapping into medium enthalpy resources will be demonstrated by the help of the innovative technological solutions. Challenges include high pressure (15-20 bar) and temperature (200-215 ° C).

The solution chosen for the realisation of the district heating system of Montieri is technologically innovative and it will be applied in the field of geothermal district heating for the first time.

Typically by the extraction of the steam is obtained, as a result of the treatment, a fluid called "two-phase" which still has an amount of energy not used; the system of Montieri will recover this energy with a flow of 0.4 kg/sec, at a temperature of 150°C and a pressure of 10-12 barA.

The system will consists of a circuit steam/two-phase with a refund of condensate directly in the two-phase pipeline (it will be a completely closed circuit with no gaseous emission outside), a close

Characteristics of geothermal fluid at Montieri 4 well

data provided by Enel

PRESSURE:	15-20 BAR A
TEMPERATURE:	200-215 °C
FLUX:	50-60 TON/H

Img.15 and 17

Two field where the geothermal heat exchange plant will be settled. Above the plant B beside city boundary and in the next page the plant B nearer to Travale's well. particular care is needed in landscape integration of buildings

Img. 16

The map shows the path of the pipeline from plant A to plant B

loop that transports heat by superheated circulations (steel pipe isolated with a polyurethane foam and protected by the coating of PEAD, length 2x2200 m) and a heat distribution network by hot water circulation (length 5100 m).
Moreover the system will consist of a primary exchange district and a secondary distribution district.
Into the primary exchange district will be exchanged heat between the two-phase geothermal fluid and superheated water into the closed loop which connects to the distribution district.
This secondary district will transfer the heat of the superheated water to the water of the closed loop of distribution system.
The "two-phase" fluid will be used to pre-heating the water of the circuit between the distribution district (B) and the primary district, that correspond to approximately the 10% of the geothermal resource.
Moreover during summer the system will be able to provide hot water using two-phase fluid and integrating it with steam if it is necessary.
The system will be powered by geothermal steam extractable from pipelines that connect the shaft of Montieri4, located in the north-west side of the town, to the system of Travale, on the north-east side of the town.

The extraction well and distribution plant

Particular care was put into choosing the location of Primary thermal power station for thermal steam / hot water and Secondary trading for superheated water / hot water. The first will be placed near the geothermal wells (A on map), at an altitude of 530 m a.s.l. for solving problems related to pumping condensate return. The second will be placed out of the town centre of Montieri (B on map).
As shown in the map, the path of pipes, chosen by surveys, is optimised in terms of minimising the total path length. Given the height difference between the exchanger steam / hot water at 530 m above sea level and the central exchanger at 700 m a.s.l., in order to keep in the circuit the superheated water at a pressure of 2 bars is sufficient to pressurise the circuit share of the central exchange, where jars of expansion will be installed.
Since the installation of a geothermal district heating net has to limit the thermal peak power on equal energy output, and maintain the network operating conditions as stable as possible, over time, by adopting thermoregulation equipment, it is supposed to keep the plant in operation even during the night.
Montieri with Geothermal Community will have a strong effect on the urban regeneration of the

whole town. Above others, there will be easily quantifiable effects on the reduction of the environmental impact and CO2 production of heating systems and domestic hot water production.

Heat source management and benefits due to geothermal district heating

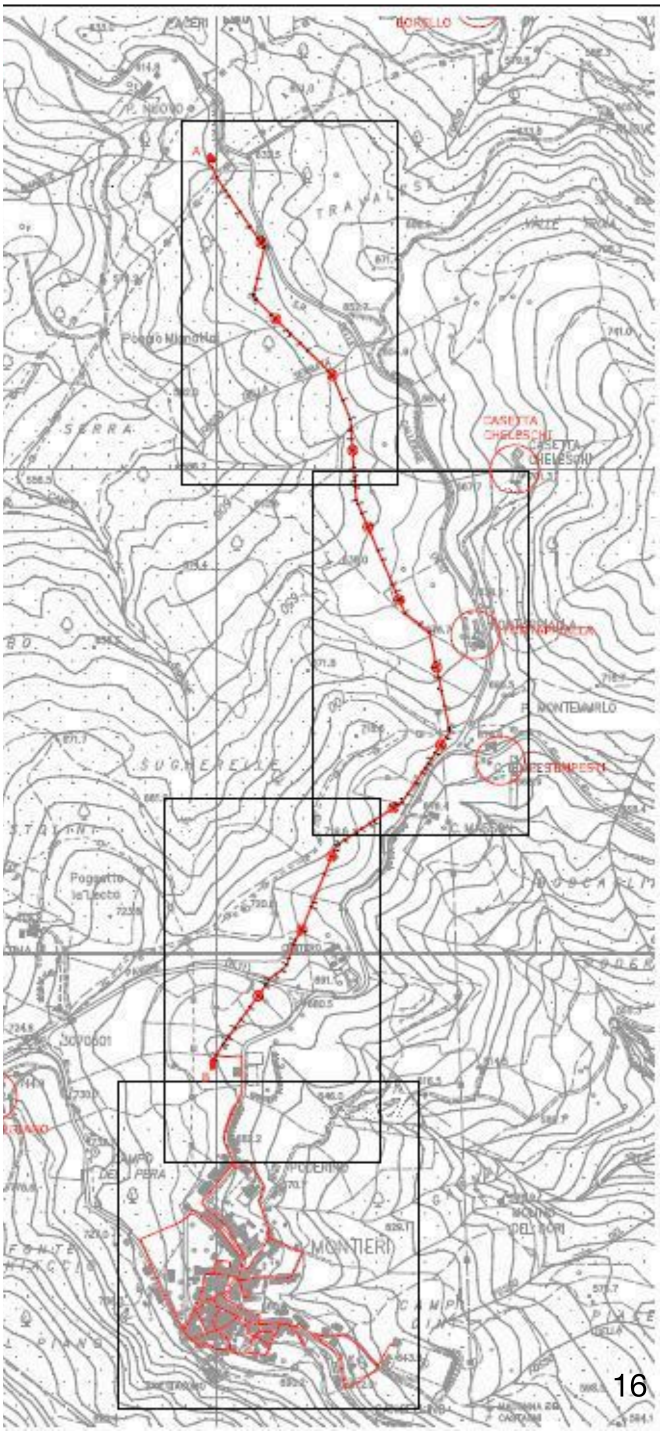
The Geothermal district heating system will provide heating and domestic hot water for 425 users (including 8 big public buildings).

Energy analysis of the town shows an energy demand for annual heating season quantified in 13.605.212,07 kWh.

Annually, from the environmental point of view the use of geothermal resource (steam + two-phase) will generate a saving of 1172.6 TEP (tonnes of equivalent oil 1TEP = 11.6 MWh) and a reduction of the CO2 and NOx emissions amounted to 3440000 kg and 7660 kg, respectively.

The geothermal district heating system will be fully automated and it will be controlled by a dedicated automatic and remote control including the controllers of heat accounting of utilities.

The control system will manage all mainly parameters of the whole system, pressure and temperature of the set-point. It will operate quickly on the system by alarm management and it will be linked to the ENEL network to improve synergy of system and data exchange. This innovative technical solution for the remote control of whole system will improve management and control of real thermal consumption and benefits of the system in real time.



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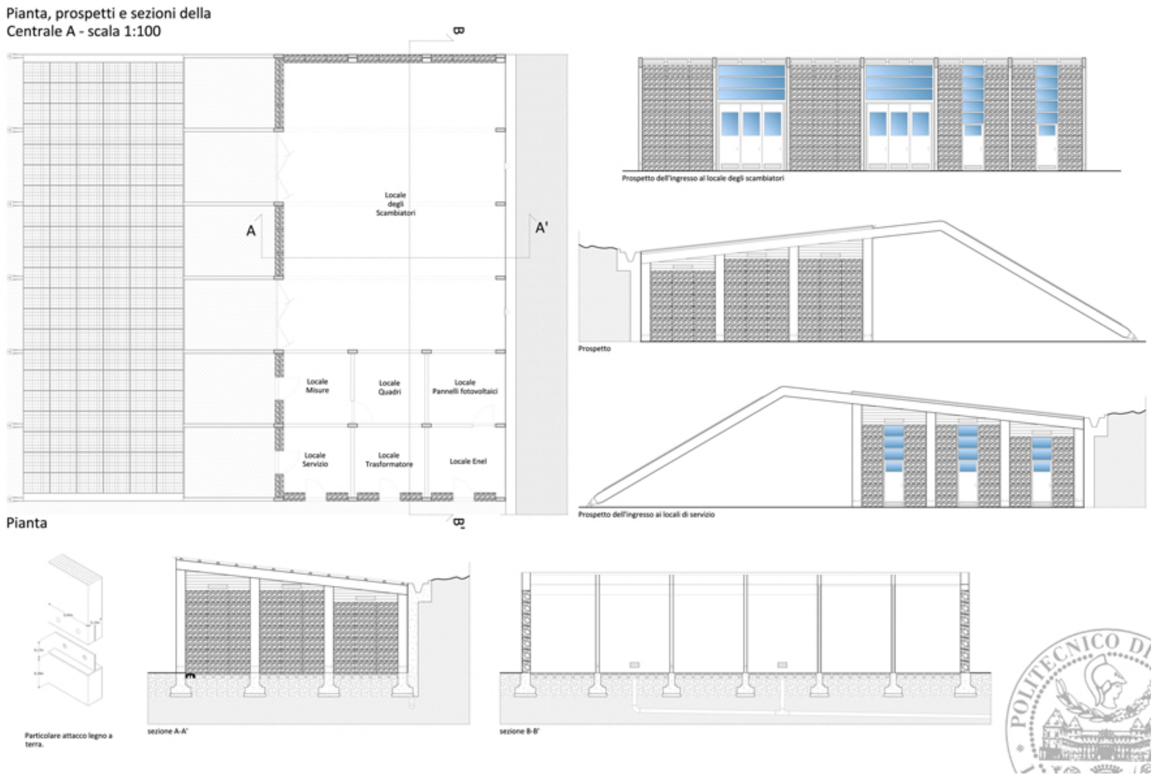
During the design workshop held in Montieri (see last chapter of this document), a group of students from the 2nd Faculty of Architecture of Politecnico di Torino studied an innovative building envelope to better integrate the two heat exchange plant in the landscape and the PV power plant far from the historical town centre.

The students kept the original size and module of the project but reinvented a structure made up of glued laminated timber beams and an envelope made up of cages of stones. A tilted shed connect the building to the field allowing the integration of PV modules toward the best orientation for maximum solar irradiation



ENERGY RETROFIT OF TOWN CENTRE

Img.18

Traditional buildings in Montieri. Masonry walls are made up of irregular stone and brick texture that used to be plastered. The present trend of removing plaster increases damp penetration by wind driven rain and humidity through external walls

Proposal of technologies to improve energy performance of Montieri's buildings

Energy retrofit objectives in GEOCOM project

The energy retrofit of Montieri town centre is one of the main objectives of CONCERTO GEOCOM project.
A series of technologies are being studied to improve the energy efficiency of the existent building respecting their cultural and historical value. A challenging target is given: to reduce by the 50% the energy performances required by the national norm in 2006 for new building constructions. Technologies must be oriented towards natural and bio-architectural solutions. A number of retrofit scenarios will be evaluated to plan the best approach of intervention from technological and economic point of view.
The characteristics of Montieri's architecture will be taken into account and targeted solutions will be studied to match the retrofit design with the benefit due to the presence of the geothermal district heating net.
Montieri will be also a demonstration site for photovoltaic and solar thermal technologies integration. A low environmental impact design of these technologies will be set by choosing an appropriate location.
Photovoltaic plant will consist in 8,5 kWp to be integrated on the buildings of the two heat-exchange stations of the geothermal district heating net. This measure will lead to a review of the original projects to achieve more appealing buildings from landscape integration point of view.
Solar thermal collectors for an area of 42,5 m^2 will be installed on the roof of sport facilities of Montieri to directly supply heat for domestic hot water where the district heating net can't provide

Img. 19 and 20

Two of the oldest building of Montieri, both dated back to Middle Age were part of defensive system of the Castle. Casa Biageschi on the left was one of the towers of external walls. Cassone Senese on the right was the old jail. These two buildings are made up of regular stone masonry. The first still presents traces of medieval arched openings, the second had been heavily modified to adapt the building envelope to residential function

it because of the location of the buildings outside the town centre. By this choice there will be no visual impact issues and the best orientation and indeed irradiation will be provided to the system.

Characteristics of traditional architecture

Montieri is a medieval village that still preserves historical characteristics of traditional architecture almost untouched.
The town centre is made up of narrow paved streets sided by two/three storeys-buildings terraced or isolated.
Older buildings are made up of stone and brick masonry and horizontal wood structures with cotto elements and "coppi" tiles on roofs. The openings have external timber shading devices called "finestra alla fiorentina".
Some very old building are recognisable among the urban texture because of stone masonry walls (a filaretto) and peculiar arches and openings. Those buildings are listed by local authority as symbols of culture and history of Montieri. Among these buildings the most famous are: three towers that were probably part of external walls of the medieval castle (Casa Biageschi, torre Narducci and the bell tower of the main church); the medieval prison called Cassone Senese, the Palazzo dei Marchesi or Papi Matii, and the town hall that was built at the beginning of 20th century on the ruins of the old court.
Some modern buildings filled in the gap between older ones and kept main geometrical proportion of existent architecture even by the use of modern technologies.
At the bounderies of the town few other buildings were added and they can be easily noticed in that context.
In the area that belongs to the ancient development a relevant portion of buildings need to be renovated, some of which are in very critical decay.

Technological solutions

In such an architectural heritage, the potential for intervention on building envelope is quite limited.
To improve the energy efficiency of the envelope heat losses and uncontrolled air infiltration have to be reduced. In older building thermal insulation of external walls is usually not possible because walls are very thick and rooms are already small. Moreover any insulating layer would reduce the effect of thermal mass on controlling and delaying peaks of outdoor temperature. For these reasons the retrofit of external walls has mainly the aim of protecting the masonry from water and moisture infiltration by laying protective plaster on surfaces.
Instead the insulation of loft space and basement ceiling is recommended where it is technically possible. This measure will reduce the heat losses in winter and the overheating in summer. A natural ventilation of the loft space must be provided to avoid moisture deposit on insulating layer.
The improvement of windows performances can be provided by the substitution of the glazing system when the thickness of the timber frame allows it or the substitution of the whole window. The former requier a good ability to not ruin the frame, the latter a good design to not change proportion and appearance of the whole facade. Low emitting double grazing with air or argon filling represent a big improvement of insulating performance of openings, timber frame is always advised because of its efficiency and its similarity to traditional one.

One of the objectives of the energy retrofit project is to provide a list of technologies evaluated from efficiency cost and quality points of view to assist local authority and local designers during design process.

The use of natural materials is promoted together with the integration of technologies respectful of the historical value of the buildings.

The project will enhance the image of the village as a whole inspiring sustainable and high quality policies for other historical villages

Other measures will be studied to improve indoor comfort.
To improve day lighting:
· central skylights opening
· careful selection of the skylights glass (light transmission/solar gains/light reflectance coefficient)
· opening of skylights in order to allow the natural light to reach the lower levels of the building;
To improve natural ventilation:
· use of the high potential for natural ventilation of buildings
· opening of skylights to increase natural ventilation
Suitable renewable energy configurations will be investigated and developed for different building types, based on a variable model, intentionally non-homogeneous, with the aim to guarantee variety of shapes, and adaptations to the architectural heritage of the town.

Img.21

Two representative buildings in Montieri's main square, Palazzo Papi Matii on the left and the town hall on the right.The first was originally built in 17th century and the façade was made up of regular stone. By a refurbishment of 20th century stones were replaced with bricks. the second was built in 1901 on the project of arch. Lorenzo Porciatti who took inspiration from medieval architecture

A catalogue of solutions, integrally estimated on each technological/typology crossing will be worked-out, in order to predict the most appropriate technology and configuration for any building type
The result will be a matrix of technologies, components, equipments and materials to be tested in the whole town centre, qualified and quantified in terms of energy benefits, environmental impact reduction, and gas emission control.
The key result will be a set of exemplar Renewable Energy Projects for the existing building stock of Montieri

Img. 22

An example of loft insulation with sheep wool mat

Geothermal Communities-239515
WP3-D3.1 Technology showcase for retrofitting

Key Example 4	Edificio in Via Garibaldi (Building in Via Garibaldi)
LOCATION	KEY IMAGE
	

RETROFIT TECHNOLOGIES

- Key Technology n. 1: Loft insulation
- Key Technology n. 4: Insulation of the basement's ceiling
- Key Technology n. 7: Windows replacement
- Heat plaster on external façade
- External insulation of walls

ENERGY PERFORMANCES

Simulated present performance (kWh/m^2 y)	Simulated retrofit performance (kWh/m^2 y)	Simulated energy saving (kWh/m^2 y)
177	100	77

Estimated money saving (Euro)	Estimated technology cost (Euro)	Estimated pay back time (years)
2310,64	5960,92	2,58

If external insulation is integrated on the building's walls

Simulated present performance (kWh/m^2 y)	Simulated retrofit performance (kWh/m^2 y)	Simulated energy saving (kWh/m^2 y)
177	72	105

Estimated money saving (Euro)	Estimated technology cost (Euro)	Estimated pay back time (years)
3150,88	12173,34	3,86

ADVICES AND CONSIDERATIONS

To reduce moisture related problems and to improve the thermal resistance of the external walls the heat plaster can be spread both east and west façade of the 3 storey building.
Also the external insulation of the walls is suitable. This measure has to be carefully designed in order to keep the original appearance of the building.
The other technologies chosen are respectful of the building historical value

The buildings chosen as case study are analysed in their present and design energy performance.

Appropriate technologies are chosen according to level of historical value, characteristics of the building and weak points of the envelope.

The cost of technologies is based on the official price list of Tuscany Region for public works.
The amount of energy saved is translated in money saving by the present price for m^3 of natural gas in Italy.
From these data the payback time of whole retrofit measures is determined.

As an average of calculation done until now, it is estimated an improvement of energy efficiency of 40 % and a pay back time of 3 years

GEOCOM
DISSEMINATION EVENT

Img. 23

At the beginning of May 2010 a design workshop was held in Montieri, where students from Politecnico di Torino could survey and study the buildings of this historical town. As conclusion of works was organised an exhibition to involve local population

Design workshop of the students of Politecnico di Torino in Montieri

The atelier on technological innovation

During academic year 2009-2010 a group of students of the 3rd year of the 2nd Faculty of Architecture of Politecnico di Torino were called to think about possible technological solution to achieve the GEOCOM projects objectives in Montieri. The highest moment of the design atelier was the realisation of a workshop to study closely the buildings taken as case studies and to share with local population and municipality the outcomes of their works.
The workshop aimed also at introducing to students the reality of geothermal energy use and its development in Tuscany. They visited the site of Larderello the oldest geothermal energy district in Italy.

Among the workshop's works a group of students analysed the buildings of the two heat exchange plants necessary to bring the geothermal energy from the nearest heat extraction point of Travale to Montieri. They implemented an innovative building envelope integrated in the landscape.
All other students focused their attention on public and private buildings of the town centre.
First of all the buildings were surveyed and the level of decay was assessed. Few students could also visit their case study building and check the exact dimensions of constructive elements and rooms.
A calculation of present energy performances of buildings was made by the use of BestClass software. This assessment and the survey were the base on which they designed the retrofit project.
A number of technological solutions were proposed by several drawings and the new retrofit performances were hypothesised.

24

25

26

27

Each group of students summed up the outcomes of its study on a poster and an exhibition was set up in Montieri's main square, Piazza Gramsci. The objective was to involve local population on the event to sensitise on energy efficiency issue and possible feasible solutions to face it.

Some people visited the one-day exhibition and a good interest arose on retrofit design possibilities for town centre's buildings. The students answered all the questions about technological an design related problems and there was a general appreciation by local public about the work done by the students.

Workshop results and feedback from local population

The workshop in Montieri was a good opportunity for Politecnico di Torino's students to understand the reality of geothermal energy use in Tuscany and the need of accurate retrofit measures for an existent historical town.

A first study of Montieri building estate is now done and it represents a base for a thorough analysis on the different building typologies and their retrofit scenarios to fulfil the objectives of CONCERTO GEOCOM project

Finally this event made the population aware of the purposes of the GEOCOM project for building retrofit and gave them the opportunity to see preliminary studies and possible solutions to energy performance issues.

Few comments from local population and authority were collected during the exhibition.

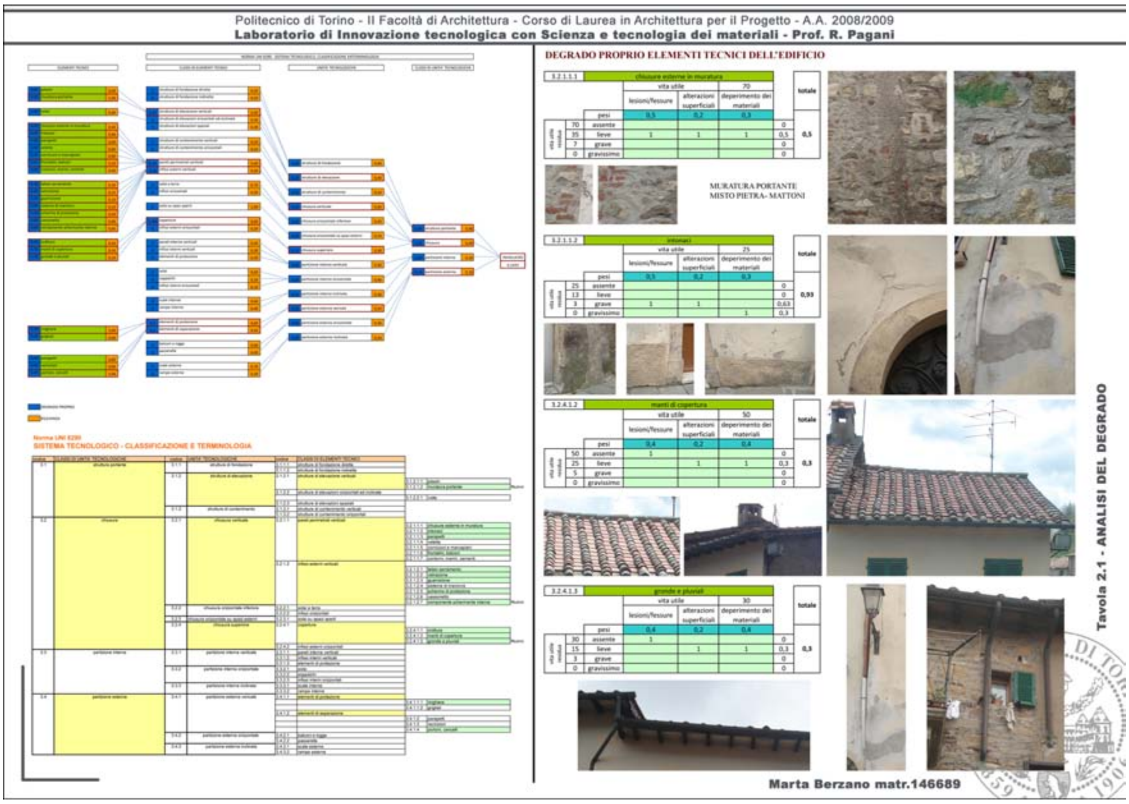
Montieri's deputy mayor: "If we knew about the quality of the students' works we could have organised a larger event..."

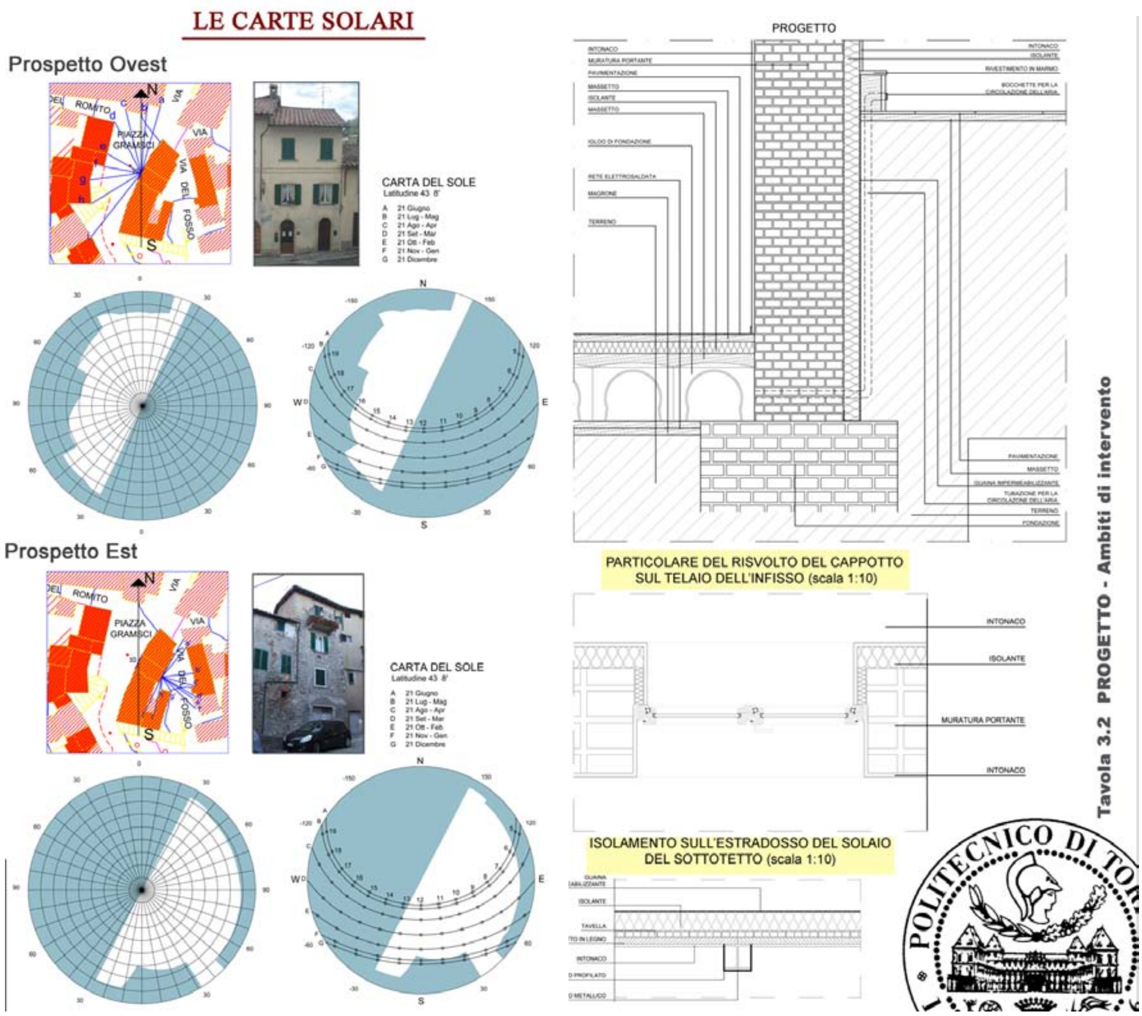
Mr. Papa (the 3rd), a local builder: "I saw in one of the posters a solution for damp problems on masonry, if you can give me more details about it I will adopt it…"

Img. 24, 25, 26, 27

Students introducing their works to local population

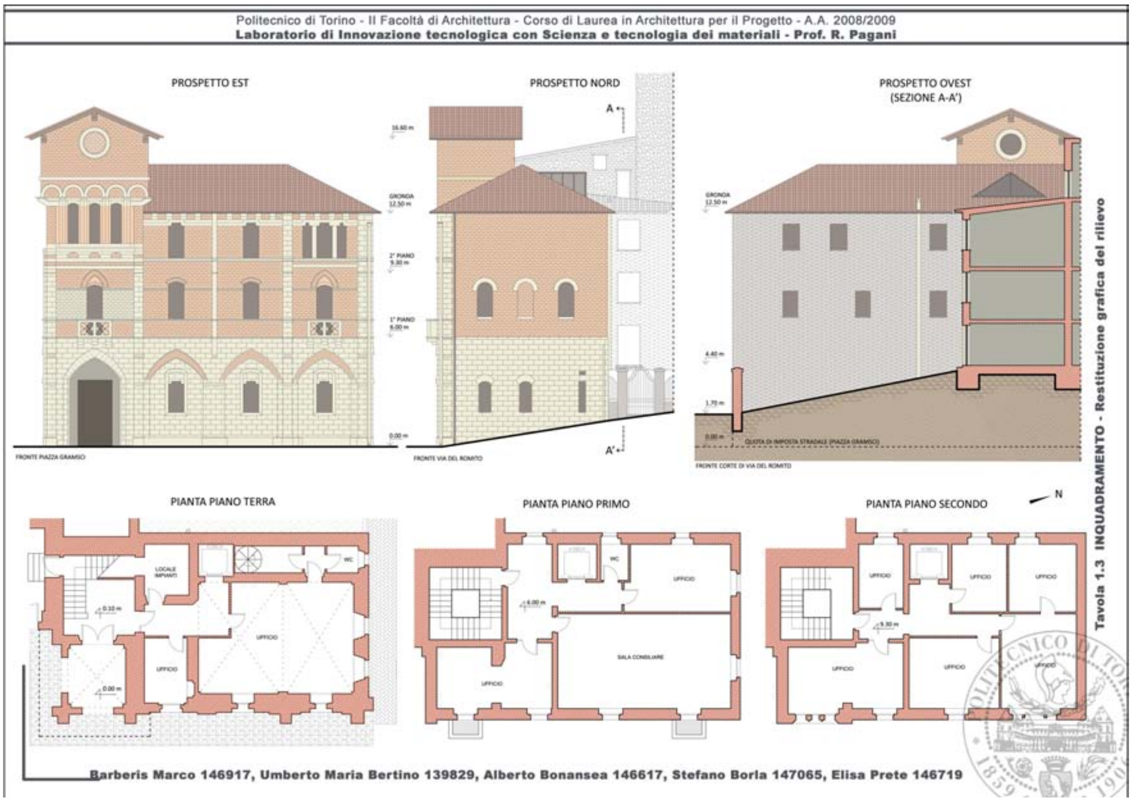
The concept of the design project was based on a process structured to take into account all characteristics of the existent building. First of all a survey and a decay analysis of the main elements of the building envelope were set. Shadows from surrounding buildings were also studied by the help of polar and solar diagrams.

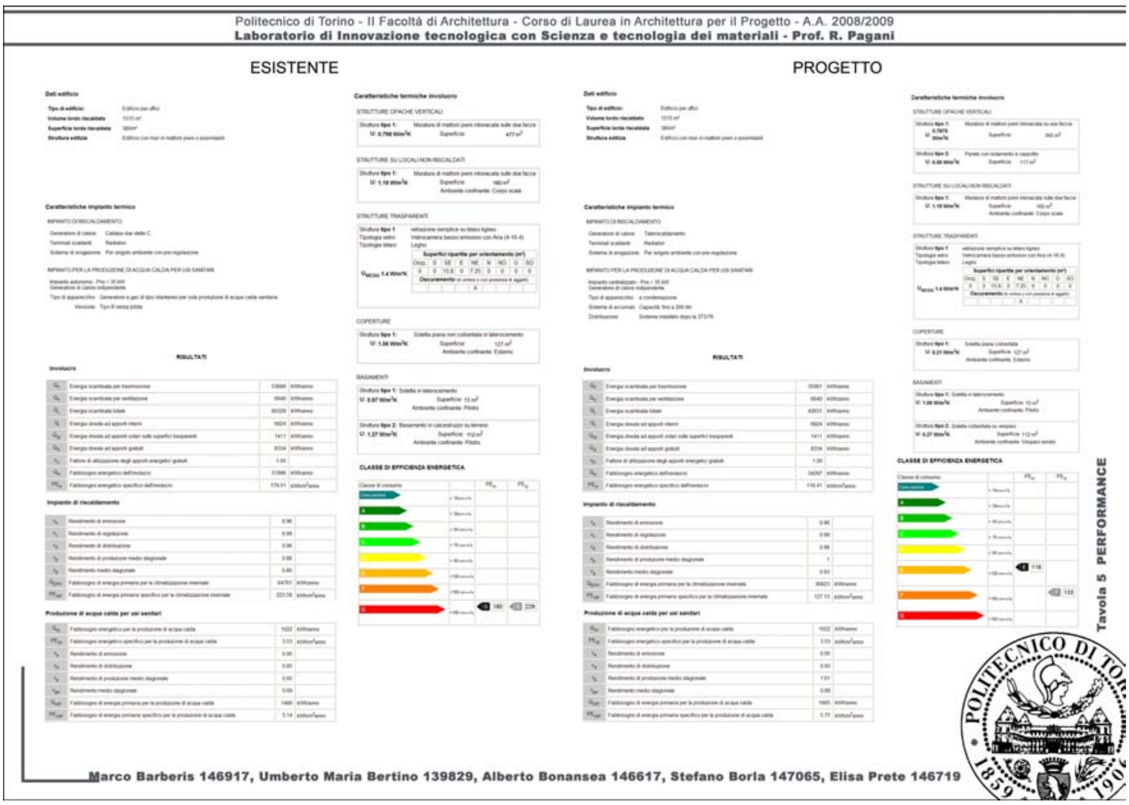




Then the building was drawn into the poster and present energy performances were assessed. Based on obtained results technological solutions were chosen and a new calculation was done. Results gave approximate energy efficiency class before and after the retrofit design.

The exhibition made on the main square represented a good event to made population aware about research going on on CONCERTO GEOCOM project objectives in addition to geothermal district heating network





GEOTHERMAL COMMUNITIES PROJECT CONSORTIUM
239515

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