

GEOTHERMAL ENERGY

FERRARA (Italy)

Geothermal energy takes a rather subordinate position among renewable energy sources. There are two possible sources for it: the radioactive decay of natural radio nuclides which causes the spread of heat onto the earth's surface, and the storage of solar energy in the top layers of the earth. For this reason, geothermal energy is available in many places and independently from the different seasons of the year, even if some regions do have a higher potential than others. This applies, for example, to the city of Ferrara in Northern Italy, they uses the geothermal source in an integrated system for district heating and cooling, together with the heat produced in a biomass plant for solid wastes and methane gas boilers as back-up.

THE CITY

Ferrara, with its streets, palaces and squares can be considered as a typical example of Italian rinascimento city. It is located in the northern part of Italy and it has a population of 133.000 inhabitants. It lies on the Padana plain, in between of Bologna and Venezia. The main activities are agriculture, commerce, culture and tourism, also small and medium sized enterprises are well developed in its territory, also within Ferrara territory there is one of the first Italian petrochemical poles.

Climatic data:

Mean temperature:
Summer 27°C
Winter 5°C.



CONTEXT

Ferrara is one of the most sustainable cities of Italy, the environmental issues are seriously taken into account by the Municipality, it subscribed the Aalborg chart in 1996 and in 1998 it started the Local Agenda 21 process, also it has been awarded by Legambiente (the Italian environmental agency) as best environment-friendly city in 2001. The municipality is member of several network of sustainable cities, both in Italy and in Europe (ICLEI, BigNet and Car Free Cities).

In this context in 1984 the "Progetto Geotermia Ferrara" begins as an integrated system for district heating, from a venture between the Municipality, AGEA (the local energy agency), AGIP (Italian public energy company) and ENEL (national electricity company). The main aspect of the project is the use of a geothermal energy source, discovered in 1956 during investigations for oil reservoirs at a depth of 1.000 m, 4 km NW from the city centre of Ferrara. At that time the well was abandoned and only after the energy crisis during the 70's (the Kippur war) was taken into account to utilize this important energy source. Works began

in 1987 and in 1990 the first buildings were connected to the district-heating network. In 1993 the CHP plant for the thermo-destruction of solid wastes was built, while a second well was opened in 1995. In 1999 a turbo alternator fed with the vapour generated by the CHP plant was installed, and by this year the project can be considered completed and fully operating.

EXPERIENCE OF FERRARA

The integrated system utilizes the following sources of energy:

- Geothermic, 400 m³/h flow rate (nominal power output of 12 MW)
- Heat from the CHP plant, with a power output of 9 MW
- 4 Gas boilers with a nominal output power of 42 MW

The system is also provided with a turbo alternator (3.3 MW of nominal power) fed with the vapour steam of the CHP plant.

Technical aspects

The main energetic source is the geothermal one, coming from 2 wells at the maximum flow rate of 400 m³/h, the water is then re-injected in the underground by another well. Integrating the main source there is a CHP plant fed by solid wastes (40.000 t/y) producing 15 t/h of overheated water vapour at 380° C. Also the system is provided with a gas backup system of 4 boilers supplying the 15% of thermal energy.

The pumping station is composed by 4 independent hydraulic circuits, 3 of which connecting the energy sources to the station, while the fourth is the district heating network distributing the heat to the city. The system is provided with 4 tanks of 1.000 m³ each in order to accumulate the thermal energy and to modulate the population's heat demand/offer.

The district-heating network is made of expanded polyurethane and polyethylene coated steel pipes; the total length is of 30 km, the main branches are of 450/500 mm in diameter, working at a pressure of 25 bar, at a temperature of 90° C.

Since 2001 about 320 buildings are connected to the network for the heat producing, in about 85 buildings also sanitary hot water demand is covered. The total volume connected is over 3.200.000 m³. The buildings are both public and private and they are large structures as condominiums, schools, hospitals, office buildings, etc.; most of them were equipped with old and low efficiency oil boilers.

The system is provided with remote automatic monitoring devices and the substations are provided with electronic device in order to optimise the consumption of heat.

From an economical point of view, the total cost of the operation was of over 72 million Euro, of which over 55 million were invested for the realization of the district-heating network; the whole project has been completely financed by public investors. The wells are owned by a joint venture Agip-Enel and they have received grants from the European Commission Thermie programme. The lifetime of the system is estimated to be 30 years.



Results

Figures of the integrated district heating system, which are on a stable level since 1998 are summarised below:

- Thermal energy production:
 - 26 GWth from the CHP plant (24% of share)
 - 14 GWth from the gas boilers (12% of share)
 - 71 GWth from the geothermal source (64% of share)
- The total volume connected is 3.200.000 m³, corresponding to 12.800 lodging equivalent.
- Saving of about 9.000 m³ of oil equivalent, that led to save emissions for 17.400 kg NO_x, 9.760 kg SO₂ and 21.300 tons CO₂
- Job creation, with 45 people working in the plants, plus all the inducted work market due to the over 70 million Euro invested over a period of 10 years.
- In 2000 the CHP plant has generated about 8.600 MWh electrical energy.

Further, the municipality of Ferrara, in collaboration with AGEA, developed another project in the field of sustainable development. At the moment this system is not connected to the district-heating network, but it is planned to be integrated in the network in the near future. It is about the recovery of the energy dissipated during the lamination process of the gas-methane. The plant is composed by a turbo expander coupled with an alternator of a nominal power of 1.000 kW; the system is then completed with 2 endothermic engines for the cogeneration of electric energy and thermal energy. At the moment the electricity is used in several AGEA plants, while the heat is utilized for the methane preheating. In 1998 the turbo expander produced 3.117 MWh without burning gas, plus 3.257 MWh produced in cogeneration by the endothermic engines, by methane burning, for a total of almost 6.400 MWh.



EVALUATION AND OUTLOOK

The integrated system for the rational use of the energy was created with the aim to use all the renewable sources available in the territory, employing the energy at local level in the most inhabited part of the municipality. For this purpose the geothermal source was fundamental to achieve these results.

The district heating system had a great impact in the population, because it "entered" in to their homes. The success of the system had been achieved thanks to its higher performance in comparison with oil systems in terms of cleaning and safety.

Currently the network serves about 12% of Ferrara population, within the next 5 years it is planned to extend the total volume connected to the system to 5.500.000 m³. To cover the energy demand a new CHP plant using solid waste is foreseen as well as conventional cogeneration units for heat production.

In detail, the Ferrara Geothermal Project can be considered:

- **Innovative**, as it is one of the first example of integrated and rational use of renewable energies
- **Pilot**, as it is integrated both in the production and in the use and it is used for several purposes (heating, cooling, sanitary hot water, industrial and agricultural use)

- **Exportable**, even if the presence of the geothermal source makes the example of Ferrara by itself, the concept of integrated system for a rational use of the energy is universal
- **Participated**, thanks to the collaboration between the Ferrara Municipality, AGEA, AGIP and ENEL it was possible to start the project and to manage today the complex system, creating the basis for a future development of the program
- **Effective**, it produced positive effects on the environment and on the local employment market. The district heating interests about 13.000 lodging equivalent, therefore there are 30.000 inhabitants directly involved in it. But there are much more people (everyone living or working in the city centre, were the district heating is located) that benefit from the reduction of the air pollution.

FURTHER INFORMATION

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