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LOW ENTHALPY GEOTHERMAL ENERGY DEMONSTRATION

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Work Package 3: Capitalization and geothermal energy efficiency rating

Action 3.1
GCHP Case Studies from Italy

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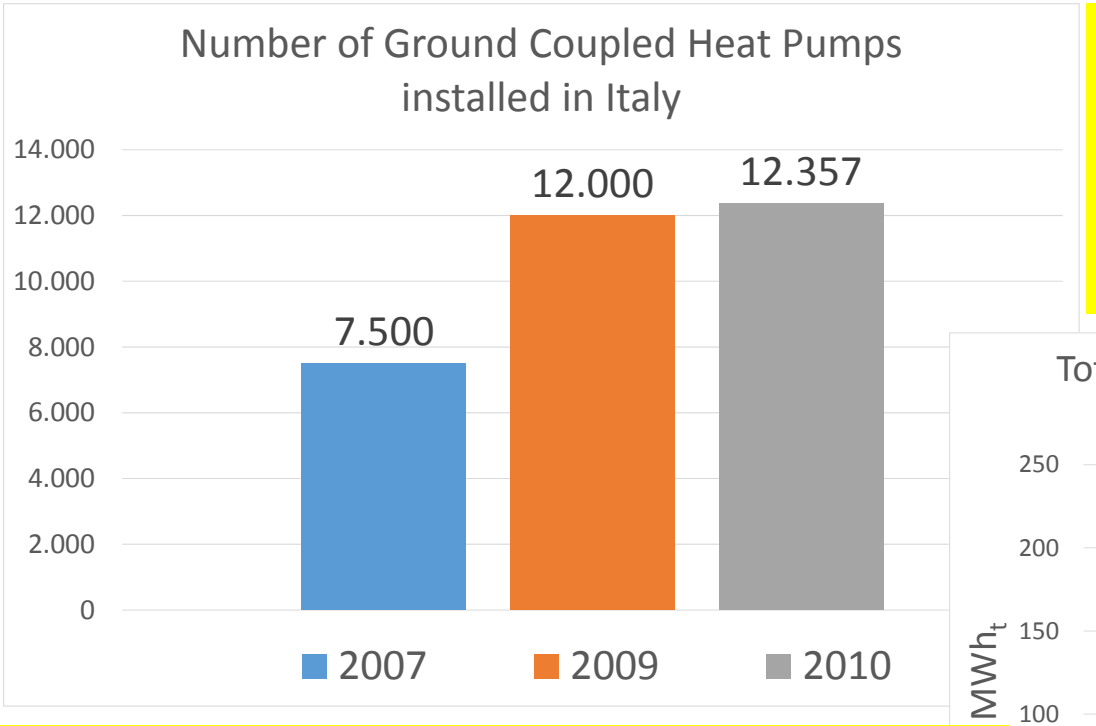
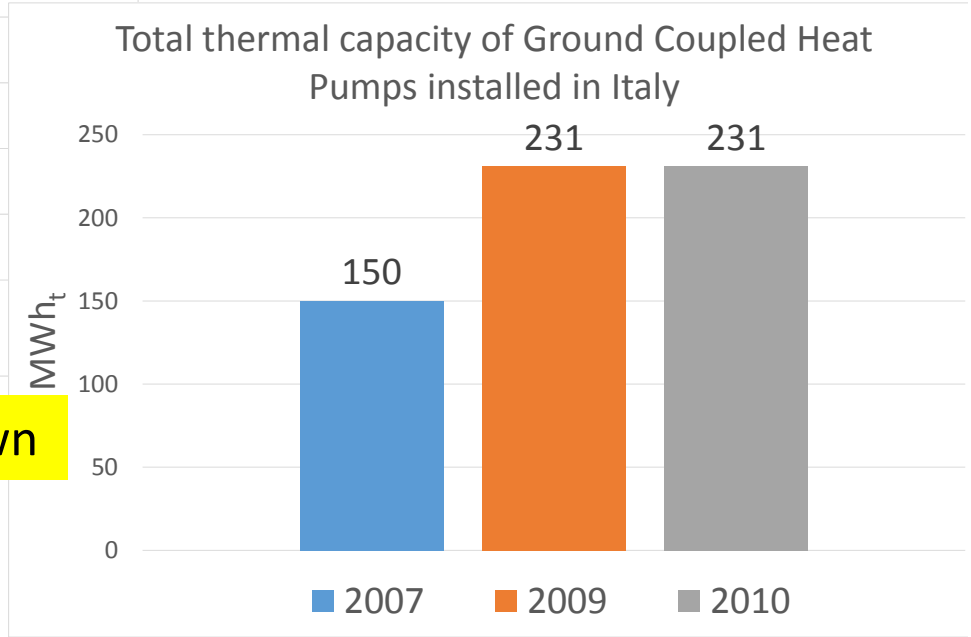


Main types:

Open Loop
Vertical Closed Loop
Horizontal Closed Loop



High increase, followed by a sharp slowdown

Source: Eurobserver Statistics

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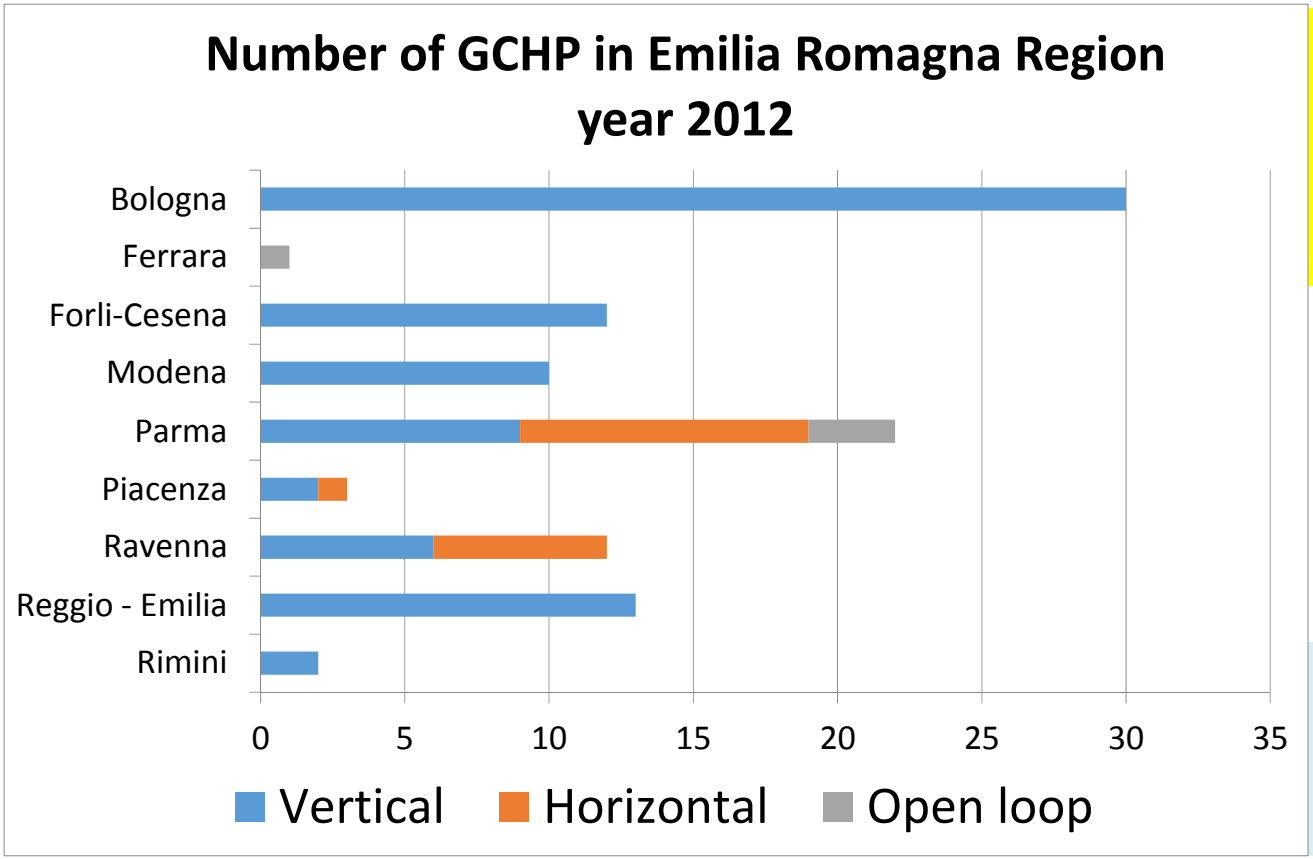

But…it represents only the known GCHP plants in Emilia Romagna Region

Source:
Geo.Power Emilia Romagna handbook

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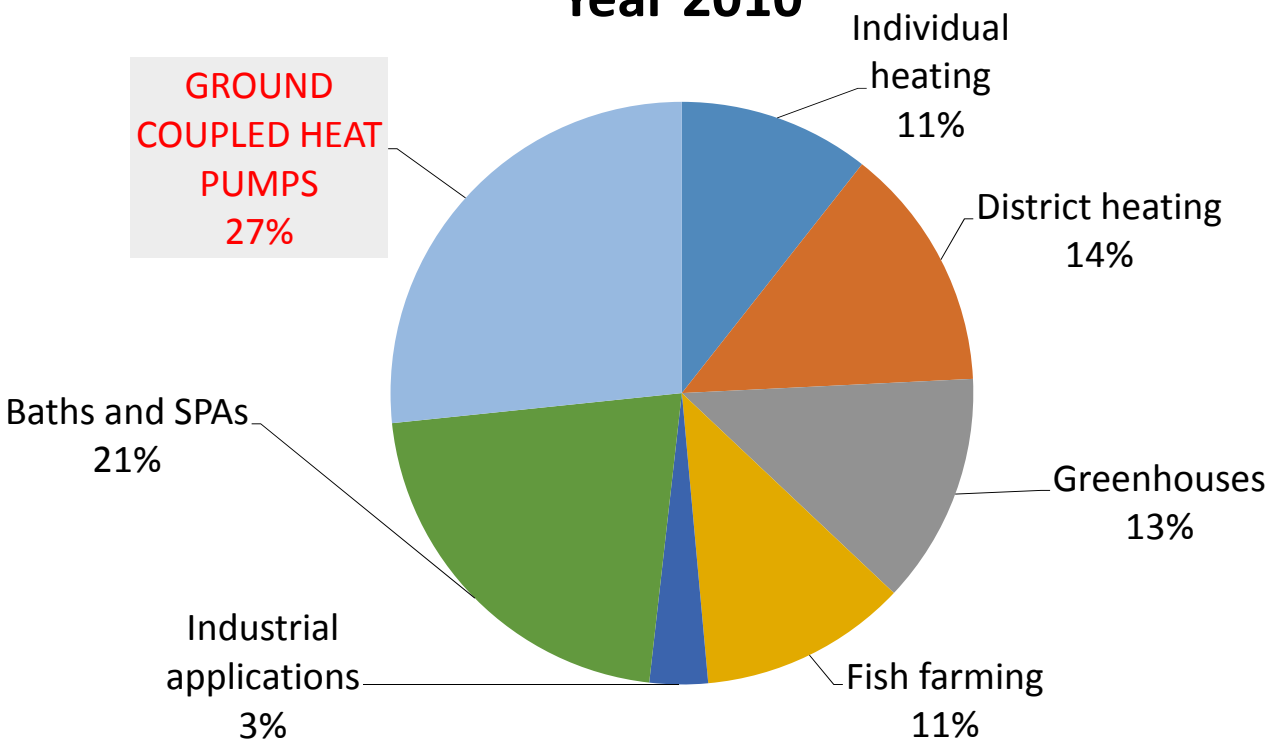
Quota of GCHP among all geothermal energy uses in Italy (excluding electricity production) Year 2010



27% of all geothermal potential was covered by GCHP

Source: International Energy Association - IGA

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Sectors of applications of GCHP systems:

- Residential sector (single family houses, villas, multifamily houses)
- Recreation sector (hotels, spas, farm holidays, swimming pools)
- Agriculture sector (greenhouses, wine cellars)
- Public sector (schools, kindergartens, theatres, libraries)
- Commercial and industrial sectors (shopping malls, sheds)

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- Residential sector (single family houses, villas, multifamily houses)

Single family house

Intervention: energy renovation, year 2008
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Single family house

Underground parameters:

- Mainly saturated sand. Estimated thermal conductivity around 2 W/(m·K)
- Presence of confined aquifer at 60 m depth
- Underground temperature around 12-13°C, after 20 m depth

System main features:

- Electric heat pump 12 kW_t – 16 kW_c
- 2 borehole heat exchangers 80 m depth
- Under floor radiant heating and cooling
- Photovoltaic panels on shelters 10 kW_p

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Single family house

Heated net floor area of the building: 200 m^2

Heating and hot water preparation

- SPF heating: 4,5
- Energy sources used: Electric energy fed by PV
- Annual energy consumption: 3.000 kWh_e covered by PV
- Annual theoretical cost: 800 € → covered by PV
- Energy consumption per heated net floor area: 30 kWh_t/m^2

Cooling

- SPF cooling: 5
- Annual energy consumption: 7.000 kWh_e covered by PV
- Annual theoretical cost: 1900 € → covered by PV
- Energy consumption for cooled net floor area: 35 kWh_c/m^2

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Single family house

Installation costs:

- Heat pump, connections and air recovery: 14.000 €
- Borehole Heat exchangers: 14.000 €
- Radiant floor: Already present in the house
- Photovoltaic Panels: 30.000 €

Incentives for renewable energy:

- Energy renovation (2008) → GCHP → Tax relief 55% in three years
- First PV energy incentive (2008) → PV 3 kW_p → Incentives on produced energy
- Second PV energy incentive (2010) →PV 9 kW_p → Incentives on produced energy

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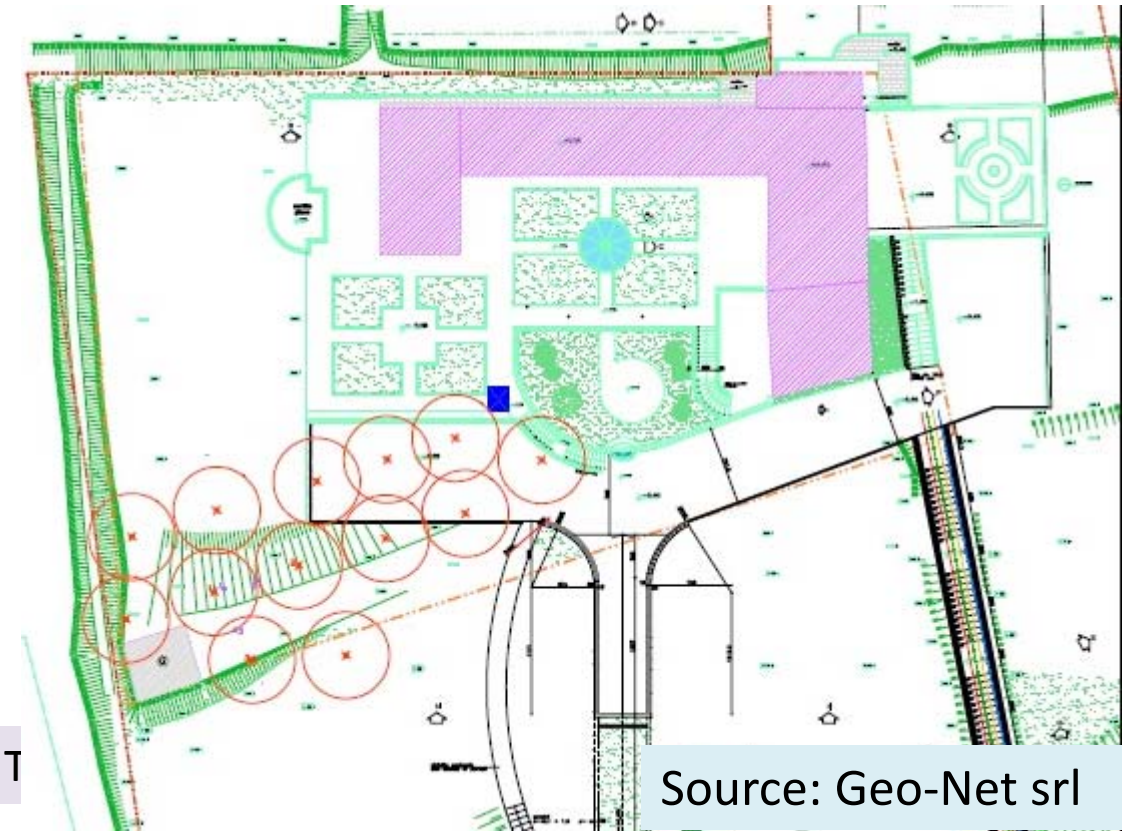
- Residential sector (single family houses, villas, multifamily houses)

Villa

Francesco T



Source: Geo-Net srl

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Villa

- Same concept of single family house but much bigger
- Usually located in places far away from gas grid
- Heating, cooling, hot water, swimming pool and, sometimes, private spas
- Always connected and fed by PV panels, to get high incentives (years 2007 – 2009) and return the entire investment in less than 10 years.
- Always linked to electronic control of comfort in the house

- In the case of Bergamo: 13 BHEs 150 m depth. GCHP > 100 kW_t

- Sometimes promotional reasons: villas and single houses property of owners of construction companies, owners of PV companies, engineers, geologists, …

Action 3.1

- Recreation sector (hotels, spas, farm holidays, swimming pools)

Hotel

- PV + electric GCHP in some hotels of adriatic area
- High use of gas absorption heat pump (air or geothermal), when presence of the gas grid and no installation of PV panels
- LEGEND Best Practices: 20 BHEs 100 m depth in an hotel in Emilia Romagna on the seaside

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Hotel

Main challenges:

- High need of cooling in summer season (Adriatic area)
- Generally not used all over the year and not always at full load
- Contemporary need of hot water, cooling, and service water (spas, swimming pools)
- Actually, selection is between air-to-air heat pumps (roof top) or ground coupled heat pump, or a combination of both

Main challenges of the system

- Usually need of peak power (basically for cooling) in few periods in the year
- Economic potential to make hybrid systems, combining GCHP to cover all demand of heating and air-to-air heat pump to cover cooling needs
- Other types of thermal renewables are generally not used
- Presence of solar thermal panels to provide hot water on the beach, when disconnected from the grid

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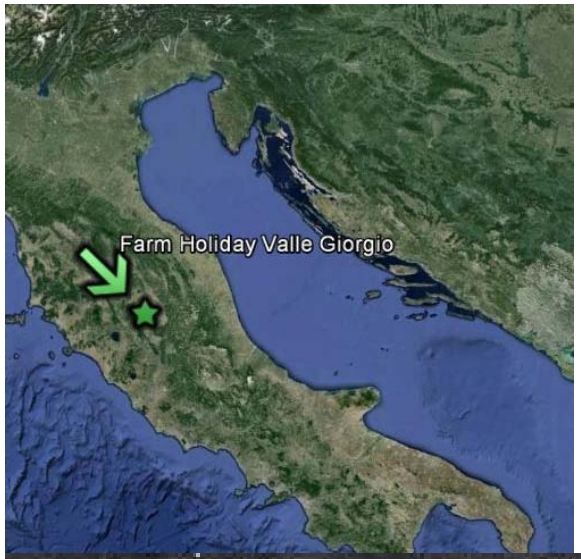
- Recreation sector (hotels, spas, farm holidays, swimming pools)

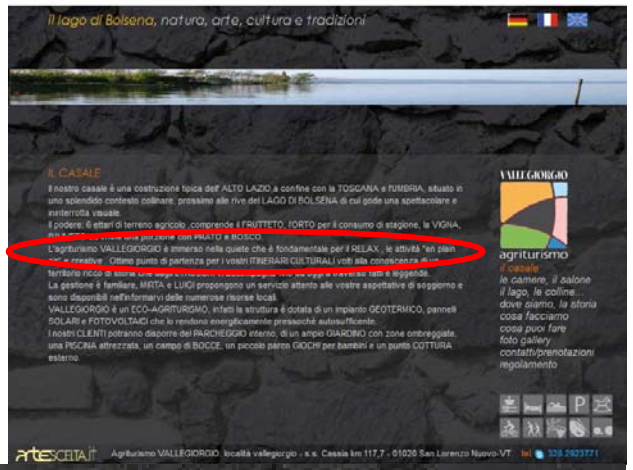
New farm holidays → Eco tourism.

Farm holidays

Nearly zero energy buildings since 2007-2008

High incentives on pv and tourism





VALLEGIORGIO è un ECO-AGRITURISMO, infatti la struttura è dotata di un impianto GEOTERMICO, pannelli SOLARI e FOTOVOLTAICI che lo rendono energeticamente pressochè autosufficente.

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Farm Holidays

Main challenges:

- New buildings far away from the gas grid
- Containment of the installation costs
- Heating, cooling and hot water
- Zero energy bill
- Promotional reasons: "green" holidays Italy for foreigners
- Not perfectly known technology in 2007. First attempts
- Basically used from spring to autumn

Main features of the system

- Surface: 500 m^2, 2 floors
- Radiant floors, radiators
- Swimming pool
- 1 GCHP 16 kW_t
- 9 BHEs 40 m depth in turf
- Solar panels for hot water and swimming pool
- Pellet boiler for back up (never used)
- PV panels 6 kW_p covering all energy consumption
- No gas grid.
- 2007 → High incentives for solar panels
- Ordinary maintenance. System working 7 years without major problems

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- Agriculture sector (greenhouses, wine cellars)

Greenhouses

Source: Floriamata

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Geothermal heating from cogeneration of nearby geothermal power plants

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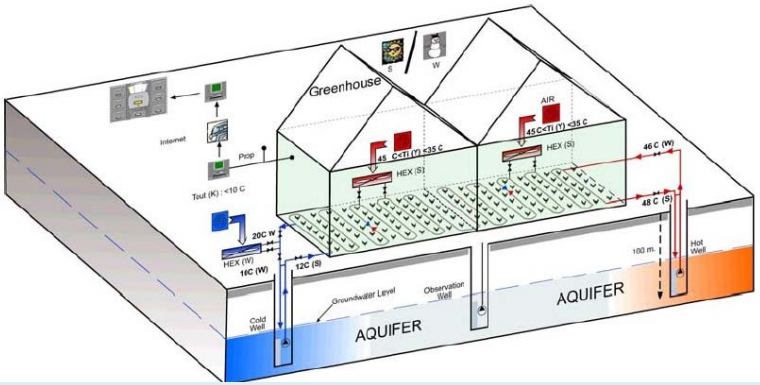
Greenhouses

Main needs:

- Mostly heating
- CO_2 introduction
- Appropriate ventilation
- Moisture control



Optimum use of geothermal energy:

- Coverage of all heating loads
- Use of absorption heat pump for introduction of CO_2
- Floor radiant panel not always the optimum solution. It depends on types of crops. Energy and cost balance between moisture and heating needs
- Cooling only when necessary. Critical point because of high consumption for some crops

See → LEGEND Best Practice from Netherlands

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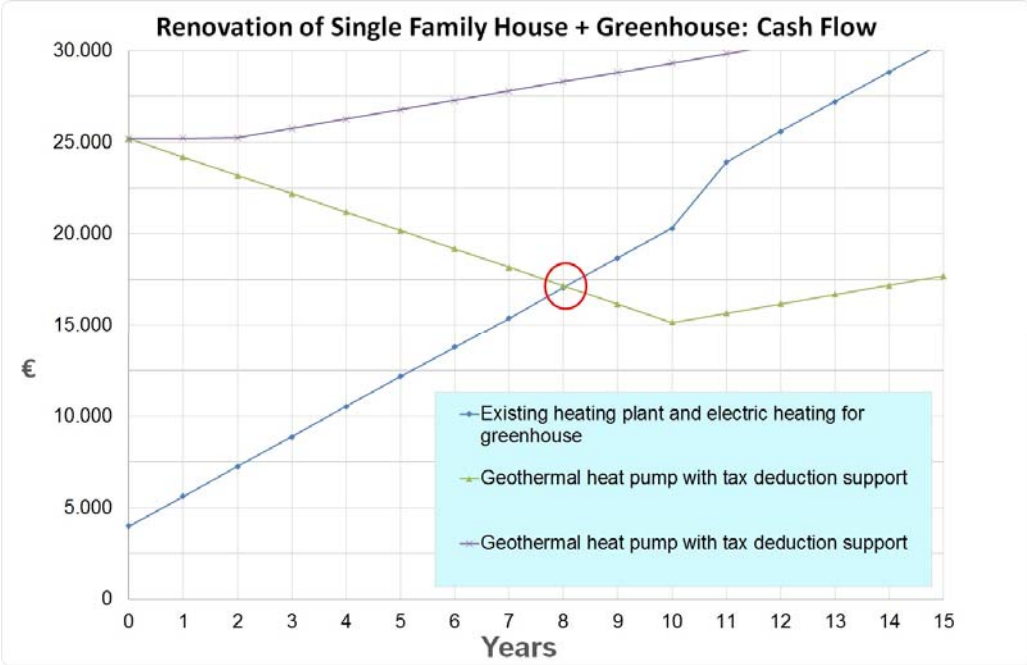
Single Family House + Greenhouses

An example of economic investment

- Renovation of heating plant of single house (60 m^2 – radiators)
- Construction of a family greenhouse (35 m^2 – underfloor heating)

- High temperature heat pump (8 kW_t)
- Alternative geo possibilities: 1 BHE, horizontal collectors, geothermal baskets
- Cascade flow: single family house radiators and greenhouse underfloor heating CONNECTED EACH OTHER (60°C – 50°C – 45°C)



Pay Back of the investment (BHE): 8 years

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- Agriculture sector (greenhouses, wine cellars)

Wine cellars

Sensors placement

Joint research at University of Bologna

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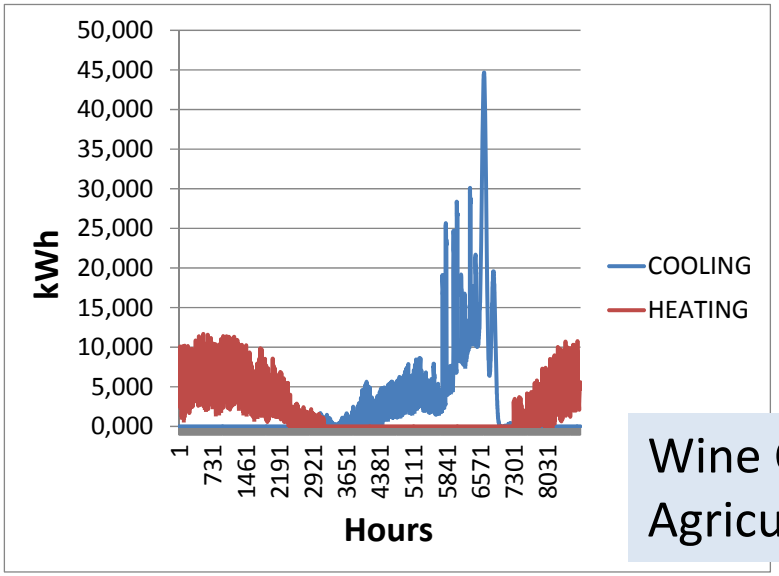
Wine cellars

Main needs:

- Room heating
- Room cooling
- Grape cooling
- Fermentation cooling
- Underground spaces thermal stabilization



Optimum use of geothermal energy:

- Coverage of all heating loads
- Inverse mode: coverage of base cooling loads
- Hybrid system, combined with air-to-air heat pump for specific cooling (September – October)
- Geothermal design not only focused on the plant, but for THE BUILDING itself, in order to optimize underground spaces through KNOWLEDGE OF UNDERGROUND THERMAL PROPERTIES

Wine Cellars energy needs. Courtesy of Department of Agricultural Sciences, University of Bologna

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- Public sector (schools, kindergartens, theatres, libraries)

School

Energy renovation of a school through OPEN LOOP system → higher amount di exploitable energy from underground

LEGEND Ferrara Pilot Action

[illegible] Università di Bologna

- GCHP serving 22,5% of the entire need of the school
- Because working temperature of 70°C, GCHP is used as pre-heating and then intervene natural gas boilers
- Huge energy savings (15 – 20%)

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School

Pay Back of the investment (BHE): 5 years WITHOUT ANY KIND OF INCENTIVES on energy production

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Dati di Funzionamento Totali Impianto Geotermico di Codigoro

Giorno di Inaugurazione: 12 Aprile 2014

	Valore	Unità di Misura
Tempo di Funzionamento	4.3	h
Produzione di Energia Termica	485	kWht
Consumo Elettrico Pompa di Calore	125	kWhe
Consumo Elettrico Pompa di Prelievo Acqua	13	kWhe
Coefficiente di Performance	3.51	
Risparmi Energetici	306.25	kWh
Metri Cubi di Metano Risparmiati	31.93	m3
Risparmi di CO2	60.52	Kg
Produzione di Energia Rinnovabile	185	kWh

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School

National governmental program: Rehabilitation of 1 public school in each town of Italy

LEGEND proposed its Geothermal Open Loop Pilot Action on the school of Ferrara Province as feasible solution with short pay-back period to the Italian government

BUT → environmental regulation and clarifications are needed when OPEN LOOP systems are applied, in order to speed up authorization process and meanwhile avoid aquifer pollution

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THANK YOU FOR YOUR ATTENTION

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