GEOFIT
SMART GEOTHERMAL

Second Geofit Training
On-the-ground experience

Overview of the four Geofit demosites

27th SEPTEMBER 2022 – On Line
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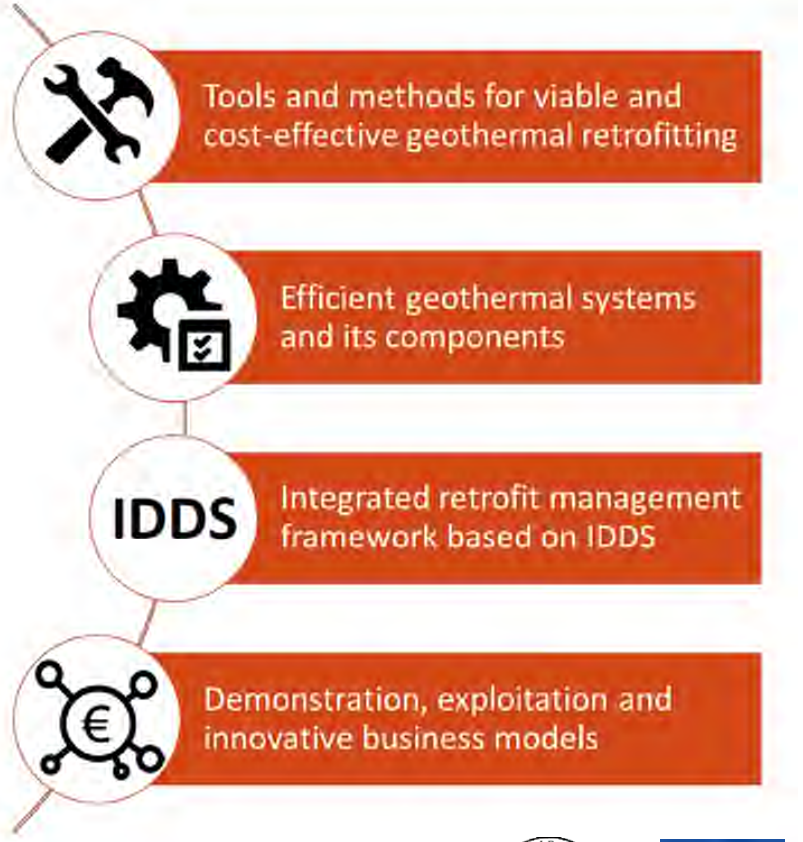
GEOFIT
GEOTHERMAL TECHNOLOGIES

GEOFIT: *Economical enhanced geothermal systems for energy efficient building retrofitting*

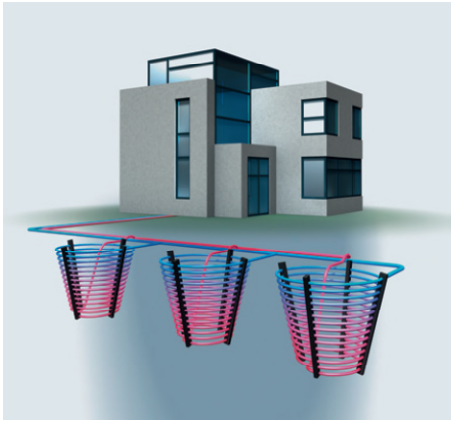
- 4,5 years H2020 project (May 2018-October 2022)
- 24 Partners
- Innovation Action supporting the H2020 Societal Challenge of Secure, Clean and Efficiency Energy
- Part of INEA's Energy Portfolio (Low Carbon Economy (LCE), Renewable Energy Technologies (RET)
- € 9.7 million cost / € 7.9 million funding

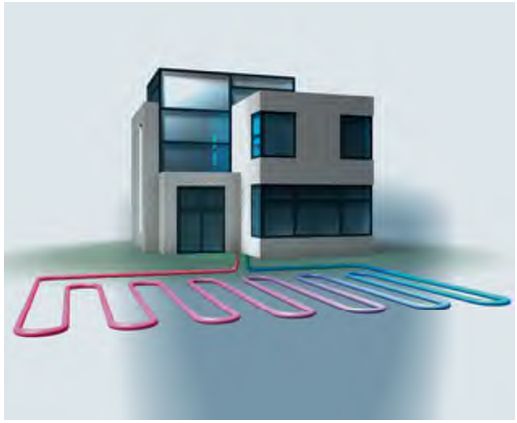


GEOFIT - NUTSHELL

- **Geothermal retrofitting: risk mitigation**
  - Ground radar for detecting underground structures
  - Ground based radar for stability monitoring
  - Structural building monitoring during drilling
- **Improved system design, component selection, GHEX options**
  - Integrated design procedures for different ground heat exchangers
  - Energy demand calculation engine
  - GEOBIM platform for geothermal retrofitting
  - Techno-economic assessment and benchmarking
- **Implementation**
  - Improve drilling productivity, drill bit wear prediction
  - New and improved heat pump technology
  - New and improved emission systems
  - Integrated monitoring and control
- **Four demo sites** showcasing different technologies

DIFFERENT GROUND HEAT EXCHANGERS
SHALLOW-EARTH HEAT EXCHANGER CONCEPTS





Images from partner Uponor and partner Catalana De Perforacions

SANT'APOLLINARE FORTRESS (X-XI Century) Perugia, Italy

GEOFIT
SMART GEOTHERMAL

Manager: UNIPG

Innovation Level: 2

Main partners involved: IDP, IDSGEO, SIART, ILECO, FAHR, R2M,COMS

STARTING POINT

Typology/use: Historical building of cultural value hosting sustainable training program.

GEOFIT Scope: two-storey building (140 m2) and basement (70 m2).

Climate condition: Humid subtropical climate

Existing HVAC system: Gas boiler (heating) and DHW (2.000l water tank); floor heating system and mechanical ventilation.

Geological data: rocks and stone in shallow layers .

Total energy consumption: 24.971 kWh/year (representing about 29% of the total consumption of the whole complex).

Previous retrofitting works: Seismic and EE renovation including high-performance building insulation, floor heating system and mechanical ventilation, and new windows (first building certified under the GBC Historic Buildings sustainability protocol).

Thermal energy consumption (H): 19.400 kWh/y

Thermal energy consumption (C): 3.400 kWh/y

Electric energy consumption (other): 3.500 kWh/y

Max. power consumption (H): 24 kW - (C): 10 kW

DEVELOPED DESIGN

Simulation and demand modelling: Heating load: 10 kW; Cooling load: 6 kW.

Drilling/excavation: shallow excavation (up to 2,5m) – slinky GHEX (2 m deep) → Nr of parallel trenches: 5; Distance between trenches : 1,35 m; Average trench length: 24 m (covering a total of 120m); Ring diameter: 1,1 m; Ring depth: 2,5 m; Nr of rings: 53

Building monitoring during drilling phase: survey in order to study building reaction.

Ground source heat pump: reversible hybrid heat pump driven by electricity and gas, adsorption and compression HP (new gas boiler and buffer tank, adsorption unit, chiller unit). Power output: 12 kW heating; 6 kW cooling. Refrigerant with low GWP (water and propane). HP operational control system integrated.

As a result the new integrated system will cover total heating and cooling demand (the existing boiler will be replaced by the new system).

No additional retrofitting works are foreseen.

BEMS: HP operational control system and intelligent thermostat

INNOVATIVE ASPECTS

- Installation of hybrid heat pump and non-standard GHEX
- Design process and retrofit using digitalization and simulation
- Site assessment and structural monitoring (seismic area)
- F.O. in order to have data from GHEX
- 2 different backfilling areas: one regular and another with drip
- Monitored works: georadar before and during excavation
- Drone monitoring

ACHIEVEMENTS AND NEXT ACTIONS

New wi-fi line installed (done).

Wifi line operating (March 2021).

Final design for all GEOFIT system components (done).

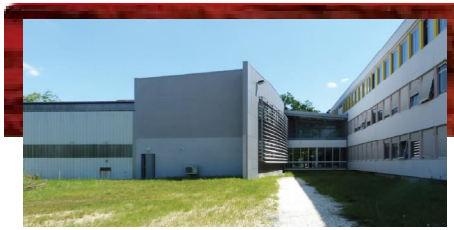
Tender 2 for installation and construction permissions (done).

Civil Works (done).

All the equipments on site except chiller (early February 2021).

Installation of the entire GEOFIT system (March 2021).

Commissioning with UNIPG personal (April 2021).



IUT CIVIL ENGINEERING (2003) Bordeaux, France

Manager: NBK

Innovation Level: 2

Main partners involved: IDP, ILECO, FAHR, COMS, IDSGEO

STARTING POINT

Typology/use: Tertiary / Educational.

GEOFIT Scope: four places (corridor with stairs; director's office; conference room; office: total area 400m2).

Climate condition: Continental / oceanic.

Existing HVAC system: Central heating network. Gas boiler independent from the central heating for the conference room and the corridor (radiators; floor heating in the conference room). Heat pump for cooling the rooms in the first floor with fan coils. Dual flow air handling unit.

Geological data: coarse sands and gravels (first 8m).

Total energy consumptº: 48 kWh/m2/year.

Thermal energy consumptº: 9800 kWh (H)

and 2800 kWh (C).

Max. power consumptº : 20 kW (H) and 8 kW (C).

No Previous retrofitting works.

DEVELOPED DESIGN

Simulation and demand modelling: H: 20 kW heating capacity (corridor and conference room); C: 15 kW cooling capacity (office, conference room and director's office).

Drilling/excavation: shallow excavation – 2 energy baskets GHEX (final design January 2021) + 1 vertical Borehole (100 m).

No building monitoring during drilling phase.

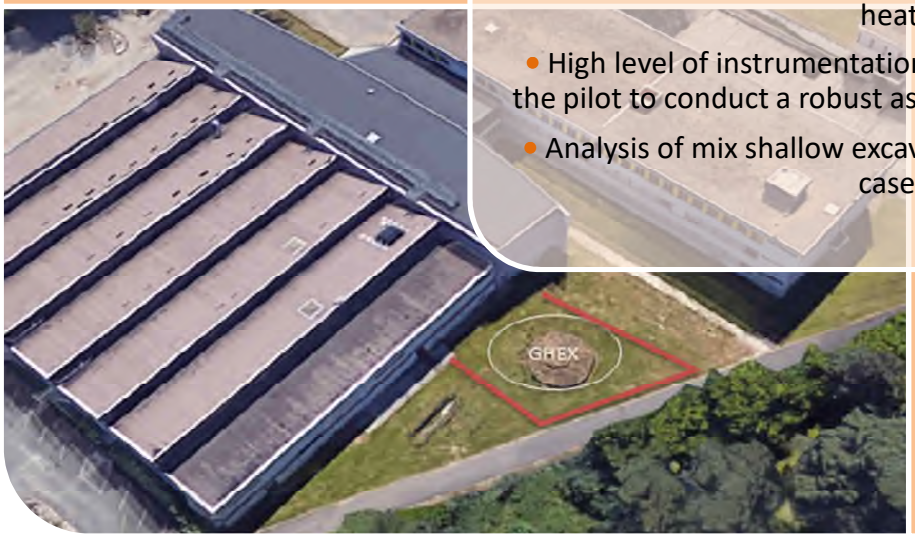
Ground source heat pump: reversible hybrid heat pump driven by electricity and gas, adsorption and compression HP (gas boiler and buffer tank, adsorption unit, chiller unit). Nominal Power output: 15 kW heating; 15 kW cooling. Refrigerant with low GWP (water and propane).

No additional retrofitting works are foreseen.

HP operational control with independent BEMS).

INNOVATIVE ASPECTS

- Shallow earth energy baskets + additional borehole and hybrid heat pump
- High level of instrumentation, monitoring and control enable the pilot to conduct a robust assessment of the deployed system
- Analysis of mix shallow excavation and borehole (educational case study)



ACHIEVEMENTS AND NEXT ACTIONS

Borehole design & GHEX optimization (done)

Drilling of the borehole (February 2021)

HP to be delivered (February 2021)

installation of shallow earth energy baskets (March 2021)

Commissioning (April 2021);

Integration of the GEOFIT system in the existing facility (April 2021).

ELS PINS DEL VALLÈS SCHOOL (1975) Sant Cugat, Spain

Manager: AJSC

Innovation Level: 2

Main partners involved: COMS, IDP, CDP, SIART, UPO, ILECO, OCHS

STARTING POINT

Typology/use: Tertiary / Educational
GEOFIT Scope: primary school building + administration building + sport pavilion (around 3000 m2)
Climate condition: Mediterranean
Existing HVAC system: Central heating system (gas boilers) with radiators
Geological data: mainly silty clays
Total energy consumption: 414.862 kWh/year (31% electricity + 69% natural gas)
Previous retrofitting works:
- PV panels (27,03kWp photovoltaic installation for self-consumption);
- Façade retrofitting (external insulation ETICS/EIFS);
- Windows Replacement in all buildings.
- LED technology lamps.

Thermal energy consumption (H): 75,51 kWh/m2/y
Electric energy consumption (H): 33,03 kWh/m2/y
Max. power consumption (H): 63 kW

DEVELOPED DESIGN

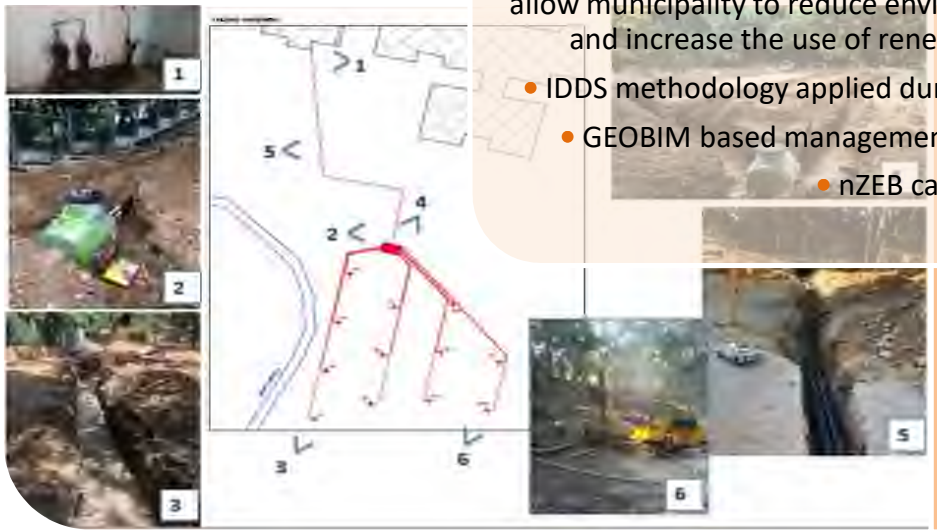
H: 192,5 kW peak load; 144,5MWh total load. C: 6 kW peak load and 3,8 MWh total load
Drilling/excavation: improved vertical drilling and HDD with Nr of bh: 12 + 1 horizontal; Depth of bh: 120m; Spacing: 10m

Building monitoring during drilling phase: previous to the Civil Works environmental survey and survey in order to study building reaction during drilling.
Electrically driven HP with 40kW heating capacity and 5kW cooling capacity with 1.500l buffer tank. Whole system designed with R1234zee refrigerant. HP operational control system integrated. Valves could be installed on radiators to optimize operation with the GSHP.
Strategy: generation GSHP with gas boiler. GSHP will cover most of heat demand; base load provided by the GSHP and peak demand by the gas boiler.
In addition to Geofit project, AJSC makes the effort to installed an energy efficient cooling solution in order to allow the collection of more exploitable data.

BEMS: Intelligent layer on top of the ecoSCADA
GW already installed during pre-intervention phase.

INNOVATIVE ASPECTS

- Retrofitting and implementation of a geothermal system that allow municipality to reduce environmental and carbon footprint and increase the use of renewable energy technologies.
- IDDS methodology applied during the whole project life cycle
- GEOBIM based management monitoring cost reduction
- nZEB case study



ACHIEVEMENTS AND NEXT ACTIONS

Civil works trenches and boreholes (done).

Final design for all components and project integration (February 2021).

HP delivery (February 2021).

Municipality Technical approval (Spring 2021)

Installation and commissioning of GEOFIT system (both heat/cooling) (Summer 2021).

KILLEANY COTTAGES, HOUSE N. 9 (1922) Aran Islands, Ireland

GEOFIT
SMART GEOTHERMAL

Manager: CFO

Innovation Level: 2

Main partners involved: IDP, ILECO, OCHS, COMS, UPO, R2M

STARTING POINT

Typology/use: Residential / Dwelling.
GEOFIT Scope: the whole house (117 m2).
Climate condition: North temperate climate.

Existing HVAC system: 21 kW diesel boiler (for both heating and DHW) and coal stove. 9 aluminium radiators with individual on/off control.
Geological data: karst limestone with very shallow soil.

Total energy consumption:
electricity 45.784 kWh;
gasoil 11.722,2 kWh (about 1.100l);
coal 20.668 kWh.
No previous retrofitting works.

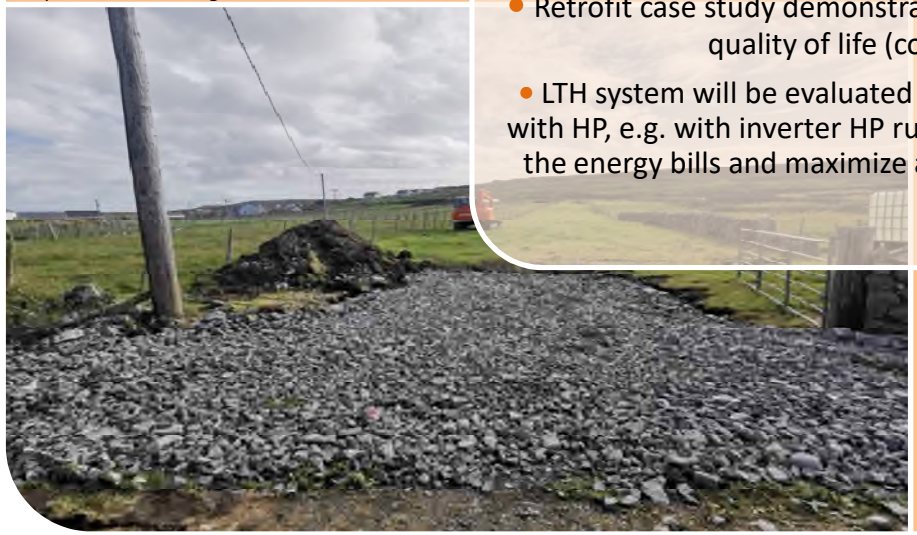
DEVELOPED DESIGN

Drilling/excavation: improved vertical drilling Nr of bh: 1; Depth of bh: 120 m.
No building monitoring during drilling phase.
Ground source heat pump: commercial electrically driven HP (6kW).
Operation strategy: GSHP should cover base load and coal stove only use for peak demand.
UPONOR underfloor heating system, with radiators available as backup for peak demand.
Retrofitting proposed: envelope insulation and LTH geothermal system (floor heating + ventilation). The LTH system is featured with high modularity with extreme low height design, which provides users with space savings and easy installation. Manager budget is responsible for internal insulation, ventilation, installation and commissioning of GSHP system, and internal works such as new flooring post-installation.

BEMS: Intelligent layer on top of the ecoSCADA GW already installed during pre-intervention phase. HP operational control system integrated.

INNOVATIVE ASPECTS

- Retrofit case study demonstrating energy savings and increased quality of life (comfort conditions).
- LTH system will be evaluated by multiple connection scenarios with HP, e.g. with inverter HP running by partial loads to minimize the energy bills and maximize advantages of LTH storage effect.



ACHIEVEMENTS AND NEXT ACTIONS

Heat recovery quotations (done).
Ventilation systems quotations (done).
Simulation estimating heating demand (done).
Final design for all GEOFIT system components (done).
Site preparation for drilling to come (done).
BH drilling is rescheduled (February 2021).
Quotes for envelope insulation and ventilation have been received.
Retrofitting works (March 2021).
Installation/commissioning of on-the-shelf GSHP (Spring 2021) .


ÖKO-MASTER
OCHSNER
OCHSNER

Lessons Learned

- Design team
- Design procedure (circuit and validation)
- Cooperation
- Demosite descriptions
- Legislation/Standards
- Data collection after installation

Thank you for your attention

GEOFIT

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