PROJECT: Demonstration geothermal pilot for applications in nZEB residential buildings (GEOPILOT)

PN-III-P2-2.1-PED-2019-2881

Summary of stage 3

Stage 3 of the GEOPILOT project took place between January 1 and August 2, 2022 and focused on completing the installation of the equipment purchased in the previous stages and putting the system into operation.
The actions carried out aimed at:

- Completion of the installation of the component equipment of the heat pump inside the container
- Interconnection of the heat pump with the internal heating & cooling installation of the EfdeN house
- Interconnection of the heat exchanger with the ground (existing) with the connecting pipes to the heat pump - with "manhole" assembly for AMC
- Realization of the TRT for the heat exchanger with the existing ground
- Installation of LED display panel and interconnection with the geothermal heat pump system
- Commissioning of the geothermal heat pump system and acquisition of operating data for the summer period - which requires the cooling of the EfdeN house.
- Dissemination of research results, by presenting the project at various domestic and international scientific events

Thermal Response Test

The thermal response test was performed on the 100 m deep borehole that feeds the geothermal heat pump.

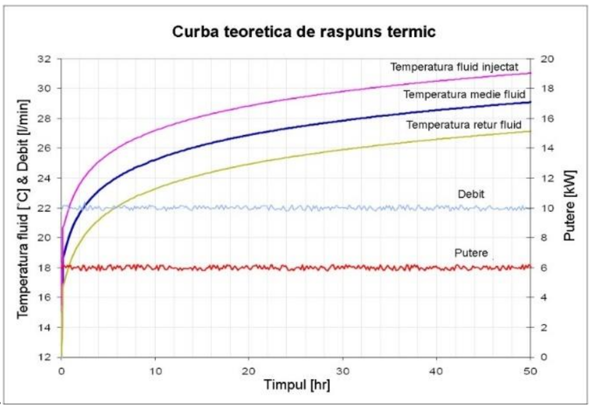


Figure 1. Monitored parameters during TRT

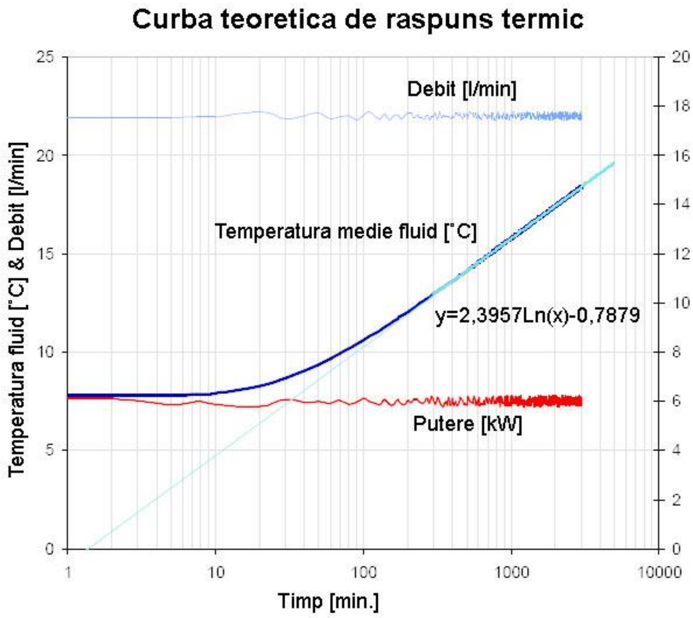


Figure 2. Thermal response - theoretical curve

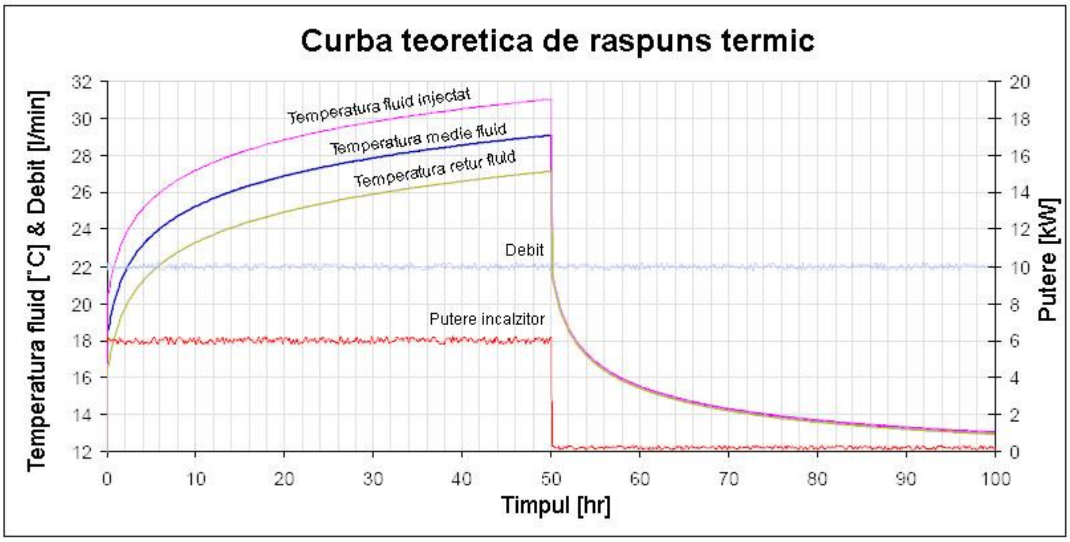


Figure 3. Theoretical curve for thermal response after heating shut-down

The thermal response test delivers the following results:

- The thermal conductivity of the soil λ
- Thermal resistance of the borehole R_b
- Additionally, it provides information to the contractor regarding the level of effort for drilling execution and equipment.

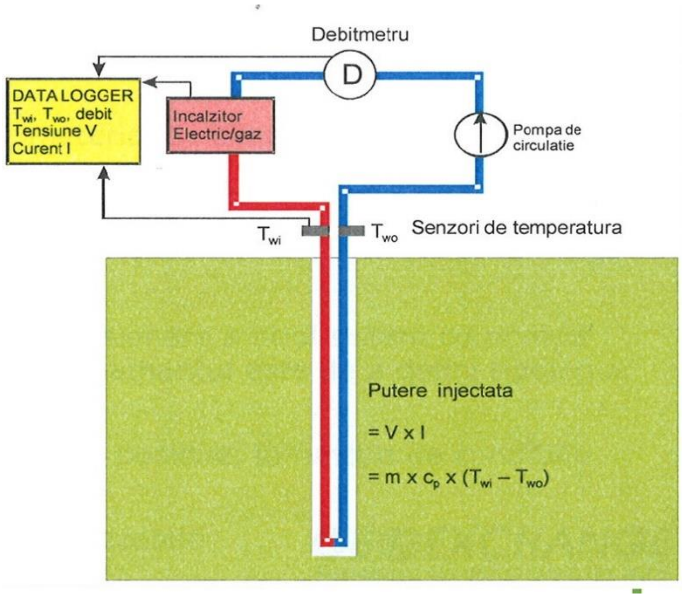


Figure 4. TRT's method principle

Experimental equipment

The determinations were made with the help of the mobile geothermal laboratory - consisting of the following equipment:

- GeoCube - Portable unit for measuring thermal conductivity (TC), thermal response (TRT) for different types of soils as well as for determining the BTR (Borehole Thermal Resistance) factor.
- 3x16 mmp cable for the electrical supply of the resistors in the GeoCube component
- Specialized software - TC/TRT Software and Ground Loop Design Software

Figure 5. GeoCube equipment

Results of the measurements in situ

Ground Loop Design

Thermal Conductivity Report - 15/07/2022

Project Name: Testare put 100 m FII

Project Address: Dd. Pache Protopopescu nr. 66

City: Bucuresti **State:** Romania **Zip:**

Prepared By: Robert Gavriliuc

Email: robertgavriliuc@yahoo.com **Phone:** +40724 907 993

Drill Date 11/19/2019

TC Test Date(s) 12/07/2022 >> 15/07/2022

Address Line 2:

City: Romania **Phone:**

State: **Fax:**

Zip: **Email:**

Calculation Results

Thermal Conductivity (W/(m*K)) :	**1.71**
Thermal Diffusivity (est.) (m^2/day) :	**0.073**
Average Heat Flux (W/m) :	**49.2**
BH Thermal Resist (BTR) (m*K/W) :	**0.19**
Average Flow Rate (L/s) :	**0.61**
Test Duration (hr) :	**12**
Calculation Interval :	**1.5 - 13.5 Hours**

Borehole Input Parameters

Undisturbed Ground Temperature (°C) :	**12.9**	(Auto-Estimated)
Depth (m) :	**100**	
Borehole Diameter (mm) :	**160.0**	
Pipe Size:	**1 1/4 in. (32 mm)**	

Grout Thermal Conductivity (W/(m*K)) :	**2.10**
Drilling Method :	**Standard**
Drilling Time (hr) :	**10.0**

Diffusivity Input Parameters

Soil/Rock Specific Heat - Dry (kJ/(K*kg)) :	**0.837**
Soil/Rock Density - Dry (kg/m^3) :	**1601.8**
Moisture (0-100) (%) :	**15.0**

Flow Rate Input Parameters

TC Unit Model Name	**GeoCube Standard**

The system proposed within the GEOPILOT project is completely independent of the initial building analyzed, which is connected to the existing internal installation by means of two motorized 3-way valves located before the general distributor-collector that transmits the heating fluid to the radiant heating/cooling installation located in the ceiling and walls of the building.

The heat pump that will be used in the experimental stand is an Ecoforest ecoGEO+ 1-6PRO& AU hybrid type heat pump that can work both in soil-water and air-water regimes, in bivalent mode thus ensuring an efficiency maximum of the whole system. The heat pump can provide the functions of heating, cooling and domestic hot water preparation and uses the refrigerant R290, a refrigerant with a very low GWP value (GWP = 0), having a low impact on the environment. The heat pump has a power that varies between 1kW and 6kW, COP (B0/W35) up to 4.9, EER (B35/W7) up to 5.2 and can provide heating fluid with a temperature up to 70ºC on the installation circuit. The technical characteristics of the heat pump are presented in the table below.

Table 1. The technical characteristics of the heat pump used

Technical feature	**Measuring unit**	**Value**
Modulation rate	%	15-100
Heating output (B0/W35)	kW	1-6
COP (B0/W35)	-	4.3
Cooling output (B35/W7)	kW	1-6
EER (B35/W7)	-	4.5
Max. temperature/with support	ºC	75/80
Functioning limits - heating source	ºC	-25 - 35
Functioning limits – cooling source	ºC	10-75
Max. consumption B0/W35	kW/A	1.7/7.6
Dimensions	mm	1060x550x602
Weight	kg	125

Figure 6. Final setup of the heat pump within the container

Figure 7. Manhole for connecting the BHE pipes with the underground pipes towards the container and the thermocouples' cable for temperature measurement in the borehole

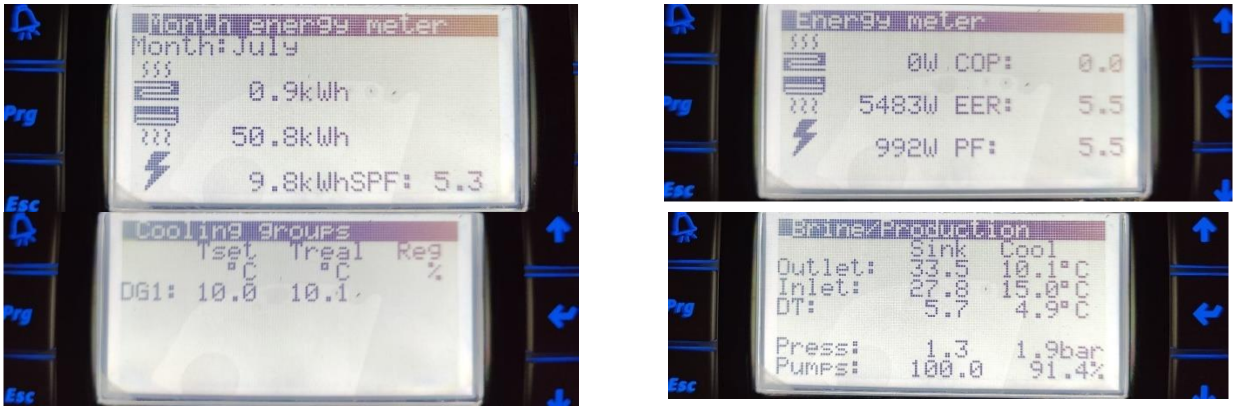


Figure 8. Monitor data of the heat pump working in cooling mode

Dissemination of the research results

Figure 9. Information on the project presented on the LED panel located in front of the entrance to the Faculty of Building Services Engineering – scroll message

Figure 10. Information panel placed in the vicinity of the container where the heat pump is mounted

The website of the GEOPILOT project has been updated within the website of the Technical University of Civil Engineering Bucharest.

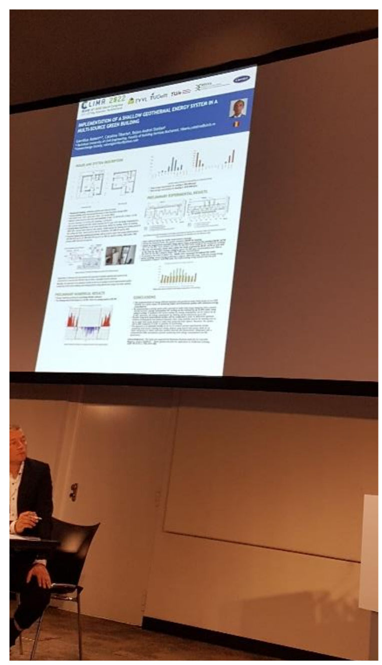
https://utcb.ro/pilot-geotermal-demonstrativ-pentru-aplicatii-in-cladiri-rezidentiale-nzeb-geopilot/

Articles / works published or in the process of publication :

1. *Implementation of a shallow geothermal energy system in a multi-source green building* – Robert Gavriliuc, Tiberiu Catalina – presented in the poster session of the Congress REHVA CLIMA 2022 from Rotterdam (Netherlands), May 20-25, 2022
2. *Implementation of a shallowgeothermal energy system in a multi-source green building* – Robert Gavriliuc, Tiberiu Catalina – in process of publication at the Romanian Journal for Civil Engineering
3. *Geothermal Heat Pump Powered HVAC System for Oregon Park Office Buildings – S*tudent Gavrila Ion Florin, Prof. Robert Gavriliuc – master thesis.
4. *Geothermal heat pump powered HVAC system for One Peninsula Residential Complex* - Student Mihaila Teodora, Prof. Robert Gavriliuc – master thesis.
5. *Residential building supplied with dual aero-geo-thermal heat pump - Student Ilies Iosif,* Prof. Robert Gavriliuc – bachelor thesis

The results of further research will be disseminated in conferences with national and international participation.

REHVA CLIMA Congress 2022 - Rotterdam (Netherlands), May 20-25, 2022 - Poster with project presentation within TUCEB booth from congress exhibition area



REHVA CLIMA Congress 2022 - Rotterdam (Netherlands), May 20-25, 2022
Project presentation during the poster session

An extremely important activity - both in terms of disseminating research results and in terms of future international collaboration activity - is the participation of the Bucharest Technical University of Civil Engineering in collaboration with the Romanian Geoexchange Society in the "Pan-European Network of Centers for Excellence for Shallow Geothermal Energy used in Civil and Historical Buildings ».
https://geo4civhic.eu/european-centers-of-excellence/#srg
This structure is created within the Horizon 2020 Project with the acronym GEO4CIVHIC, and brings together the following partners:
- Politechnical University of Valencia (Spain)
- University « Friedrich Alexander » (Germany)
- University of Padua (Italy)
- Romanian Geoexchange Society
Among the common activities that the network of centers of excellence proposes to carry out are listed:

- Publication of a training manual
- Creating research articles and publishing them in prestigious publishing houses
- Student exchanges through the Erasmus Program

TUCEB updates and extends its Erasmus contracts (already existing) with the Politechnical University of Valencia and the University of Padua, and initiates a new contract with the "Friedrich Alexander" University (Germany).

Also, the center of excellence - which will practically operate in the TUCEB campus in Bd. Pache Protopopescu no. 66 - will have the capacity to offer courses for various categories of stakeholders, such as: local authorities, architects, but also specialists of various types (engineers, technicians). The technical and legal basis for the professional training courses will be the achievement of the professional standards for the professions of "heat pumps installer " and "installer for geothermal systems". In this way, the center of excellence will contribute to reducing the shortage of specialized workforce in the geothermal field.

Project Manager,

Prof. Robert GAVRILIUC, Ph.D.