

**PROJECT: Demo geothermal pilot for application in residential
buildings nZEB (GEOPILOT)
PN-III-P2-2.1-PED-2019-2881**

Stage I summary (August - December 2020)

The building sector is responsible for a large share of greenhouse gas (GHG) emissions and energy consumption in the European Union. In order to meet the EU's energy reduction targets, buildings must have near-zero consumption to meet the "almost zero energy" (nZEB) standard set individually by each country. From 2020, all buildings must meet the nZEB standard and must use a certain amount of renewable energy sources to reach this threshold.

Among the energy consumers in buildings, heating and cooling account for over 75%. Although space heating gas boilers have lower costs, they cannot provide air conditioning and do not use renewable energy sources (RES). The best alternative is to use geothermal heat pumps that are highly efficient and can avoid large amounts of GHGs. Using vertical boreholes up to 200-300 meters, the use of surface geothermal systems is an attractive and efficient solution for powering buildings in the perspective of smart cities. A major obstacle to decarbonisation in the building sector is the low share of new construction that combines multiple sources to meet the nZEB standard.

This project, based on previous research on simulations and coupling of several energy sources, will demonstrate a new perspective on the integration of surface geothermal energy with other classical installations or RES. Experimentally studied hybrid systems will be controlled and analyzed through a direct digital controller, and the data will be transmitted in an online web application. The aim of the project is to demonstrate and evaluate the feasibility of coupling geothermal sources with existing / new systems of future nZEB buildings.

For this stage, the feasibility of coupling the geothermal energy source with HVAC systems (heating, ventilation and air conditioning systems) existing in nZEB buildings was shown - preparation and monitoring activities of the system and the connections between

the different components. The existing building has been prepared for the integration of the proposed geothermal system.

At the same time, an intelligent energy management system (BEMS) has been designed for the integrated control of the multiple energy sources used - to maximize the efficiency of the proposed geothermal system coupled with other renewable energy sources, control and energy management strategies will be developed in a system. integrated automation. The BEMS system will include components that will ensure communication with the equipment in the system: heat pump, terminal units, other renewable energy sources, integrating the different communication protocols of the manufacturers and creating a dedicated control and monitoring application with intuitive interface.

Activities carried out between August and December 2020

The GEOPILOT project is organized around four main phases / work packages (Figure 1). Each package includes several activities, which can be found in the Project Implementation Plan. Between August and December 2020, a number of six activities were planned: Act 1.1, 1.2, 2.1, 2.2, 2.3, 4.1 (Figure 1). Some of these activities will also take place in stage 2 of the project, corresponding to the year 2021. The activities carried out in stage 1 of the project are part of the work package WP1, WP2, respectively WP4.

The work plan of the GEOPILOT project for this stage is structured as follows:

Work Package 1 (WP1). Integration / coupling of the geothermal energy system with the existing HVAC system in the building

A1.1. Design / Study of the HVAC technical system

A1.2. Purchase of necessary logistics (equipment and materials)

Work Package 2 (WP2). Design of the intelligent building management system (BEMS)

A2.1. BEMS design

A2.2. Purchase of necessary materials

A2.3. Implementation of BEMS (2 publications at national / international conferences); to be partially achieved in 2020.

Work Package 3 (WP3). Optimization and coupling of the geothermal system with other energy sources - no activities are planned for 2020.

Work Package 4 (WP4). Dissemination of project results

A4.1 - Dissemination of project results - ISI listed articles and 1 scientific progress report, year 2020.

Description of the prototype house and of the existing interior HVAC

The study is based on the EFdeN solar house prototype located in the courtyard of the Faculty of Installation Engineering, a construction that represented Romania at the Solar Decathlon Europe 2014, the most important competition for architecture and energy efficiency. The Romanian European Center of Excellence for Geothermal Energy will be located on the campus of the Faculty of Installation Engineering within the Technical University of Constructions Bucharest (Figure 2), thus being easily accessible for disseminating and raising awareness about the energy sources used.

The building already has some of the necessary equipment for the start of the project: aerothermal heating / cooling system, geothermal probe with 21 temperature sensors for measuring temperatures inside the geothermal pilot, solar thermal system and photovoltaic system, as well as all necessary indoor installations (heating / radiant cooling in walls and ceiling, ventilation with heat recovery equipped with heating / cooling battery). The building and the existing interior HVAC are presented in the following chapters, together with the proposed solution that includes the geothermal source that can ensure an independent solution for heating and cooling the building.

The efficiency of the building's facilities is very good, but many improvements can be added to reduce energy consumption by connecting the geothermal energy source. The existing HVAC system will be connected to the proposed new geothermal system, and the symbiosis between the two installations will be tested in combination / coupled with the other renewable energy sources present.

After connecting the geothermal heat pump, we will design the intelligent energy management system (BEMS). This phase of the project is divided into several stages, from the design of the data needed to be collected through PLCs (programmable logic controllers) to the development of the web interface for control and monitoring. Intelligent control methods will also be developed for the interconnection of heat pumps with other renewable energy sources: the existing photovoltaic system, solar thermal panels, which will substantially reduce the damping period of the entire proposed system. Through

intelligent control and algorithms configured within the BEMS system, the overall efficiency of the system will be greatly improved.

After the realization of the geothermal system and the design of the BEMS system, experimental measurements and optimization activities of the entire system will be performed.