OPEN POST-DOC POSITION: Use of energy geostructures for heat storage in the ground

WHERE: at the Laboratoire 3SR – Université Grenoble Alpes (UGA, France), in collaboration with University of Perugia (UNIPG, Italy) and Norwegian University of Science and Technology (NTNU, Norway).

DURATION: 24 months starting in 2025.

SUPERVISORS: Alice Di Donna (UGA), in collaboration with Diana Salciarini (UNIPG) and Rao Singh (NTNU).

FUNDING & environment: European project "Large-scale climate neutral Energy Geostructures in District Heating & Cooling systems/networks (LEG-DHC)". The candidate will be involved in the project meeting and will have to interact and collaborate with the other partners.

GENERAL TOPIC:

Despite the enormous potential, geothermal energy systems see fewer installations compared with other renewables. Since the 1980s, the development of Energy Geostructures (EGS) has allowed shallow geothermal energy (SGE) to be exploited from structural concrete elements in contact with the ground (e.g. piles foundations, retaining walls, tunnels, figure 1) by integrating heat exchanger pipes into them. Therefore, EGS are novel dual functional engineering sub-structures that can be used not only as load-bearing structural members but also for heat transfer and storage. This innovative dual role, combining structural and energy harvesting functions yields great sustainability since the concrete elements are already required for resistance and stability reasons. The recent introduction of fifth generation district heating and cooling (5GDHC) (Buffa et al. 2019, Figure 1) networks can pave the way for the exploitation of EGS as ground-coupled low temperature energy sources and stores for providing energy demands of a wider range of energy users in districts rather than single buildings. To improve the efficiency and sustainability of DHCs, systems need to be integrated with more reliable and efficient thermal resources. The potential of EGS as energy resources need to be investigated in the context of integration into the district heating networks, to evaluate the capability and feasibility of the integration of EGSs with DHC systems.

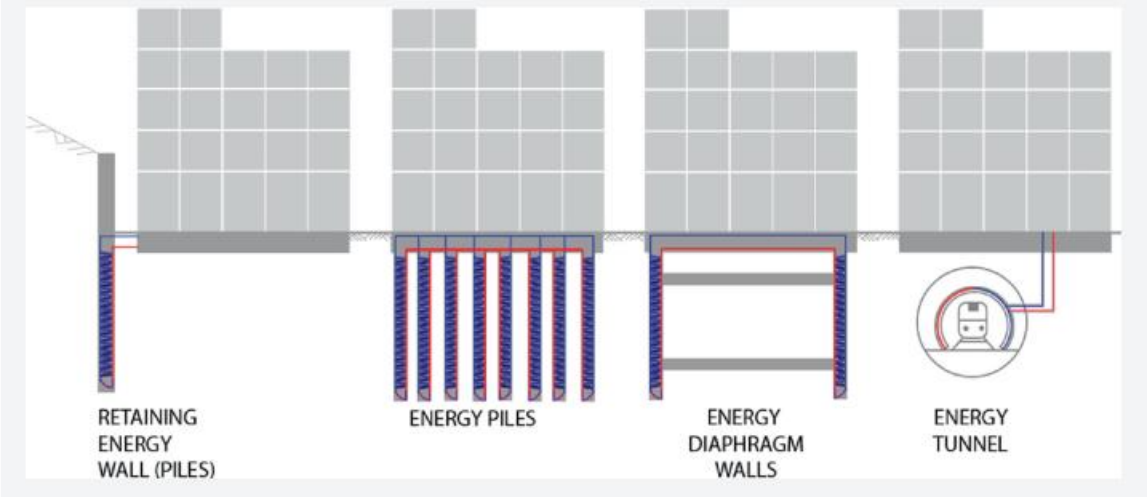

Figure 1. Energy geostructures.

SPECIFIC WORK TO BE DONE:

This open position is part of a wider European project which aims to investigate the possibility of integrate EGS in DHC systems, at the urban scale. In particular, the recruited person will be in charge of study the use of concrete EGS for thermal storage by investigating the effect of high thermal loading on thermal and thermomechanical performance of EGS. This will include several issues to address, in the diverse climatic and thermal conditions across Europe, from North to South. The work will include:

• **A preliminary literature analysis on different thermal sources**. The variety of surplus thermal energy sources that could feed into EGS for storing thermal energy. Surplus heat can come from industry, solar thermal, incinerators, and existing DH network. The amount of heat and maximum temperature will depend upon the type of surplus heat source, for example from incinerators a large amount of heat can be delivered, and maximum temperature can go up to 80°C, however in case of 5GDHC the maximum temperature may go up to 25- 30°C. This task will identify various thermal sources and their temperature variability at a city scale, as well as how thermal loads can be redistributed from a source to high demand location, how and where excess thermal energy can be stored during low demand period.

• **The investigation of the thermal performance of EGS used for heat storage**. This task will examine the effect of integrating EGS in a large scale (district/city) heating/cooling system in terms of their thermal performance by determining how much thermal energy can be take in and out without affecting the temperature change significantly in EGS and the surrounding ground. Experimental and numerical study will be carried out to study the effect of soil type, ground conditions, ground water table and water flow.

• **The investigation of the mechanical performance of EGS used for heat storage**. The primary function of EGS is to support the building but integrating them in DH system will affect thermal loading siginificantly on a daily basis and especially when the thermal energy will be stored inside them. This task will study stress and strain behavior of EGS and surrounding ground during thermal energy storage as a function of amount of energy stored and temperature changes, which are expected to be higher than in the case of classical geothermal exploitation.

The possibility of a real scale installation on the site of a private partner of the LED-DHC project will also be considered.

BACKGROUND & PREREQUISITES:

Background on THM FEM modelling, multiphysics geomechanics, geothermal energy systems, and thermal properties of soils is required.

APPLICATION:

If you are interested, please send an e-mail to the following address, including your CV and any other potentially useful information. Get in touch also if you have questions to address before placing your application.

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