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Fourth International Scientific Conference

ALTERNATIVE ENERGY SOURCES, MATERIALS AND TECHNOLOGIES

AESMT ’21

Proceedings of short papers

Volume 3

Ruse, Bulgaria, 14 - 15 June 2021

MAIN TOPICS

ALTERNATIVE ENERGY SOURCES
- Solar and Hybrid Thermal Systems
- Solar Photovoltaic Systems
- Solar Radiation Measurement and Sun-tracking
- Geothermal Energy Applications
- Phase Change Materials (PCM) Applications
- Wind Energy
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ALTERNATIVE MATERIALS
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ISSN 2603-364X

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F O R E W O R D

The Fourth International Scientific Conference “Alternative Energy Sources, Materials & Technologies AESMT’21” was held between 14th and 15th June 2021 in Ruse, Bulgaria. Representatives of 34 countries (Austria, Bulgaria, Chile, China, Cyprus, Egypt, France, Germany, Greece, Hungary, India, Iran, Iraq, Israel, Italy, Kazakhstan, Kosovo, Kuwait, Latvia, Lebanon, Lithuania, Macedonia, Nigeria, Norway, Portugal, Romania, Russia, Serbia, Spain, Tajikistan, Turkey, United Kingdom, and Yemen) sent their works to the conference. Selected reports (69 works) have been published as short papers in the proceeding of the conference.

It is my pleasure to be an editor of the presented short papers, which focus on new international scientific results in the field of Alternative Energy Sources, Materials and Technologies (Solar and Hybrid Thermal Systems, Solar Photovoltaic Systems, Solar Radiation Measurement and Sun-tracking, Geothermal Energy Applications, Phase Change Materials (PCM) Applications, Wind Energy, Biotechnologies, Hydrogen Energy, Ocean/ Tidal Energy, Energy Materials Science, Mechanical Engineering and Technologies, Electrical Engineering, Low-Carbon Technologies, Energy Efficiency).

Prof. Aleksandar Georgiev, PhD (European Polytechnic University, Pernik, Bulgaria)

Chair of the AESMT’21 conference

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Alternative Energy Sources, Materials & Technologies (AESMT'21), Volume 3, (pp. 51-52) 2021
ALTERNATIVE ENERGY SOURCES, Geothermal Energy Applications

Scale drillability maps as a tool to select the drilling technology to install Borehole Heat Exchange (BHE) probes

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The main aim of EU funded project GEO4CIVHIC is the development, growth and spreading of more efficient and low-cost geothermal systems for conditioning retrofitting civil and historical buildings. Within this context, the assessment of the most suitable drilling technique to install borehole heat exchangers (BHE) is affected by the local geological, hydrogeological and thermal conditions. In order to provide professional (i.e. drillers, designers) and decision makers (i.e. building owners, policy makers) with preliminary information about expected drilling-time and costs for different geothermal systems, drillability maps at European and municipality scale are here presented.

Keywords: Geothermal drilling, shallow geothermal systems, ground thermal properties, drillability, GIS

INTRODUCTION

The European Green Deal sets an ambitious target of reducing CO_2 and climate-altering gas emissions by at least 55% by 2030 (compared to 1990 levels) and climate neutrality by 2050. In this respect, geothermal energy (GE) plays a key role because it provides two main advantages, (1) a further shift in the energy mix towards renewable and (2) a substantial reduction in energy demand in the residential sector. In detail, the Energy Transition initiative of the European Commission is focusing on increasing the retrofitting of the building stock from the current 1 % level to 3 % and to shift the nature of the interventions towards deep retrofits. The application of shallow geothermal installations in the built environment is attractive, but to be competitive on the market the total investment cost of geothermal systems has to decrease compared with alternative solutions. In this framework, the high drilling cost needs to be tackled and, at the same time, a better understanding of available drilling technology suitable for shallow geothermal installation is needed [1-2].

Drillability mapping

In GEO4CIVHIC "drillability" is defined as the most suitable drilling methods related to BHEs installation taking into account the estimated installation time in function of the rig and drilling technology and the local geological constrains. At first it is necessary to define the main geological parameters as the stratigraphic sequence, type of rocks, ground hardness, degree of consolidation., geothermal and hydrogeological conditions. Then, the common drilling techniques used in the whole Europe for shallow geothermal installations were identified based on the contribution of partners expert in drilling technologies. Finally, a correlation between main identified lithologies and best methods to drill them was finalized. In this way, maps able to support the design phase of new GSHP (Ground Source Heat Pump) systems and to provide a first evaluation of the drilling costs and time expected to install BHEs in different locations is provided.

European scale map

For the installation of a BHE, the classic drilling methods (percussing, rotating, and combined percussion-rotation methods) were combined with more than 200 geological settings identified following the European Geological Data Infrastructure (EGDI) description at 1:1.500.000 scale. According to the lithological distribution four main regions were identified:

- Northern Europe, characterized mainly by hard rocks requiring a combined percussion-rotation method

- Central and Southern Europe, characterized by different kind of rocks requiring rotating or combined percussion-rotation methods depending on rock hardness
- European fold belts where rocks are folded and metamorphosed and drilling is done mostly with percussion-rotation, sometimes only rotation
- European sedimentary basin, where unconsolidated sediments are prevalent and drilling can be done with rotary rigs, often using temporary casing to stabilise the hole

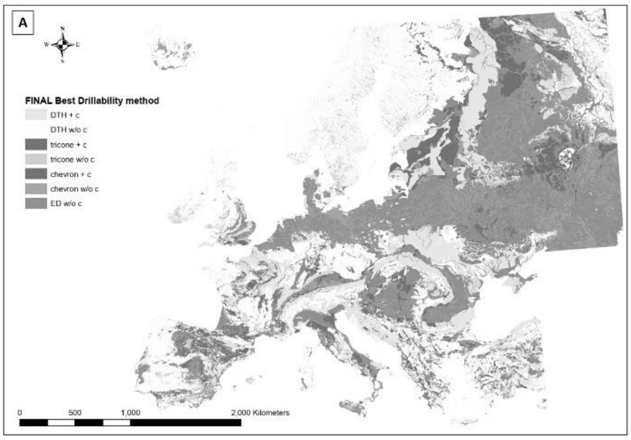

Fig.1. Map of the drilling methods selected according to underground lithological variability at European scale

Municipal scale map

The approach proposed at European scale was then implemented at municipal scale (≤ 1:25.000). In the four demonstration sites belonging to GEO4CIVHIC project (Dublin - Ireland, La Valletta- Malta, Mechelen – Belgium, Ferrara - Italy), showing very different underground conditions, local drillability maps based on local geological, hydrogeological, geotechnical and geothermal information were realized. The aim was to provide a tool useful for drillers and GSHP designers, containing preliminary information about the most suitable drilling technology, the ground thermal properties and the timing/costs of the installation.

CONCLUSIONS

Several approaches have been proposed so far to describe the geo-exchange potential and related techno-economic concerns for shallow geothermal systems [3-4-5]. GEO4CIVHIC approach focus on drillability definition and aims to produce maps able to provide a first evaluation of the drilling method, time and cost to be expected according to underground variability. This information, summarized in a series of maps, will support both administrators, direct users and experts (designers and drillers) in the decision making and authorization processes. The maps at municipal or regional scale will identify the suitability to GSHP systems installation, providing both technical (underground, drilling method) and economic (time and cost) information.

ACKNOWLEDGEMENTS

This work has been supported financially by the EU project GEO4CIVHIC, which is gratefully acknowledged by the author. The project has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No. 792355REFERENCES.

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