

## Critical aspects on shallow geothermal energy systems: development, design and infrastructure

### Summary

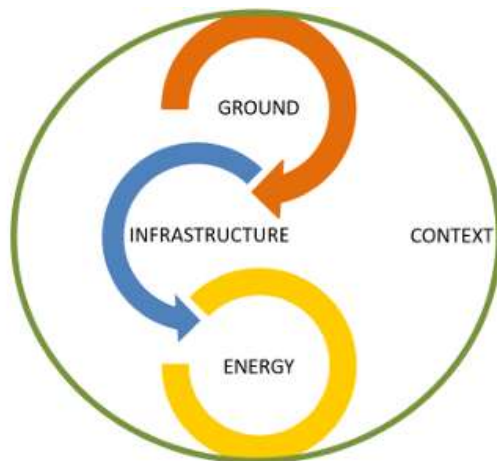
The efforts for more sustainable solutions for the complex energy trilemma – reliable, clean and affordable energy systems - has driven many countries to search and rely on alternative sources of energy which are not reliant on fossil fuels. Nowadays, indoor living conditions have become more and more demanding due to higher living standards and thermal comfort represents a large share of energy consumption in buildings. Shallow geothermal energy supplies efficient heating, cooling and hot water. Its exploitation has been widely used but it still faces challenges that need to be addressed to harvest its potential in decarbonising societies. These challenges can be divided into three categories: technical, socio-political and environmental. These are the focus of the thesis.

The design of shallow geothermal energy systems involves the analysis of: the source capacity, the building needs, and the equipment characteristics. Additionally, the socioeconomic and regulatory context of the project influences the design procedure and decisionmaking process. These four issues are the backbone of the research work, which aims to provide a transversal guide for successful SGE projects and ensure its sustainable development, while presenting some important scientific contributions as specific objectives. These include a regulatory review, field testing, laboratory testing, design optimisation and feasibility study of SGE systems in Lisbon.

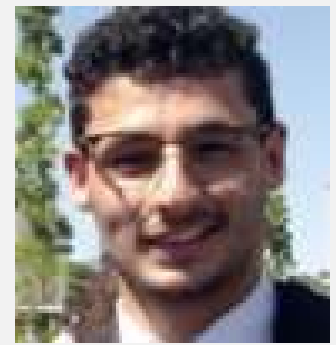
The main contribution is a comprehensive collation of the critical aspects in designing and developing shallow geothermal energy systems, having a clear focus on Portugal in which its market is still embryonic.

### Keywords

Energy transition, shallow geothermal energy, thermal behaviour of soils, renewable heating and cooling, district heating and cooling.



Roadmap for the investigation undertaken.



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