Energy plays a key role in the functioning of modern society. One of the challenges confronting today's society is to ensure continuous and sustainable access to energy from renewable sources. As the demand for energy grows, it is essential to find innovative solutions for its storage and efficient use. In this context, thermal energy and thermal energy storage technology are becoming increasingly interesting areas of research and development. Thermal energy storage (TES) is an important aspect in the field of renewable energy and energy efficiency. Against the background of climate change and increasing pressure to reduce greenhouse gas emissions, thermal energy from renewable sources such as solar or geothermal is becoming an increasingly attractive alternative. However, one of the main challenges in harnessing this form of energy is its intermittency - the moment of conversion of mechanical energy into thermal energy, for example, often does not coincide with the moment of demand. In response to this challenge, latent heat storage is becoming an increasingly interesting solution. Latent heat is a measure of the energy required to change the physical state of a material, such as a hydrated salt or paraffin, whose phase transformation occurs at a specific temperature. This process allows energy to be stored and released in an efficient and sustained manner, allowing thermal energy to be used in a more consistent and predictable manner.

The main objective of the proposed project is to develop new polyurethane materials capable of storing thermal energy and releasing it in an efficient and sustainable manner. The project includes a series of studies on the preparation of phase-change materials in eutectic mixtures form, the microencapsulation process of phase-change materials and the preparation of polyurethane materials by in-situ and electrospinning methods. In the course of the project, the structure and chemical and physical properties of the obtained materials will be characterised. The synthesised materials will also be subjected to thermal tests to determine the effectiveness and durability of thermal energy storage. Furthermore, the project work will investigate the effect of the number of heating and cooling cycles on the stability of the materials obtained. A novelty, so far poorly described in the scientific literature, is the use of eutectic mixtures as phase change materials, which will be microencapsulated and then introduced into the polyurethane materials. The use of such a system will allow more latent heat to be stored than with polyurethane itself. The final research objective is to carry out a life cycle assessment (LCA) of the products obtained. This research will define the ecological aspects and potential environmental impact of the new polyurethane materials developed. There is a lack of research in the commonly available literature on the life cycle analysis of phase change materials, the microencapsulation process as well as the preparation of polyurethane materials, hence there is a great need for comprehensive research on this topic.

The results of our research will provide new knowledge on thermal energy storage technology, the synthesis of new materials capable of storing thermal energy and their processing. The research proposed in the project will increase the environmental awareness of society and the research results will enable the preparation of a number of scientific publications from the so-called JCR list and will result in the development of scientific disciplines.