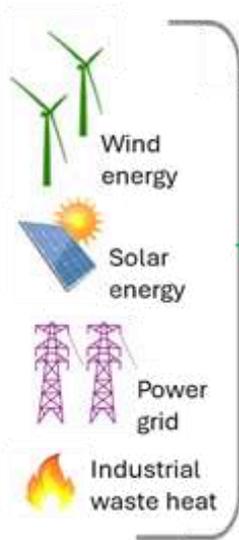




PROJECT NEWSLETTER

Development of an innovative low-cost and highly efficient Energy Storage system
Grant Agreement n° ENTERPRISES/ENERGY/1123/0027

Variable Energy Input

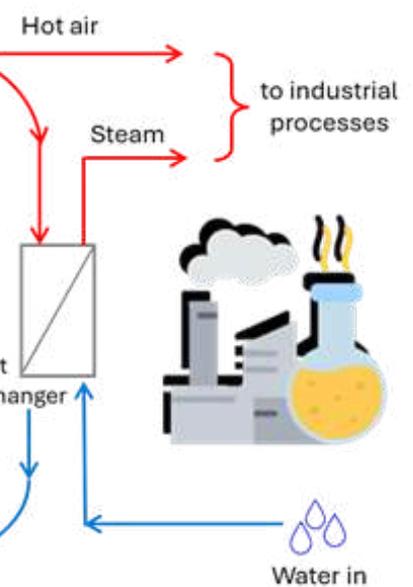


Charging

Thermal Energy Storage



Thermal Energy Output



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DIAS Project at a glance

The DIAS project develops an innovative **Thermal Energy Storage (TES) modular system of low-cost and high performance**, which can operate at high-temperatures and be installed in both small and large facilities. This new TES system is based on geopolymers produced from recycled Construction and Demolition Waste (CDW), specifically, waste bricks. Geopolymerization achieved to transform waste bricks into materials with **mechanical and thermal stability at high temperatures, up to 700 °C**, making them ideal for sensible heat storage applications.

Compared to the Ordinary Portland Cement (OPC)-based materials currently used in such applications The CDW-based geopolymers are highly advantageous, not only in terms of cost and energy storage efficiency, but mainly of structural integrity above 450 °C, where the latter materials decompose.

The **DIAS GeoTES System** can store as thermal energy the surplus electricity produced by the renewables and release it through a heat transfer fluid (HTF) to be used in industrial processes as heat or electricity, when demanded.



Importance of the DIAS project for Cyprus

Energy sector in Cyprus faces a major challenge: although the country has some of the highest solar potential in Europe, it lacks large-scale energy storage capacity.

As a result, up to 20% of solar energy produced annually is wasted because the grid cannot absorb or store it. The TES system proposed in DIAS project aims to address directly this challenge by:

- Providing a low-cost energy storage option, utilizing local waste sources
- Enabling better use of the sustainable local renewable electricity
- Supporting industrial sectors with significant heat requirements
- Promoting circular economy practices
- Ensuring an easy integration into existing energy systems, thus promoting green energy transition

Key Achievements

Between April and November 2025, DIAS Consortium achieved significant technical progress:

- ✓ Production of the first GeoTES small-scale module sample and testing in batch charging–discharging cycles operation
- ✓ Upscaling of GeoTES module and testing under simulated operational conditions
- ✓ Advancement of TES prototype design and digital twin development
- ✓ Techno-economic evaluation and Life Cycle Assessment of the DIAS TES system

These achievements prepare the pathway for testing in continuous cycles and preparing and pilot-scale demonstrating a GeoTES prototype modular unit.

Evaluation of the GeoTES system performance in lab

A GeoTES module, which is the basic component of the innovative GeoTES system, was produced by casting method at small-scale, with 10 x 10 x 25 cm dimensions, using waste bricks. The GeoTES module was subjected to extensive lab-scale testing of charging-discharging batch cycles across 400 to 700 °C (Fig. 1), and its performance was evaluated in terms of energy storage efficiency.

The operation of GeoTES module in cycles was repeatable and reproducible, ensuring high potential for industrial use. Its volumetric heat capacity ($\sim 1.5 \text{ MJ} / \text{m}^3 \text{ }^\circ\text{C}$) is comparable to OPC concrete-based commercial products, confirming suitability for industrial applications.



Fig. 1: Experimental set-up

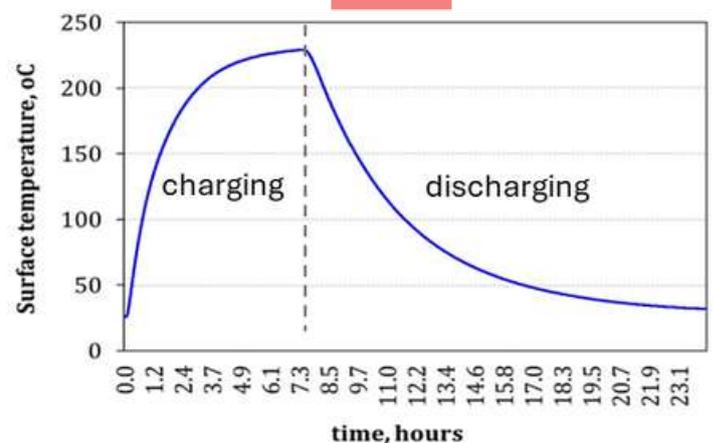


Fig. 2: Batch cycle operation at 400 °C

Upscaling of GeoTES system

The upscaling of the new GeoTES system was completed in three steps:

- Investigation of performance stability in charging-discharging batch cycles after the addition of aggregates from waste bricks, fine (250 - 600 μm) and coarse (600 - 1000 μm), as well as study of
- Testing under simulated operating conditions of successive batch cycles with charging through heating for 7 hours at 600 $^{\circ}\text{C}$ and discharging through natural cooling at 200 $^{\circ}\text{C}$
- Testing of a small-scale GeoTES system in cycling operation

During the upscaling process, emphasis was paid on two main points: the smoothness and repeatability of the production process and the thermal pretreatment of modules to avoid thermal shocks and subsequent structural damages. Moreover, a comparative evaluation of the GeoTES material with commercial materials currently used in industrial sensible heat storage applications was performed.

Material	ρ (kg / m^3)	C_p ($\text{J}/\text{kg K}$)	K ($\text{W}/\text{m K}$)	Temperature ($^{\circ}\text{C}$)		Volumetric storage density (MJ/m^3)
				Cold	Hot	
GeoTES	2050	957	0.9	200	700	773
Concrete	2200	850	2.0	200	400	693
Basalt	2500	900	1.5			
Slag	2700	840	-	200	700	794
Limestone	2200	683-908	2-3			
Brick	3200	800	1.6	200	700	637
Ceramics	3500	900	1.3			
Tiles	1900	800	0.8			
Glass	2500	840	0.7	200	700	

Table 1: Properties of materials used in sensible heat storage applications

Design of the pilot-scale GeoTES prototype

The design of the pilot-scale TES prototype modular system was finalized (Fig. 3), marking a significant step toward the demonstration of its operational capacity at pilot-scale.

The GeoTES prototype is built modularly, using nine casted geopolymer blocks arranged in a compact 3D configuration of rectangular geometry. The prototype has the following characteristics:

- Nine geopolymer blocks (modules) with 10x10x120 cm dimensions, each one of them composed by 3 consecutive sections with 10x10x30 cm dimensions
- The central block carries a stainless-steel helical tube used for heat exchanging (water is used as the heat-transfer fluid)

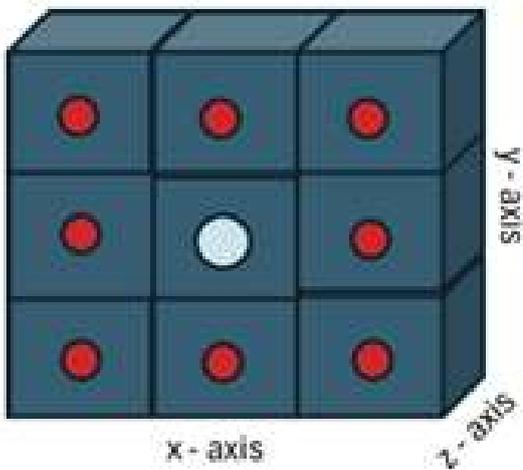


Fig. 3: DIAS GeoTES modular system design

Digital Twin development

A digital twin of the TES system is being developed (Figure 6) that will use real-time data from the charging and discharging operation of the prototype. This virtual model will enable continuous performance assessment and support the optimization of the

TES design.

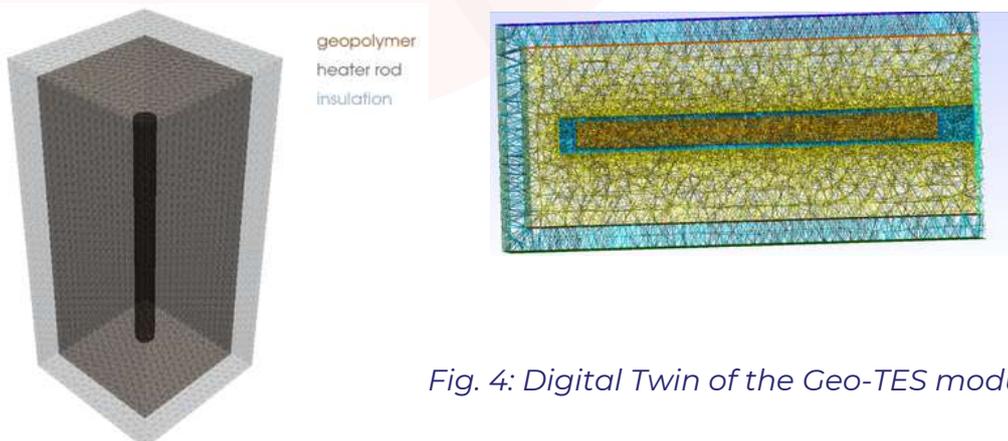


Fig. 4: Digital Twin of the Geo-TES module

Techno-economic evaluation and LCA

Based on the performance data received so far and the possible applications of the new GeoTES system developed in DIAS project, its techno-economic evaluation is ongoing. The findings of this evaluation will reveal the share in energy market of the new developed TES system.

Regarding the environmental assessment of the new GeoTES system:

- The Life Cycle Assessment is under progress using OpenLCA and Ecoinvent
- Initial modelling confirms a substantial environmental advantage of CDW based geopolymers compared to cement-based TES materials

Dissemination Activities

The consortium continued to disseminate its results through scientific publications, conference presentations, and media outreach.

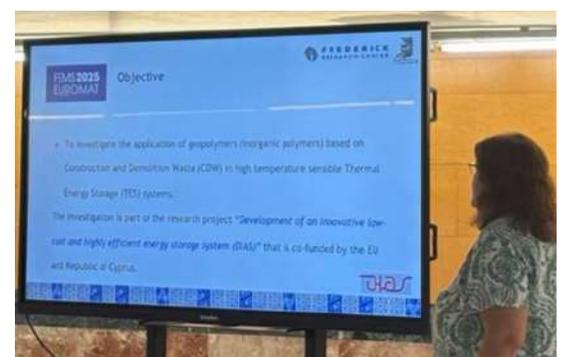
Journal Publication:

Giannopoulou I., Georgiou L., Oikonomopoulou K., Spanou M., Michaelides A., Nicolaidis D. "Study on the design and development of advanced inorganic polymers for Thermal Energy Storage (TES) Systems." **Energies 2025, 18, 3107.**



Presentation at International Conferences

18th European Congress on Advanced Materials and Processes – FEMS 2025 EUROMAT, 14-18 September 2025, Granada, Spain: Giannopoulou I., Oikonomopoulou K., Georgiou L., Michaelides A., Nicolaidis D. "Innovative and sustainable materials for high temperature Thermal Energy Storage (TES) systems"



9th International Conference of the Hellenic Metallurgical Society, 3-4 November 2025, Thessaloniki, Greece: P. Mavromatidis, M. Spanou, K. Oikonomopoulou, L. Georgiou, A. Michaelides, I. Giannopoulou, D. Nicolaidis. "Cycle Performance of a Novel Thermal Energy Storage (TES) System Based on Geopolymers from Construction & Demolition Waste"



Meetings and news

3rd Consortium Meeting

The DIAS Project convened its 3rd Consortium Meeting on the 30th of October 2025, online. During the meeting, the participants reviewed the most recent advancements and progress made in the project, along with the upcoming actions scheduled until its completion. In this meeting, the current status of each Work Package was presented, along with the respective work performed within their designated tasks. Moreover, the table of project's critical risks and mitigation measures was presented, discussed and updated, ensuring smooth progress of the project towards its objectives. The meeting concluded with a comprehensive discussion, regarding the upcoming demonstration event.

Upcoming steps and Demonstration Event

Looking ahead, the DIAS project partners will begin testing of the upscaled GeoTES system in continuous cycles, proceed with the production and assembly of the pilot-scale prototype and complete the techno-economic and environmental assessments of the innovative GeoTES system.

A **Demonstration Event** of the pilot-scale GeoTES system is organized by TALOS (Host Organization of DIAS project) along with the support of FRC and will take place shortly before the end of the project at the Frederick Research Center with the participation of local academic and industrial stakeholders, public organizations and governmental bodies. The Demonstration Event will be combined with the **DIAS Information Day**, including presentations of the main project achievement by the involved Partners.

This specific event is aimed to open also the discussion on the current situation of the renewable energy management in Cyprus, as well as on prospects for sustainable solutions in this crucial area.



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