European project CEEGS demonstrates breakthrough in CO_2-based energy storage

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As the CEEGS project concludes this month, the consortium celebrates the successful completion of a pioneering European initiative that has proven the feasibility of using CO_2 for clean, efficient, and safe energy storage combined with geological storage at the laboratory scale.

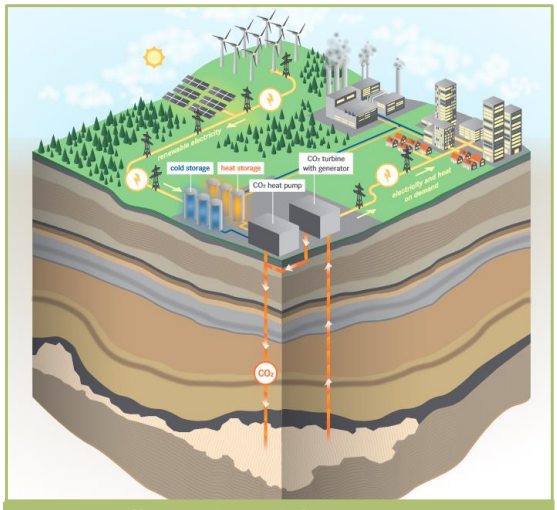

Image: Illustration of the CEEGS concept.

Europe's path to climate neutrality, as set out in the European Green Deal and the EU's long-term climate strategy, depends on the large-scale use of renewable energy sources such as wind and solar. Yet, because these sources depend on weather conditions, effective energy storage systems are essential to ensure a stable supply. At the same time, carbon capture and storage (CCS) remains crucial to decarbonising heavy industries such as cement, steel, and fertiliser production—sectors where emissions are difficult to avoid.

The Horizon Europe-funded CEEGS project addresses both challenges through an innovative CO_2-based electrothermal and geological energy storage system. The concept integrates renewable energy storage with CO_2 capture and underground storage, turning CO_2 from a waste product into a valuable working fluid for clean energy storage and recovery. This cross-sectoral approach helps to increase the efficiency and cost-effectiveness of both renewable energy and CCS technologies—at a low environmental impact.

Innovative prototype marks major milestone

Over the past three years, the project has developed and tested a closed-loop system that connects surface energy cycles with subsurface reservoirs. A major achievement has been the design, construction, and commissioning of a 20 kW laboratory-scale prototype. This pilot system, based on transcritical CO_2 cycles, demonstrates how renewable energy can be stored as heat and then converted back to power when needed.

Initial experimental results are highly promising, confirming the technical soundness of the concept and paving the way for future pilot-scale demonstrations that could support a more flexible and resilient European energy system.

Strong European collaboration

The success of CEEGS reflects the close collaboration among leading research centres, universities, industry partners, and not-for-profit associations from across Europe. The consortium has produced more than 15 scientific publications, 40 conference presentations, and one patent application, showcasing its strong research and innovation capacity.

With a total budget of €2.99 million, CEEGS has been coordinated by the University of Seville and includes 10 partners from five European countries, bringing together expertise in energy systems, geology, geothermal technology, CO_2 storage, and social sciences.

Funded by the European Union

A vision for the future of energy

The CEEGS concept shows how CO_2 can become a key enabler of the energy transition, linking renewable power, geothermal energy, and carbon storage into one integrated system. By bridging the power and geological sectors, CEEGS sets the stage for next-generation European energy systems and supports the EU's long-term climate and energy goals.

About CEEGS

The CEEGS (CO_2-based Energy and Geological Storage) project is funded by the European Union's Horizon Europe research and innovation programme. It aims to develop innovative solutions for sustainable energy storage and carbon management, supporting the EU's transition toward a climate-neutral energy system.

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