CEEGS Novel CO_2-based Electrothermal Energy and Geological Storage system

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Prospect analysis of the CEEGS concept for Europe (D6.4)

This report assesses the viability of CEEGS technology in Europe, combining industrial, economic, and regulatory analysis. It compares operational scenarios, grid-connected and PV-supported for various years of investment and capacities, parameters crucial for evaluating the market and industrial scale-up potential of this technology. The major outcome of this analysis can be summarized in 3 main points:

1. Grid-connected configuration shows a competitive LCOE for European standards.
2. PV integration, while promising for decarbonization, currently results in higher costs
3. Replicability and industrial uptake depend on regional geological conditions and regulatory maturity.

CAPEX is influenced by:

- Year of investment (inflation, supply chain volatility, technology maturity)
- System capacity (non-linear scaling; optimal well configuration critical)
- Geothermal structure (depth, permeability, connectivity)

OPEX depends on:

- Energy source selection (direct connection to the grid vs. PV integration level)
- Installation costs are highly site-specific and sensitive to geological and market conditions.

Major Barriers to Industrial Scale-Up include

1. Geological Uncertainty
- Risks related to CO_2 retention, geomechanical stability, and thermal drawdown.
- Site-specific variability affects performance and long-term reliability.

2. Regulatory Fragmentation
- While most EU countries have transposed Directive 2009/31/EC, permitting, monitoring, and liability rules vary widely.
- Multi-agency permitting causes delays and investor uncertainty.

3. Public resistance remains a barrier, especially for onshore storage.

4. Financial & Institutional Gaps
- High infrastructure costs and limited technical capacity in countries like Portugal, Bulgaria, and Estonia.
- Lack of financial support instruments
- Liability transfer issues create legal uncertainty

On the bright side:

1. Strategic Opportunities for Deployment
- Cross-border cooperation in the North Sea and Mediterranean could enable shared CO_2 pipelines and storage hubs, reducing costs and permitting complexity.
- EU Taxonomy alignment enables access to green bonds, climate finance, and ESG investments.

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2. Capacity Building & Public Engagement
- Educational partnerships and reskilling programs are essential in Hungary, Romania, and Poland.
- Pilot projects in Slovenia, Croatia, Serbia, and the Czech Republic can test permitting systems and build local expertise.
- Transparent risk communication and community benefit-sharing are key to building public trust, especially in countries with past project failures (e.g., Castor in Spain).

3. Innovation Potential
- High-risk/high-reward profile: CEEFS is a high upfront cost technology but… it combines carbon capture, storage, and utilization supporting EU decarbonization goals, energy system flexibility, and industrial decarbonization.

The SWOT analysis is summarised in Figure 1.

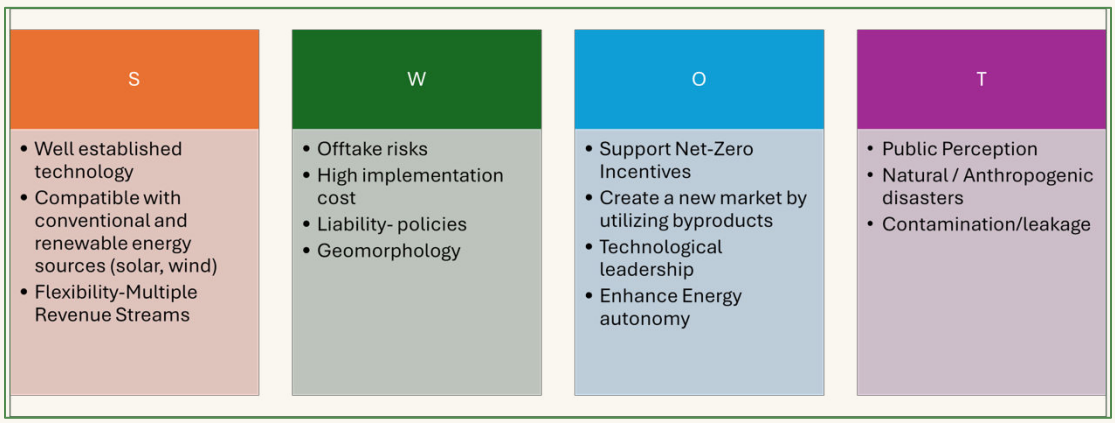

Figure 1. SWOT analysis for the CEEGS project.

How do I find out more about the project?

Video teaser: https://youtu.be/fvH5HlrsJME?si=d1-IGwywE8CAJZN3
Project Brochure: https://tinyurl.com/2p9hc9n4
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