CEEGS assessment protocol based on the LCA results (D6.3)

Within WP6, Deliverable 6.3, "CEEGS evaluation protocol based on LCA results", is the report for the CEEGS evaluation protocol containing the LCA results. It is part of task 6.3 "Techno-economic analysis and life cycle analysis" in which life cycle cost and life cycle analyses are carried out by USE to identify the positioning of the technology, possible business models and potential markets and their feasibility in order to reach TRL4 level.

This report contains the results derived from the life cycle analysis of the CEEGS concept. The study aims to assess the environmental impact of energy storage technology under different scenarios using life cycle assessment (LCA). The LCA analysis was performed using the commercial software Simapro (USE) and the Ecoinvent v3.1 database. The LCA developed in this work applies the UNE-EN ISO 14040:2006 (principles and framework for the evaluation of a life cycle analysis) and ISO 14044 (requirements and guidelines for carrying out life cycle analysis) standards. The analysis is performed for six energy storage integration scenarios, considering different energy sources and sizes, and as a functional unit the impact of generating 1 MWh of electricity is considered. This assessment aims to identify a scenario with better environmental impact:

- S1 & S2: Electricity from the grid mix (5 & 100 MW)
- S3 & S4: Electricity from renewable sources directly integrated (5 & 100 MW)
- S5 & S6: Electricity from renewable sources in excess in the grid (5 & 100 MW)

The concept can be integrated as a standalone energy storage system for the grid or as an energy storage system integrated into a renewable plant. Depending on their integration, different impacts are expected. The analysed system consists of four subsystems: Thermoelectric Energy Storage System (TEES), geological repository & TES, electricity source and CO_2 transport.

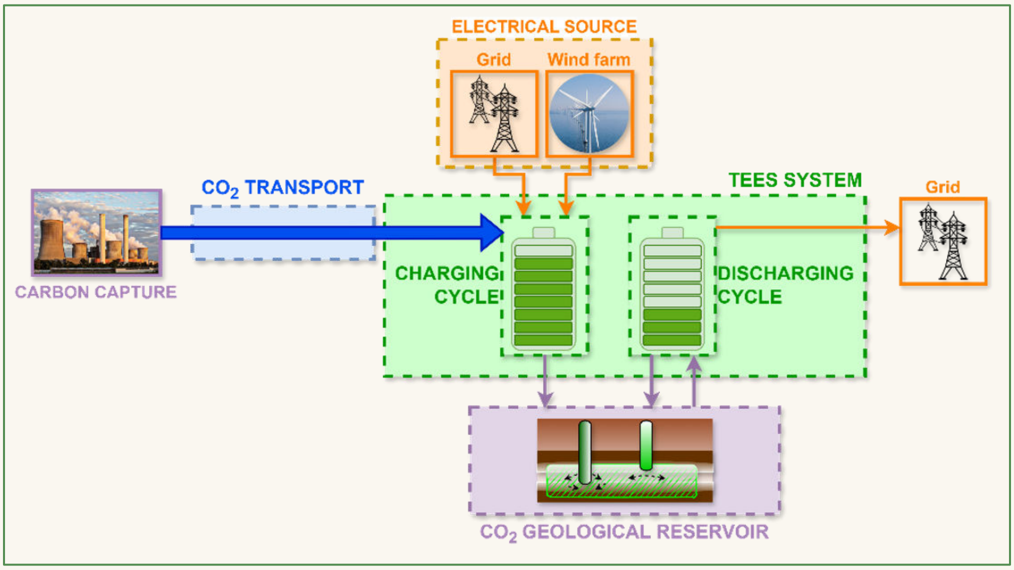

Figure 1. Subsystems of the transcritical carbon dioxide electrothermal energy storage system CEEGS for the LCA analysis.

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The results show the potential of the energy storage concept to integrate with renewables and use excess renewable electricity in the grid without accounting for the generation impact in the energy storage concept. The CEEGS system is an interesting and viable option in terms of impact for storing surplus energy. The impact of the system is of the same order of magnitude as that generated by the PV or wind farm, adding no substantial additional impact and allowing for prolonged operation.

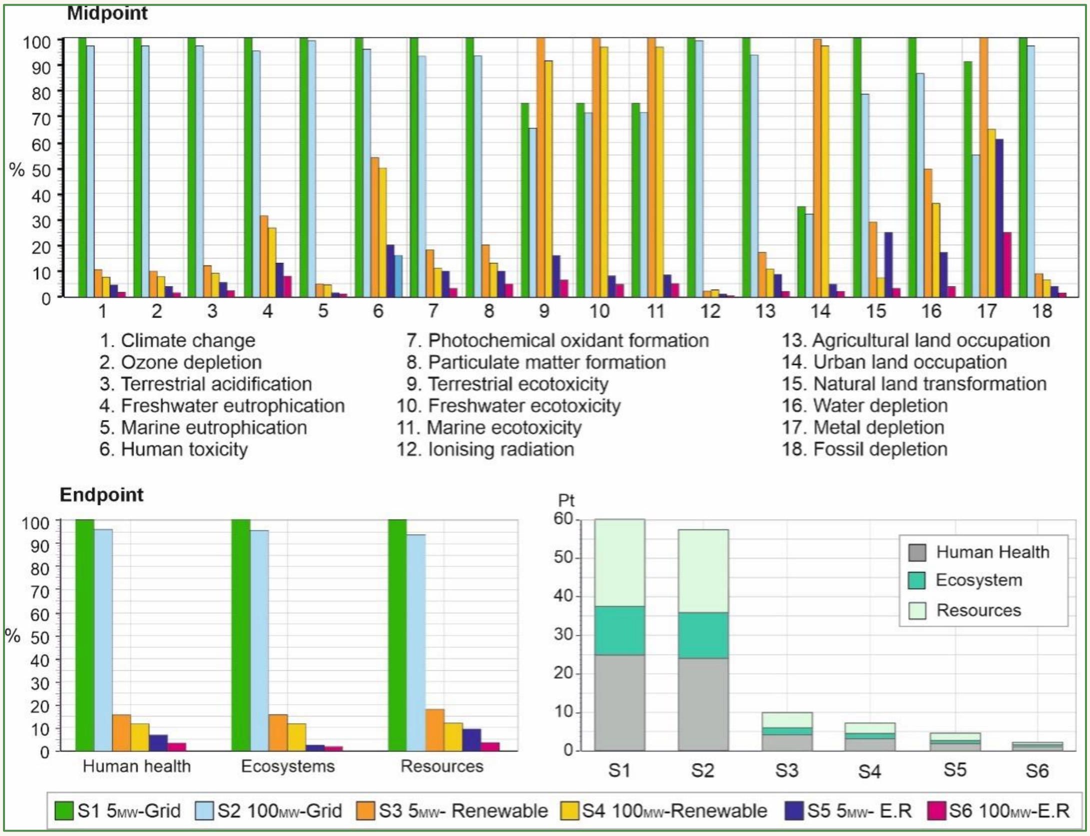

Figure 2. Life cycle environmental midpoint impacts of the six scenarios.

From an LCA point of view, the technology is competitive, and the overall values reported are of the same order as those presented by other low-impact technologies. From an LCA perspective, larger energy storage systems will be more interesting. In any case, the study of LCA is limited due to the limited number of specialised databases, and further research progress will be made in the future. The development of a specialised database to refine this model and other similar projects is a valuable task that will be further explored in future work. It is essential to increase the accuracy of the inventory data for this specific technology in order to achieve more representative values of the process as the technology evolves to more mature phases and details on construction, maintenance and decommissioning.

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The first part of Task 6.3 has evolved satisfactorily, and relevant results have been obtained. They will allow advance in the next steps within task 6.3 and the rest of the related tasks in WP6. Deliverable d6.3 shows an LCA analysis for the CO2-based electrothermal energy and geological storage system. In this first approach, six scenarios have been considered to assess the environmental impact of the concept. They have been defined according to the size of the system and the origin of the integrated energy. No constraints have been found in the development of the technology. The results support the feasibility of advancing the technology to higher levels of technological readiness.

How do I find out more about the project?

Video explainer: https://youtu.be/y94fHCM__us
Project brochure: https://tinyurl.com/2p9hc9n4
Project website: https://ceegsproject.eu/

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