

**Carbon Capture, Utilisation and Storage:
Opportunities, challenges and pathways to Net Zero**

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**Geological CO₂ Storage: Integrating Geophysics for Site
Characterization and Monitoring - Examples from ECCSEL
ERIC facilities**

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The European strategy to combat global warming caused by increasing greenhouse gas emissions into the atmosphere, among which CO₂ plays a major role, assigns a key role to CCUS (Carbon Capture, Utilisation and Storage) within the EU Green Deal, supporting the energy transition of energy-intensive industries and the power sector. Geological CO₂ storage involves capturing CO₂ from emission sources, transporting it, and injecting it into the subsurface at suitable depths and into geological formations capable of receiving and securely containing it. The long-term storage of CO₂ must then be ensured, both in terms of environmental impact and overall safety.

To support research aimed at identifying safe and sustainable CO₂ storage sites, it is essential to develop and test methodologies and procedures to detect, characterize, and quantify potential CO₂ leakages from the storage complex. Research, innovation, testing, and verification require Research Infrastructures and services capable of addressing major scientific and technological challenges under realistic conditions and with state-of-the-art instrumentation.

Two research activities are presented, carried out using geophysical instrumentation available at the facilities of the Italian National Node of ECCSEL ERIC.

The first study focuses on the use of Marine Fibre-Optic Distributed Acoustic Sensing (DAS) for monitoring natural CO₂ emissions, tested at Panarea Island, part of the Aeolian Islands in the Southern Tyrrhenian Sea, which is characterized by naturally occurring CO₂ emissions.

The second study was conducted at the Sotacarbo Fault Lab and focuses on the geophysical characterization of a fault through the integration of different geophysical methods, with the aim of investigating the potential behaviour and migration pathways of CO₂ in the presence of fault structures. The availability of dedicated test sites, such as Panarea and the Sotacarbo Fault Lab, together with advanced geophysical instrumentation accessible to the scientific and industrial communities through the ECCSEL ERIC Research Infrastructure, represents a fundamental resource for advancing CCUS technologies and enabling the transition from technical development to pilot projects, demonstrations, and real-world deployment of low-carbon geoenergy technologies.

Keywords: *Geological CO₂ Storage, CCUS Geophysical, Monitoring CO₂ Leakage Detection, ECCSEL ERIC, Research Infrastructure*

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