# Carbon Capture Utilization and Storage (CCUS)



### **Monitoring Solutions**

BROCHURE

#### BACKGROUND

ESG has been conducting subsurface monitoring projects since 1993 for mining and the energy sectors. Using our toolbox of solutions, ESG customizes our projects to specifically meet each client's needs. To date we have installed over 300 downhole microseismic systems that operate autonomously having data stream to our processing center for real-time alerting and processing.

Although CCUS operations have been around for decades, the number of commercial projects on the horizon has vastly increased recently. ESG has been working in long term monitoring space for decades, including CCUS operations. This brochure walks through ESG's monitoring technologies for CCUS operations, along with long term monitoring recommendations.

#### WHAT DO OPERATORS CARE ABOUT?

- reducing risk and understanding containment,
- monitoring fault activation,
- monitoring for any induced seismicity,
- understanding the extend of the CO<sub>2</sub> Plume and visualizing the CO<sub>2</sub> oil front.

#### **TOOLBOX OF SOLUTIONS FOR CCUS**

Technology	What it tells you?
Microseismic Monitoring Combines our manufactured microseismic sensors with our Paladin <sup>®</sup> digitizers and acquisition software for a fully integrated microseismic detection system for projects of any duration.	Casing integrity, caprock integrity, microseismic activity subsurface (reservoir and basement) associated with injection.
 Seismicity Monitoring (ISM) Low frequency sensors to record and measure seismicity associated with injection operations. Seismicity monitoring systems will be set up for real- time processing and alerting.	Notifies operator in real time of any concerning seismicity associated with operations.
<b>Electromagnetics</b> Electromagnetic imaging uses a generated electric field measured on an array of surface receivers to image fluid/gas movement or void detection.	Visualization of CO <sub>2</sub> plume evolution and image the Oil to CO <sub>2</sub> boundary for CO <sub>2</sub> EOR operations.
<b>Fiber Optics</b> Deploy fiber independently or combine it with geophones for strain or DAS microseismic, and DTS.	Cross-well Strain measurements DAS (Distributed Acoustic Sensing) Microseismic DTS (Distributed Temperature Sensing)

SEEING DATA AT A WHOLE NEW LEVEL

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#### **RECOMMENDATIONS/LEARNINGS**

Why should you monitor?

- Monitoring allows operators to fully understand any activity within the caprock, reservoir and basement. This is important to understand the risk around containment and induced seismicity.
- Additionally, long term monitoring allows operator to understand the evolution of stress over time resulted from the continued storage of CO<sub>2</sub>

#### What technologies should you use?

- <u>Hybrid<sup>™</sup> Monitoring (downhole array + ISM array)</u>: ESG strongly recommends at minimum to have a downhole and ISM array for all CCUS project. Having a full understanding of subsurface activity associated with operations ensures operations can be conducted safely and increases operational up time. Utilizing both downhole array and ISM array is extremely important for depth and magnitude accuracy.
- <u>Electromagnetics</u>: For those operators who would benefit from visualizing the extent of CO<sub>2</sub>, ESG's Electromagnetics technology is the solution. Snapshots can be conducted at set intervals to provide operators with this information.
- <u>Fiber Optics</u>: Fiber Optics data can be used to supplement the Hybrid<sup>™</sup> solution. This technology provides high spatial resolution and large aperture sensor data to monitor seismicity and cross well strain data. While fiber optics data is helpful as a supplementary data source, it cannot replace the Hybrid<sup>™</sup> monitoring solution.

When should you start monitoring?

• Monitoring should start in advance of injection. Ideally monitoring of both microseismic and seismicity will be conducted a minimum of six months in advance of operation to establish a sufficient baseline of activity.

When should you expect to see seismic activity?

• From ESG's experience, once pressure builds up seismic (small and larger scale) activity is expected. However, it is not uncommon for there to be no microseismic activity at the start-up of operations.

Where should you monitor seismic activity?

• ESG recommends monitoring for seismic activity in the caprock, reservoir and basement. From ESG's experience, basement activity can occur.

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