Monitoring CO_2

At the heart of any permission, license or other regulatory allowance to carry out a CO_2 capture and storage (CCS) project, is the ability to monitor the CO_2 that is injected and verify that it is where it is intended to be. Monitoring and verification continues past the injection stage and will carry on for years after a project has stopped injecting in order to demonstrate storage is permanent.

Why monitor?

For CCS to be categorised as a climate change mitigation option, it has to permanently prevent the emissions of CO_2 to the atmosphere. If CO_2 is injected into a storage formation, then for the operator to be able to class this as stored CO_2, they have to be able to demonstrate or prove that the CO_2 has remained stored securely.

Monitoring techniques have been developed to be able to show where the CO_2 that has been injected has gone, how far it has travelled, and how much is there.

How does monitoring work?

Subsurface monitoring uses pressure sensors, to monitor the pressures within the storage formation. By monitoring the pressure as it increases during injection, if a leak should occur the pressure would drop and indicate leakage. Other monitoring tools will then determine the location and rate of the leak and allow operators to fix it, preventing environmental impacts.

Seismic monitoring is used to create a picture, showing where the injected CO_2 is, both in terms of depth and how far it has spread out within the storage formation. The Sleipner project operating offshore of Norway has used seismic monitoring very effectively. The project has been operating for a number of years and the differences between the repeat surveys show the development of the CO_2 area in the subsurface. This allows operators to verify how much has been injected, where it has travelled, and where it is now. The images from seismic surveys look confusing to an untrained eye, but with the correct understanding, they can provide a wealth of information for the site operators.

Other monitoring techniques are available and are used to verify the same facts about the injected CO_2. Monitoring can also assess the condition of wells drilled into the storage formation, both old and new, and determine which need remediation or plugging / sealing before an injection project starts.

Surface and near surface monitoring focuses on water systems, air quality and ecosystems in the vicinity of a project. By monitoring the groundwater in an area, the operators can determine if any CO_2 has leaked to the groundwater. Surveys before injection starts are important here as groundwater can contain different levels of CO_2 depending on many external factors, so it is important to know what the original groundwater was before testing to see if any CO_2 has leaked into it.

Atmospheric monitoring tests the composition of the air to determine if the CO_2 levels are rising due to leaks. These tests can be very location specific, so if there is a leak, not only can these methods detect it, but they can also pinpoint it to allow site operators to determine where it is coming from and fix it.

By monitoring changes within ecosystems, both plant and animal, operators can detect if any small leaks are causing changes to the animals and vegetation in the area. Some species can act as early indicators, and can be used to identify any small changes over time.

Summary

With even the most rigorous site selection, and careful injection programme, there will be those who are cautious over the safety of CCS. By utilising and deploying monitoring technologies site operators can offer an extra reassurance that the site is operating properly, safely, and within pre-ordained restrictions laid down by regulators.

By demonstrating that the injected CO_2 is accountable, it is acting as expected, and is where it is expected to be, reassurance can be offered to interested parties and safety can be assured and demonstrated.