



Seven Things to Look for in a Carbon Storage Site Operations Partner

Carbon Capture and Storage (CCS) requires a long-term plan for safe storage of captured carbon (CO₂), from injection to closure and environmental monitoring. The right site operations partner can help companies maximize tax credits while minimizing risks and costs for operation, management and monitoring.

Solving for the “S” in CCS

Carbon capture and storage is moving into the mainstream, thanks to breakthrough technologies and tax credits like 45Q. These tax credits have made CCS viable and profitable for a wider range of CO₂ emitters, including power companies, ethanol producers, oil & gas processing facilities, and steel and cement production facilities.

However, most companies do not have the expertise on staff to oversee and manage the operations side of the equation. Site operations for a CO₂ storage site is a decades-long commitment, with an injection phase that can last from 12 to 30+ years and long-term monitoring commitments of up to 50 years after closure.

Most companies seeking to take advantage of 45Q and other incentives will benefit from engaging with a site operations partner that can handle the technical, logistical and regulatory details for long-term CO₂ storage and monitoring. But with a project of this scope, scale and duration, it is essential to select a partner that has the right combination of expertise and is certain to be there for you for decades to come.

What to Know About 45Q

45Q is the largest U.S. Federal tax incentive for CCS. The 2022 Inflation Reduction Act significantly increased the per-ton credits and made credits available for smaller projects, making CCS viable for a broader range of CO₂ emitters. It also created a direct pay model for project developers (rather than tax credit only).

How much is the credit?

- \$85/metric ton for CO₂ captured from an industrial facility and stored in secure geologic formations in accordance with the approved Class VI permit (\$60 if used for Enhanced Oil Recovery)
- \$180 per metric ton for CO₂ captured directly from the air and stored in secure geologic formations (\$130 if used for Enhanced Oil Recovery)

Who is eligible?

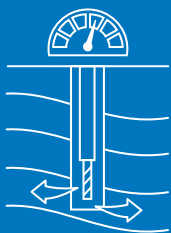
- Power plants emitting ≥18,750 tons
- Industrial facilities emitting ≥12,500 tons
- Direct air capture (DAC) companies capturing ≥1,000 tons

Please note this information should not be considered legal or accounting advice.

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CCS Site Operations: What's Involved

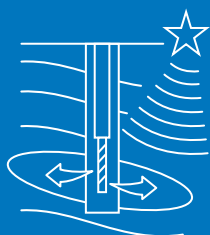
Capturing CO₂ emissions is just the beginning for CCS. Once you've selected a storage site, secured a permit (e.g., Class VI UIC permits in the U.S.), drilled the injection well(s), and implemented a capture system, what comes next? Site operations for CCS encompasses a number of different tasks over the lifetime of the project, some of which may persist for decades. 45Q currently provides up to 12 years of tax credits or direct payments for each permitted project, but an injection well may be usable for up to 30 years or even longer, depending on the storage capacity of the underground formation. Once the well is decommissioned, environmental monitoring must continue for up to 50 years or until the CO₂ plume is proven to be stable (a minimum of five years). Here are the basic elements of CCS site operations.



Injection Monitoring

After the well is drilled and CO₂ injection starts, the site operator must monitor injection rates and pressures and ensure safe operation during the injection process in accordance with the operational and safety procedures laid out in the permit.

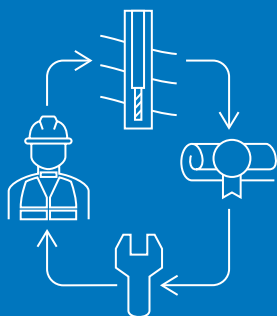
- Monitor injection rates and pressures and optimize injection
- Track how much CO₂ has been sequestered each quarter and in total
- Ensure safe pressures are maintained



Plume Modeling and Monitoring

During and after injection, the CO₂ plume must be monitored and modeled to determine how it is behaving, predict future plume movement, and make sure CO₂ is staying safely sequestered in the formation as predicted by the model. A variety of methods are used to monitor plume and pressure front movement, including seismic imaging, geophysical logging, distributed temperature sensing (DTS) and fluid chemistry.

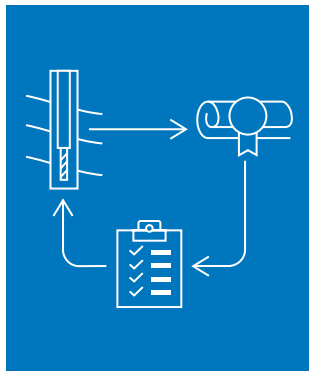
- Monitor CO₂ plume movement and behavior
- Update models to reflect actual plume behavior
- Implement changes in injection strategy based on plume behavior



Well Operation, Inspection and Maintenance

The injection well must be continually monitored and inspected on a regular basis to ensure continued safe operations. If downhole monitoring or visual inspection indicates a potential problem, the contractor must be able to troubleshoot the issue and take corrective action.

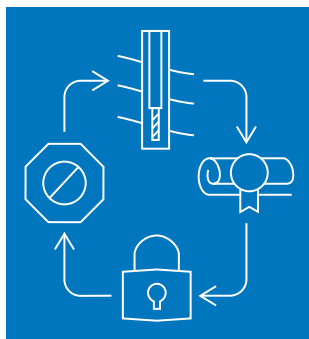
- Maintain continuous passive downhole monitoring (temperature, pressure, seismic activity, etc.)
- Conduct routine visits for visual site inspection and collect samples for fluid chemistry analysis
- Perform well maintenance activities, troubleshoot emerging issues, and adjust injection activities based on data



Reporting and Compliance

To qualify for tax credits or direct payments through 45Q, project developers must submit quarterly and annual reports to the IRS documenting how much CO₂ has been injected. The EPA also requires semi-annual reports for environmental compliance.

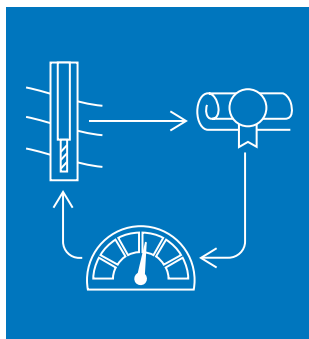
- Verify how much CO₂ has been stored for tax credits
- Verify that the project is operating within the constraints of the permit
- Provide reports documenting plume movement to verify that CO₂ is not escaping into the atmosphere or aquifers



Decommissioning and Site Closure

Once the injection phase is complete, the well must be closed, and the site must be completely remediated. Closure activities ensure that CO₂ is safely sequestered for long-term storage and environmental obligations are fulfilled.

- Remove wellhead and plug well to prevent escape of sequestered CO₂
- Establish and maintain monitoring wells for environmental compliance
- Remediate the site to fulfill EPA and permit requirements



Long-Term Monitoring

The EPA requires long-term monitoring for up to 50 years after site closure, unless the project developer can prove the plume has stabilized before then. It may be possible to close out monitoring after five to ten years if the plume is stable.

- Monitor CO₂ plume movement using passive downhole sensors in monitoring wells
- Update models to reflect actual plume behavior and verify when plume stability has been reached
- Provide required reporting documentation to EPA

CCS Timeline

(1- 3 years)

Planning Phase

Feasibility studies, site selection and characterization, project design, permitting

(6-12 months)

Construction Phase

Implementing CO₂ capture compression & transport solutions, drilling wells for injection and monitoring, installation of monitoring and other specified systems

(12- 30 years)

Injection Phase

Data management, Site operations, well maintenance, operational monitoring, plume monitoring, environmental monitoring, model updates, forecasting, regulatory filing, outreach, inspection & audit

(5-50 years)

Post Injection Site Care Phase

Well decommissioning, plume monitoring, site remediation

Storage Site Operational Phase

Seven things to Look for in a CCS Site Operation Partner

When choosing a site operations partner for CCS, there are several important factors to keep in mind.

1. Stability

Site operations and monitoring will potentially go on for decades—and you need a site operations partner who will be there for the duration. Losing a partner or switching operations companies in the middle of the project could be detrimental to both safety and compliance.

The Battelle Advantage: Battelle has been in continuous operation since 1929 and has a track record of innovation going back nearly 100 years. As a mission-driven, not-for-profit research entity, our articles of incorporation and organizational structure ensure that we will continue to be here to serve our clients and partners for many decades to come. We conduct more than \$9 billion in contract research for government and private industry annually.

The Leading Edge of CCS

Battelle has a fully funded CCS R&D program and brings cutting-edge technologies and methods to CCS operations, including:

- Proprietary monitoring technology to reduce long term monitoring costs
- Proprietary workflows for site optimization
- Workflows to validate all monitoring techniques proposed for each site
- Continuous model optimization using High Performance Computing (HPC) and real-time field data

2. CCS Experience

It is important to work with a company that has specific experience in CCS and a proven track record of successful project management and completion. Project developers should recognize that CCS is very different from other, more mature subsurface industries such as oil & gas extraction, CO₂-enhanced oil & gas recovery (EOR), wastewater disposal and gas storage. While there are some valuable analogues, the behavior of CO₂ in a saline formation, the performance of commercial subsurface technologies, and the regulatory environment demand more specific expertise than that developed by these industries over the decades.

The Battelle Advantage: Battelle has been at the forefront of technology and method development for CCS for more than 30 years, since the earliest days of the industry. In fact, we have pioneered many of the methods used today. Over the last three decades, we have managed more than 100 CCS projects and pilot programs globally, including leadership of the Midwest Regional Carbon Sequestration Partnership (MRCSP), a multi-state pilot program that was instrumental in bringing CCS to commercial scale for the industry as a whole. We now apply the deep experience we have gained in our Department of Energy (DOE) pilot projects to benefit our commercial partners.

3. Scientific Expertise

The technologies and methods for CCS are still emerging and evolving. Most site operations companies are staffed with technicians who are skilled at applying the technologies of today. But do they have the scientific expertise on staff to evolve your project over time and solve the unexpected problems that may occur in a CCS project, such as a CO₂ plume that isn't behaving as expected?

The Battelle Advantage: Battelle doesn't just follow a standard roadmap for site operations. We truly understand what is happening in the subsurface and how various methods and technologies can be used for monitoring the behavior of the injected CO₂ and mitigating risk. Having this unique understanding allows Battelle to troubleshoot issues and suggest alternate methods if a problem arises. Battelle is much more than just a contract operations partner. Our commercial organization can leverage significant R&D resources that are at the forefront of innovation across dozens of relevant science and technology disciplines. Battelle employs an additional 100+ subsurface and geotechnical experts in other divisions. Across Battelle are PhD-level scientists and engineering experts for virtually every discipline needed to solve complex problems. As new methods and technologies are validated, we'll be among the first to know—and you'll be among the first to benefit.

4. Data Science and Modeling Capabilities

CCS isn't just about drilling wells and injecting fluids. It's also about data—and lots of it. Passive downhole sensors generate millions of data points, in addition to data generated by active monitoring methods (such as seismic acquisition). Sophisticated data science and modeling capabilities, along with a deep understanding of subsurface geology and geophysics, are required to create and update plume movement models and generate accurate reports of injection volumes for tax credit and compliance purposes.

The Battelle Advantage: At Battelle, you'll find not only the leading subsurface scientists but also industry-leading expertise in data science, computer modeling, cybersecurity, and machine learning.

We apply cutting-edge methods to manage and analyze very large data sets, find patterns in data, and generate usable, understandable and actionable reports. We can develop and implement a data plan for you to find trends and potential problems in monitoring data, generate required IRS and EPA reports, and protect your data with the highest levels of security.

5. Regulatory Compliance

A successful CCS project must meet strict compliance requirements for both the EPA and the IRS. IRS filings must be accurate, in the proper form, and timely in order to ensure that all earned tax credits or direct payments are received. At the same time, environmental monitoring and restoration activities must be completed and documented in accordance with EPA regulations and permit requirements to avoid fines and penalties. With a less experienced operations partner, project developers may miss out on their full tax credit or face penalties that erase the financial benefits of the project.

The Battelle Advantage: Battelle has a deep history of compliance with regulatory agencies, including EPA, and understands the IRS requirements for 45Q tax credits. We have been involved with dozens of large-scale environmental monitoring and restoration projects for government agencies (including EPA and the Department of Defense (DoD)) and commercial clients in oil & gas and other sectors. We can help you develop and implement a compliance plan to maximize your returns and avoid penalties.

6. Business Model

The business model of your site operations partner is also an important consideration when evaluating the potential return on investment for a CCS project.

The Battelle Advantage: We offer flexible terms for site operations contracts, including fee-for-service contracts that do not ask for a share of the tax credit. Our fee structure is simple and transparent, so you know exactly what you are getting and how much it will cost. And we can work within the business model that best supports our clients. We can help you optimize your CCS operations to ensure a maximum return on your investment.

7. End-to-End Service

Many contractors in the CCS industry are specialized in a specific component of the required services and may not fully appreciate the overall solution. For example, some may specialize in drilling but not plume modeling, environmental monitoring, or 45Q reporting. Working with multiple contractors to handle various parts of the project can negatively impact project accountability and adds to the risk that something will be overlooked along the way. Contracting with a partner who can handle all aspects of the project is easier and safer. In addition, there are synergies to be gained from permitting through to operations that make engaging a partner with full lifecycle expertise and experience most beneficial.

The Battelle Advantage: We are experienced in all aspects of CCS, including site selection and characterization, CO₂ capture and transport, design and construction, site operations and injection, and closure and long-term monitoring. Our team can handle every aspect of your project, from the initial feasibility study to final decommissioning. We can also help you with Class VI permitting. Whether you need end-to-end service or just specific task completion, we'll work with you to create a project plan that suits your needs.

Class VI UIC Permitting

The submission of a Class VI UIC permit is a costly and time-consuming undertaking. EPA guidelines are designed to protect freshwater aquifers and are both detailed and complex. The permit structure covers the complete life cycle of a CO₂ sequestration project including:

- Site location
- Surface and subsurface characterization
- Financial responsibility
- Injection well construction and operation
- Testing and monitoring activities
- Post-injection monitoring and site closure

Each task is complex with many dependencies, uncertainties and, consequently, risks. It is ultimately the responsibility of the site operator to ensure that all these elements are implemented and adhered to throughout the complete project lifecycle. Because of this dependency between permit and operations, it is highly advantageous to the site owner to engage a site operator that can do both.



25+
Years of
CO₂ Storage
Experience

75+
Completed
CCS Projects
Worldwide

100+
Subsurface
Geotechnical
Experts

25+
U.S. States Where
CCS Projects Have
Been Executed

Are you ready to start your CCS project?

You can count on the CCS site operations team at Battelle to help you optimize injection rates and maximize your returns while ensuring the safety and compliance of your project.

Talk to one of our CCS experts to get started.