Brochure

Subsurface Science & Engineering Solutions for

Carbon Storage

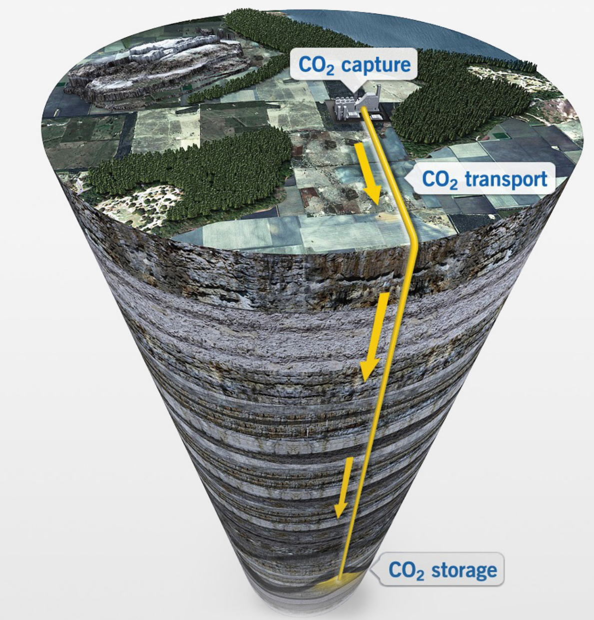
Overview

Carbon Capture Utilization and Storage (CCUS) has the potential to play a key role in reducing emissions from the hardest-to-abate industry sectors. Its ability to prevent carbon dioxide emissions at the source and permanently store the captured CO_2 in the subsurface makes it an essential part of the solution.

Storing carbon in a geological formation poses key technical challenges, including assessing geologic reservoirs, and estimating storage capacity, injectivity, containment for the permanent and safe storage of CO_2, and demonstrating the reliability and conformance of the process.

We provide the technology needed to ensure the success of carbon storage projects throughout their lifetime. Our comprehensive suite of subsurface solutions helps you:

- Accurately evaluate storage capacity
- Assess and preserve storage containment integrity
- Optimize injection capabilities
- Increase subsurface predictability
- Demonstrate regulatory conformance



Source: Global CCS Institute

Figure 1. The carbon capture and storage process.

Accurate Storage Capacity Evaluation

The reliable estimate of CO_2 storage capacity is of utmost importance in order to increase a carbon storage project's chance of economic success. Accurate characterization of the storage reservoir enables operators to de-risk the storage capacity assessment and determine if the reservoir is adequate to permanently store CO_2.

The first step in the characterization study is to collect all available data. For a depleted field or well, seismic and production data are usually available, whereas for a saline aquifer, data might be scarcer. AspenTech's Subsurface Science & Engineering suite provides geoscientists with a full range of reservoir characterization and modeling solutions that help assess heterogeneities and build geologically realistic models regardless of the amount of data available.

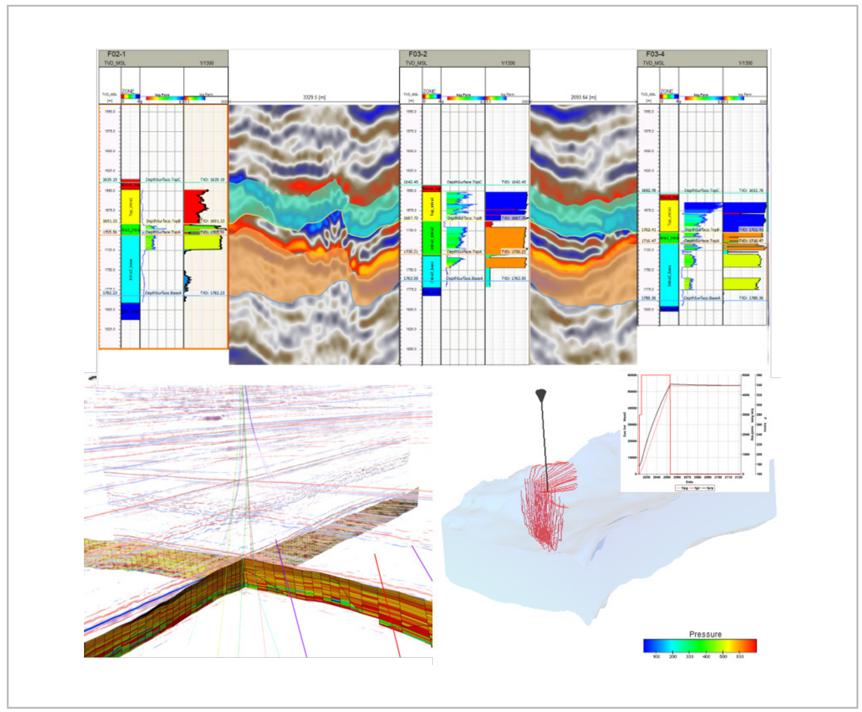


Figure 2. Static and dynamic modeling to support the evaluation of storage capacity.

The Aspen Geolog™ suite for petrophysics analysis provides solutions to perform the standard deterministic interpretation and calculation of porosity, permeability and lithology logs. The Aspen SeisEarth™ quantitative seismic interpretation solution offers the level of integration, qualification and analysis needed by geoscientists to confidently use seismic amplitudes to identify quality storage sites, clearly delineate storage reservoirs and characterize reservoir properties. The geomodeling solution provides the technology to build 3D models that deliver an accurate picture of the storage complex, capturing rock property trends and heterogeneities. The flexibility of this solution allows geoscientists to not only integrate well and seismic information when available, but also to integrate conceptual knowledge.

The geological models can be used directly for site-specific or regional storage capacity evaluation in saline aquifers and depleted oil and gas fields. The model can also be exported to a dynamic simulator for a more accurate estimation of storage capacity.

In the case of storage in a depleted field, calibrating the models to historical production data is the starting point for a reliable estimation of the porous rock volume available to store the injected CO_2. Aspen Tempest™ ENABLE technology includes a state-of-the-art history matching tool. By considering all engineering data and tolerances concurrently, ENABLE intelligently drives the simulator through hundreds of realizations and greatly accelerates the history-matching process. The ensemble of calibrated models can then be used as input to simulations, in order to forecast the CO_2 flow in the storage reservoir and provide a range of actual storage capacity.

Tempest MORE is a modern, full-field, black oil and compositional reservoir flow simulator. It enables engineers to estimate storage capacity through dynamic modeling. Optimized for running large models in parallel, engineers benefit from fast and robust simulations, including a wide range of engineering features for solving carbon injection and storage challenges and predicting CO_2 flow in the subsurface.

Storage Containment Assessment

Leakage of CO_2 along faults or wells, or due to fracturing, can undermine the value of geological carbon storage. Therefore, a reliable assessment of long-term storage containment integrity is a critical component of business decisions regarding site selection and development.

Our comprehensive subsurface science and engineering solutions provide the digital technology to help geoscientists and engineers gain confidence in their assessment of storage containment, as well as:

- Gain a good understanding of the seal quality
- Identify discontinuities in the subsurface
- Evaluate the fault sealing potential
- Assess the stress field
- Determine the maximum injection pressure
- Monitor the well integrity

With its broad range of modules, Geolog provides tools for analyzing capillary pressure and assessing the long-term integrity of the caprock unit, identifying critically-stressed fractures and fault families in the current stress field to mitigate geomechanical risks, and monitoring well integrity to eliminate potential leak pathways.

Integrated solutions for high-resolution seismic velocity model determination, seismic inversion, geologic modeling, petrophysical analysis and visualization enable the creation of a defensible pore pressure prediction model and the estimation of fracture pressure. Understanding pressure limits allows an informed injection strategy design.

The Aspen EarthStudy 360™ full-azimuth imaging solution is designed to take full advantage of rich-azimuth seismic acquisitions. EarthStudy 360 delivers unique discontinuity images and allows the recovery of stresses, fractures and geomechanical properties from full-azimuth amplitude and residual moveouts. Discontinuities can be interpreted from high-resolution depth images and integrated in a 3D model for a holistic analysis of structural trapping.

Geomodeling and flow simulation solutions can connect to geomechanical simulators to predict the behavior of the subsurface when injecting and storing carbon. All subsurface science and engineering solutions offer a superior 3D gridding technology to ensure the generation of optimal finite element meshes that fully capture current and future reservoir geomechanical behavior.

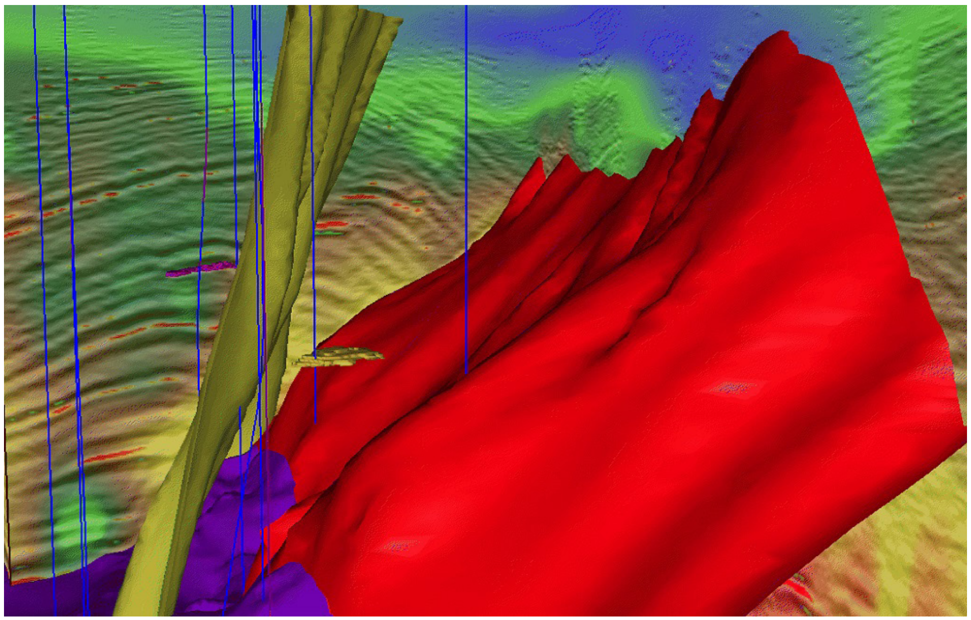


Figure 3. Predicted pore pressure co-rendered with seismic and interpretation data. The growth fault in red and the interpreted higher angle fault in yellow appear to form pressure bound.

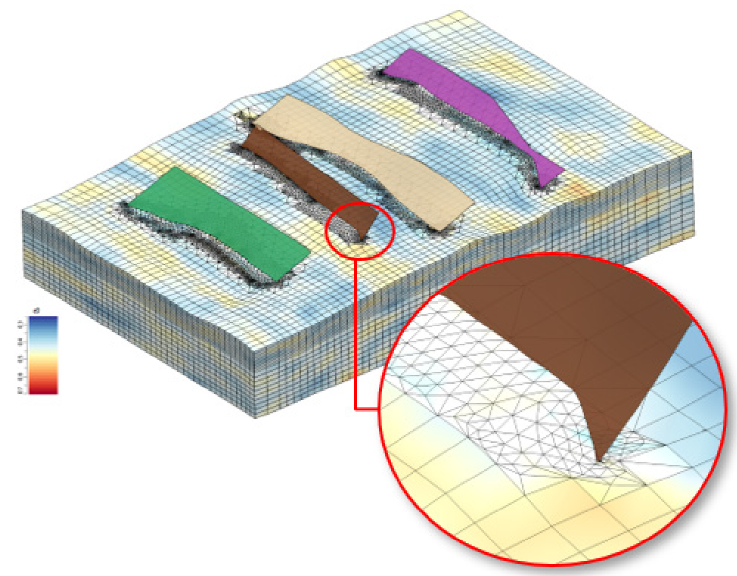


Figure 4. 3D mechanical hybrid grid including hexahedral and tetrahedral elements to perfectly capture faults and fine-scale heterogeneities impacting the storage complex geomechanical behavior.

Injectivity Optimization

Injection efficiency must be optimized in order to inject the CO_2 at a sufficient rate for a successful carbon storage project.

To ensure the efficient and safe flow of CO_2 from surface to subsurface, the flow assurance and optimization technology, Aspen METTE™, provides tools for the efficient design and operation of the injection system by performing both dynamic and steady state analysis of well and flow lines. The injection can be optimized by envisaging multiple scenarios to assess the limits of the injection system. METTE unlocks the possibility of creating a digital twin of the CO_2 injection network from topside to storage reservoir, providing a deep understanding of the entire injection system and mitigating operational risks.

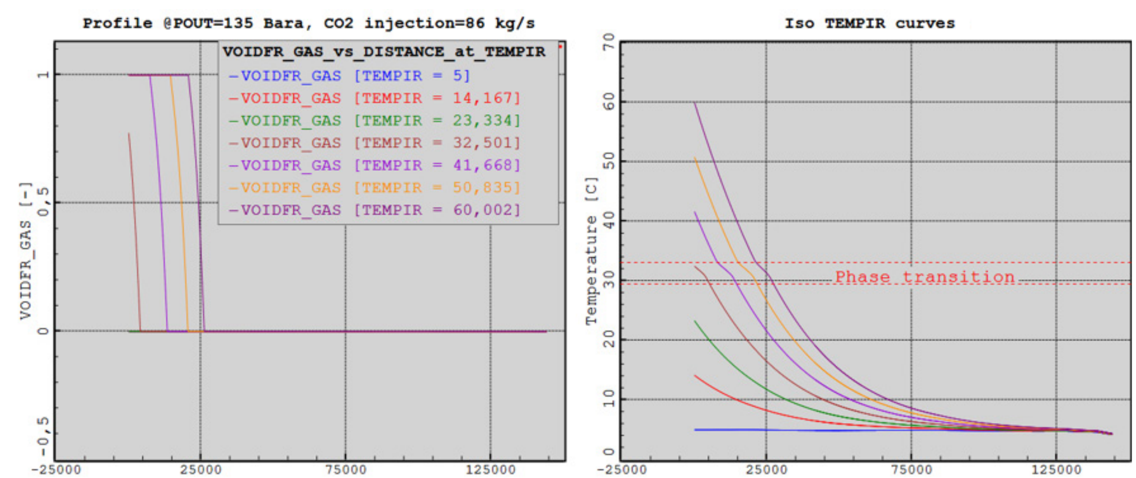


Figure 5. Flow performance calculations in METTE for a 144 km CO_2 pipeline. Left: Void fraction of CO_2. Right: Profiles for different injection temperatures.

Risk Assessment and Mitigation

Another important goal for mitigating risk and optimizing carbon storage project execution is to increase subsurface predictability. This can be achieved by performing a thorough uncertainty analysis and integration procedure. Petrophysical, geophysical, geological and engineering uncertainties lead to uncertainties in storage capacity, containment and injection performance.

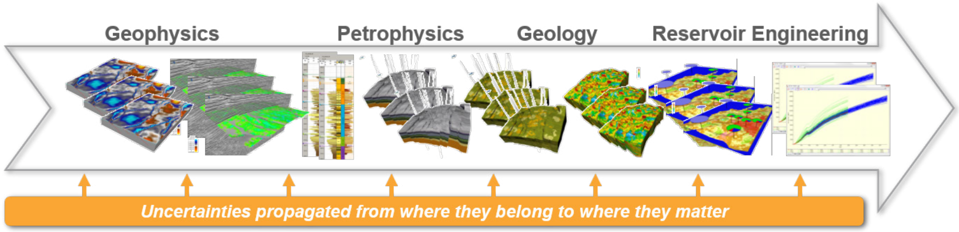


Figure 6. Big Loop workflow enables propagating uncertainties and assesses overall storage risk throughout the lifecycle of a storage complex.

All subsurface science and engineering solutions include tools to assess data and interpretation uncertainties. The uncertainty offering also includes Aspen Big Loop™, an application-agnostic ecosystem for setting up automated, reproducible and auditable workflows. These help propagate uncertainties and capture their dependencies, resulting in reliable probabilistic predictions regarding storage capacity and performance.

Monitoring CO_2 Storage Projects

The demonstration of storage process reliability and performance verification are based on tracking the movements, concentration and long-term fate of CO_2 plumes in the subsurface.

The SeisEarth interpretation suite incorporates 4D seismic analysis to check the reliability and repeatability of time-lapsed surveys. High-fidelity opacity rendering, RGB blending and volume math operations allow geoscientists to extract and understand differences in time-lapsed seismic volumes and track the movement of CO_2 in the subsurface.

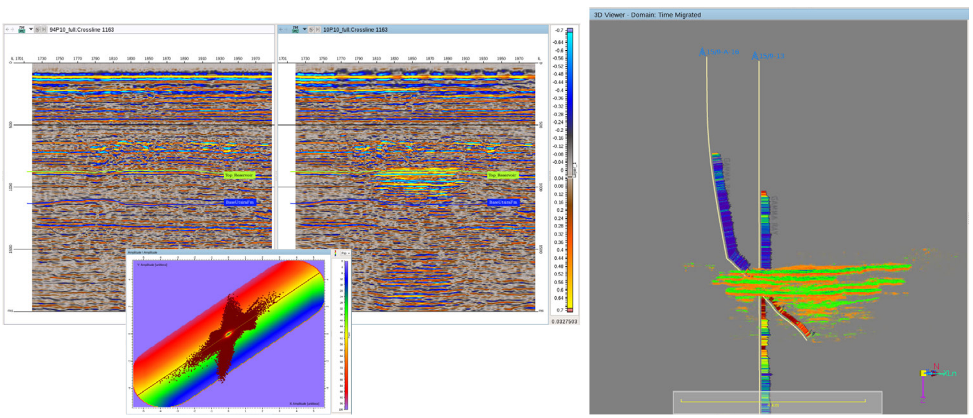


Figure 7. Sleipner 4D seismic analysis to extract and understand the differences between time-lapsed seismic. Data courtesy of Equinor.

The geomodeling solutions allow geoscientists to integrate monitoring data in automated workflows, in order to easily update models carried forward from the site selection phase. Similarly, as an evergreen workflow, Big Loop offers the ability to update an ensemble of models with the latest monitoring information while calibrating the models to any type of observed data, including 4D seismic. The result is a ready-to-analyze flow model calibrated to multiple geophysical, geologic and injection data, ensuring consistency with the underlying geology and providing a reliable prediction of the fate of the CO_2 plume in the subsurface.

Technology That Loves Complexity

About AspenTech

Aspen Technology (AspenTech) is a leading software supplier for optimizing asset performance. Our products thrive in complex, industrial environments where it is critical to optimize the asset design, operation and maintenance lifecycle. AspenTech uniquely combines decades of process modeling expertise with machine learning. Our purpose-built software platform automates knowledge work and builds sustainable competitive advantage by delivering high returns over the entire asset lifecycle. As a result, companies in capital-intensive industries can maximize uptime and push the limits of performance, running their assets safer, greener, longer and faster.

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