NATIONAL ENERGY TECHNOLOGY LABORATORY

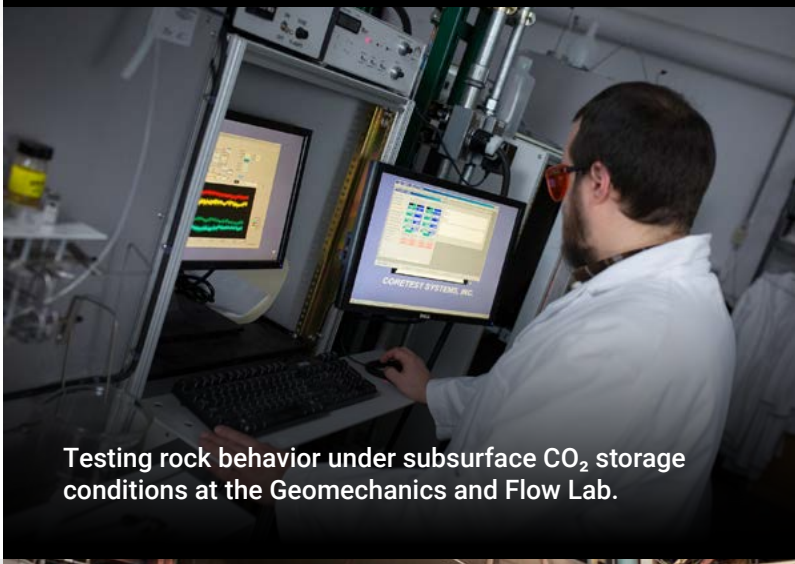
Carbon Management

NETL conducts research to advance carbon management technologies that support the continued use of U.S. hydrocarbon energy resources, enhance energy reliability and ensure economic competitiveness. NETL develops technologies and decision-making tools that improve carbon capture and enable productive use of captured carbon dioxide (CO_2), such as using CO_2 for enhanced oil recovery. NETL's capabilities in this area include materials design and testing, integrated systems modeling, techno-economic analysis and field deployment.

R&D Applications

- Carbon Conversion and Utilization
- AI-Driven Materials Development
- Storage and Transport Infrastructure Development
- Wellbore Integrity and Subsurface Infrastructure
- Point Source Carbon Capture
- Subsurface Modeling and Data Integration
- Monitoring, Verification and Accounting
- Risk Assessment and Decision Support Tools
- Techno-Economic Analysis

Developing advanced materials for efficient CO_2 capture at the Polymer Synthesis Lab.



Testing rock behavior under subsurface CO_2 storage conditions at the Geomechanics and Flow Lab.

Mobile Carbon Capture Unit at U.S. Steel Plant

NETL deployed its mobile membrane test unit to U.S. Steel's Edgar Thomson plant to evaluate advanced polymer membranes under real blast-furnace gas conditions. The membrane showed superior carbon and nitrogen selectivity and stability in humid environments, supporting industrial-scale capture options that preserve U.S. manufacturing strength.

Research Highlights

Industry-Supported User Center for Gas Separations

NETL is leading the development of an industry-supported test center for gas separation technologies. Current work includes establishing baseline techno-economic and life cycle case studies; developing protocols for measurement, reporting and verification; and modeling material performance and degradation. These efforts enable consistent evaluation of gas separation systems and provide a technical foundation for future field validation in collaboration with industry partners.

Advancing CO_2 Conversion Technologies

NETL researches thermochemical, electrochemical and biological pathways to convert CO_2 into fuels, chemicals and materials. This includes work at NETL's ReACT (Reaction Analysis and Chemical Transformation) facility, which enables evaluation of CO_2 conversion systems under realistic operating conditions. Researchers use the facility to study catalyst behavior, system integration and reactor performance with simulated and actual flue gas streams. NETL also applies techno-economic and life cycle analysis to benchmark technology viability and to assess trade-offs across pathways. This combined modeling and experimental approach allows NETL to rapidly advance practical CO_2 conversion options for industrial consideration.

National Risk Assessment Partnership (NRAP) and EDX4CTS

NETL's tools, such as EDX4CTS and NRAP support accelerating and expanding access to critical datasets and interpretive resources (EDX4CTS) and assess and manage the overall risks of geologic CO_2 storage projects (NRAP). Priorities include data identification and integration, development of geospatial tools, and visualization and communication resources. These efforts are using artificial intelligence for improved subsurface property prediction, decision support permitting tools and operational safety and optimization.

Mineralization Storage and Enhanced Minerals Recovery

Carbon dioxide mineralized into a solid form following injection represents a permanent form of CO_2 storage. NETL supports research, development and deployment to help advance mineralization storage by investing in studies to better understand the relevant geochemical and geomechanical processes, as well as to develop or adapt modeling and monitoring tools as needed. NETL is also invested in enhanced critical minerals recovery with in-situ carbon mineralization within reactive reservoirs.

Publications

- Alumbaugh, D., Gasperikova, E., Crandall, D., Commer, M., Feng, S., Harbert, W., Li, Y., Lin, Y. & Samarasinghe, S. (2023). The Kimberlina Synthetic Multiphysics Dataset for CO_2 Monitoring Investigations. Geoscience Data Journal. https://doi.org/10.1002/gdj3.191.
- Boerst, J., Pena Cabra, I., Sharma, S., Zaremsky, C., & Iyengar, A. K. (2024). Strategic Siting of Direct Air Capture Facilities in the United States. Energies, 17(15), 3755.
- Brown, M., Irish, M., Steinberg, D., Moss, T., Cherney, D. P., Shultz, T., ... & Schmitt, T. (2024). Representing carbon dioxide transport and storage network investments within power system planning models. Energies, 17(15), 3780.
- Hammack, R., Veloski, G., Sams, J. & Kohnke, C. (2023). Aeromagnetic surveys for the location of undocumented orphaned wells. The Leading Edge. 42. 798-807. 10.1190/tle42120798.1.
- Hughes, S., Zoelle, A., Woods, M., Henry, S., Homsy, S., Pidaparti, S., Kuehn, N., Hoffman, H., Forrest, K., Sheriff, A., Fout, T., Summers, W. M., Herron, S., Mantripragada, H., Cvetic, P., & Grol, E. (2023). Cost of Capturing CO2 from Industrial Sources. https://doi.org/10.2172/2007619.

NETL is a U.S. Department of Energy (DOE) national laboratory dedicated to advancing the nation's energy future by creating innovative solutions that strengthen the security, affordability and reliability of energy systems and natural resources. With laboratories in Albany, Oregon; Morgantown, West Virginia; and Pittsburgh, Pennsylvania, NETL creates advanced energy technologies that support DOE's mission while fostering collaborations that will lead to a resilient and abundant energy future for the nation.

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