Texas Department of Transportation

CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY REPORT

0-7231: Synthesis: Carbon Capture and Repurposing By-Products

Background

While decarbonization of the energy and industrial sectors has advanced in recent years, the delivery and management of transportation infrastructure has received comparatively less attention and development. The Texas Department of Transportation (TxDOT), which manages one of the nation's largest infrastructure networks, has an opportunity to build a foundation for adopting innovative, carbon-reducing technologies as they become more viable. By assessing the state of Carbon Capture, Utilization, and Storage (CCUS) technologies today, TxDOT can prepare to take advantage of future policy shifts, funding opportunities, and industry advances that will shape sustainable, resilient and cost-effective infrastructure development in the coming decades.

What the Researchers Did

The research team undertook a comprehensive, multi-method assessment of CCUS for transportation infrastructure applications. The researchers began with a technical review of CCUS methods used across industries, ranging from direct approaches such as pre-combustion, post-combustion, and direct air capture, to indirect methods such as mineralization, afforestation, and bioenergy with carbon capture and storage. Material-focused innovations were also evaluated, including advances in concrete, asphalt, aggregates, steel, and soil stabilization, along with sector-specific applications within the transportation industry. Each CCUS technology was assessed for its Technology Readiness Level (TRL) to help determine its near-term potential.

A lifecycle case study was then conducted on a major TxDOT project, the I-35 CapEx South project, to evaluate the impacts of CCUS-aligned alternatives. Select strategies were modeled and compared using a simplified life cycle assessment (LCA) methodology. In parallel to this work, a national survey of departments of transportation (DOTs) was carried out to obtain perspectives on awareness, barriers, and opportunities related to CCUS adoption.

Finally, the research team developed an implementation guideline resource, which includes a series of steps (distilled from the key literature findings and from firsthand insights obtained from the LCA study) to guide decision making for incorporating CCUS into TxDOT project planning.

What They Found

The research found that materials innovation represents the greatest near-term opportunity for cost-effective emissions reductions. In particular, concrete offers the most immediate potential through CO_2-mineralized concrete (such as through the technology matured by CarbonCure), supplementary cementitious materials like fly ash, slag, and limestone calcined clay cement, and recycled aggregates. These solutions not only lower embodied carbon, but also improve

Research Performed by:
Center for Transportation Research

Research Supervisor:
Dr. Christopher Rausch, CTR

Researchers:
Raissa Ferron
Aniruddha Baral
Caitlin Dubay
Laura Rogers
Lisa Loftus-Otway

Project Completed:
08-31-2025

durability, reduce maintenance needs, and lower lifecycle costs. Nature-based solutions also presents a highly viable CCUS option for TxDOT (in the form of right-of-way vegetation through native grass species and cactus vegetation).

The result of the nationwide survey found that most state DOTs remain in the early awareness stage with respect to CCUS. While interest is growing, implementation is hindered by high costs, regulatory uncertainty, and limited performance data. However, DOTs expressed strong interest in pilot projects, case studies, and guidance documents. This shows that TxDOT has the opportunity to take a national leadership role by validating and standardizing CCUS applications.

What This Means

The research concludes that TxDOT is well positioned to begin integrating CCUS into its planning and procurement processes. Although immediate, large-scale deployment of CCUS in transportation is not yet feasible, low-carbon concretes, supplementary cementitious materials, and advanced asphalt mixes are already ready for adoption. By piloting these solutions and updating specifications, TxDOT can align procurement practices with sustainability goals, leverage prospective future federal incentives and ensure that projects meet evolving performance standards.

Ultimately, this project provides TxDOT with the technical foundation and decision framework necessary to adopt CCUS technologies into its projects. While CCUS is still nascent in its widespread deploying, it represents an opportunity as a strategic enabler for reducing embodied carbon, enhancing resilience, lowering costs, and delivering longer-lasting infrastructure, and preparing the agency to capitalize on future opportunities. The key value of this research lies in equipping TxDOT to respond proactively, efficiently, and credibly as CCUS becomes a greater priority in transportation planning and environmental policy.

For More Information

Project Manager:
Tom Schwerdt, RTI Tom.Schwerdt@txdot.gov

Research Supervisor:
Christopher Rausch, CTR c.rausch@utexas.edu

Project Monitoring Committee Members:
Jackie Ploch, Maria Hruska, Miguel Arellano, Miles Pearson, Rose Marie Klee, Scott Ford, Vivek Thimmavajjhala

Research and Technology Implementation Division
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov
Keyword: Research

Technical reports when published are available at
https://library.ctr.utexas.edu.

This research was sponsored by the Texas Department of Transportation and the Federal Highway Administration. The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented here. The contents do not necessarily reflect the official view or policies of FHWA or TxDOT. This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. Trade names were used solely for information and not for product endorsement.