

United States Energy Association

CO₂ Pipelines: The Backbone of America's Carbon Capture Network

OVERVIEW

Carbon capture and storage is moving from promise to practice in the United States, and CO₂ pipelines are the critical link that will make this transformation possible. Today's 5,300-mile network—though modest compared to oil and gas systems—demonstrates that CO₂ transport is proven, regulated, and expandable. Analyses by DOE and Princeton confirm that a ten- to twenty-fold expansion by mid-century is both necessary and achievable to support the nation's CCUS goals. Momentum is building: PHMSA's 2025 proposed rule updates mark a generational leap in safety standards, ensuring that future pipelines will meet the highest levels of engineering integrity, geohazard resilience, and community protection. Federal incentives through 45Q, updated in the OBBBA, are creating early market demand, while industry advances in fuels, cement, and steel are signaling durable commercial interest. However, challenges remain—permitting patchworks, financing complexity, and community trust must all be managed with care. But the opportunity is clear: a national CO₂ pipeline network can become the "Interstate of Carbon," linking emitters to storage hubs, enabling industrial competitiveness, and positioning the United States as a global energy leader. With continued alignment on safety, siting, and market demand, CO₂ pipelines will not only unlock billions in investment but also deliver enduring benefits to American industry, workers, and communities.

WHY CO₂ PIPELINES MATTER

Carbon capture can provide a practical path to reducing emissions in some of the hardest-to-abate sectors—cement, steel, refining, chemicals, ethanol, and fossil power. But capture technology is only half the equation: the CO₂ must be reliably transported to geologic storage or utilization sites. Pipelines are the only mode that can handle the scale required for commercial deployment. While rail or truck may be viable for small-scale or pilot projects, they cannot move the multi-million-ton volumes needed to support broad industrial adoption.

Pipelines provide three decisive advantages:

- **Scale & Continuity:** They can move millions of tons of CO₂ every year in a continuous 24/7 flow, at far lower operating costs than any other option.
- **Geographic Reach:** Shared, hub-and-spoke systems allow many emitters—large and small—to connect to regional storage hubs. This lowers unit costs, spreads infrastructure risk, and avoids the "one-plant/one-well" trap.
- **Longevity:** Built for 30–50 years of service, pipelines become durable backbone assets that enable learning curves, commercial confidence, and system-wide cost reductions for capture and storage.

Today, the U.S. network totals only about 5,300 miles—most of it built to deliver CO₂ for enhanced oil recovery rather than long-term saline storage. Compared to nearly 3 million miles of oil and gas pipelines, CO₂ transport remains a minor system.

HOW CO₂ PIPELINES WORK AND HOW THEY DIFFER FROM OIL & GAS

DIMENSION	CO ₂ PIPELINES	OIL & GAS PIPELINES
THERMODYNAMICS & PHASE	Usually transported in <i>supercritical (dense-phase)</i> state at high pressure; can also move as gas or sub-critical liquid. Water must be removed to prevent carbonic acid corrosion in steel.	Oil and natural gas generally transported in liquid or gaseous form; corrosion risks are different and easier to manage.
ROUTING & RIGHTS-OF-WAY	Rights-of-way are assembled across private/public lands. No single federal siting authority—decisions are state-led. Federal permits may still apply (e.g., water crossings, federal lands).	Interstate natural gas pipelines are authorized by FERC, while intrastate pipelines are authorized by state agencies; oil pipelines vary but generally face clearer federal frameworks.
SAFETY REGULATION	49 CFR Part 195, administered by PHMSA, historically covered only supercritical CO ₂ . The January 2025 proposal expands it to gas-phase CO ₂ and adds new rules on emergency-planning zones, vapor-dispersion modeling, and geohazard monitoring.	PHMSA regulates, but long-established standards exist for oil and natural gas.
SITING & EMINENT DOMAIN	Controlled by states, leading to inconsistent outcomes (approvals, restrictions, or denials).	Interstate natural gas pipelines benefit from federal eminent-domain authority under the Natural Gas Act. By contrast, oil and CO ₂ pipelines fall under PHMSA’s safety jurisdiction (49 CFR Part 195) but lack federal siting or eminent-domain authority, which remains governed by individual state laws.
ENVIRONMENTAL REVIEW	National Environmental Policy Act (NEPA) applies for federal actions.	NEPA applies, .

CO₂ PIPELINE DESIGN & OPERATING BEST PRACTICES

Because CO₂ pipelines differ from oil and gas systems, regulators and developers are converging on a set of design and operating best practices that reflect lessons from previous incidents and the unique physics of CO₂.

CATEGORY	KEY PRACTICES
ENGINEERING	Dehydrate CO ₂ to prevent corrosion in carbon steel; specify pipe to arrest fractures; route lines to avoid landslides, floods, or seismic risks; use remote block valves, pressure monitoring, and plume modeling to define emergency planning zones.
OPERATIONS	Maintain emergency responder plans; run drills with local authorities; deploy robust leak-detection and automated shutdown systems; ensure clear community alerting protocols.
NETWORK DESIGN	Build hub-and-spoke, open-access pipelines to connect multiple emitters; add interconnects for redundancy; coordinate rights-of-way with states to minimize duplication and land-use conflicts.

PUBLIC ENGAGEMENT

Communicate risks and benefits in plain language; provide tangible community benefits such as air monitoring, responder gear, training programs, and local jobs.

HOW MUCH BUILD-OUT IS NEEDED?

Princeton University's *Net-Zero America* analysis projects that achieving U.S. net-zero emissions by mid-century will require between 30,000 and 90,000 miles of dedicated CO₂ pipelines, compared to roughly 5,300 miles in operation today. The analysis reaches similar conclusions across multiple net-zero pathways, each relying on a vast expansion of transport infrastructure. The message is consistent: without a continent-scale pipeline network, carbon capture cannot operate at scale. The policy takeaway is that shared regional infrastructure and open-access storage hubs are the most efficient path forward. They reduce unit transport costs, create redundancy if one storage site is delayed, and enable many smaller emitters to connect. Building these regional backbones requires coordinated development of shared pipeline corridors, compression stations, and hub-linked storage sites, ensuring that infrastructure growth keeps pace with capture deployment.

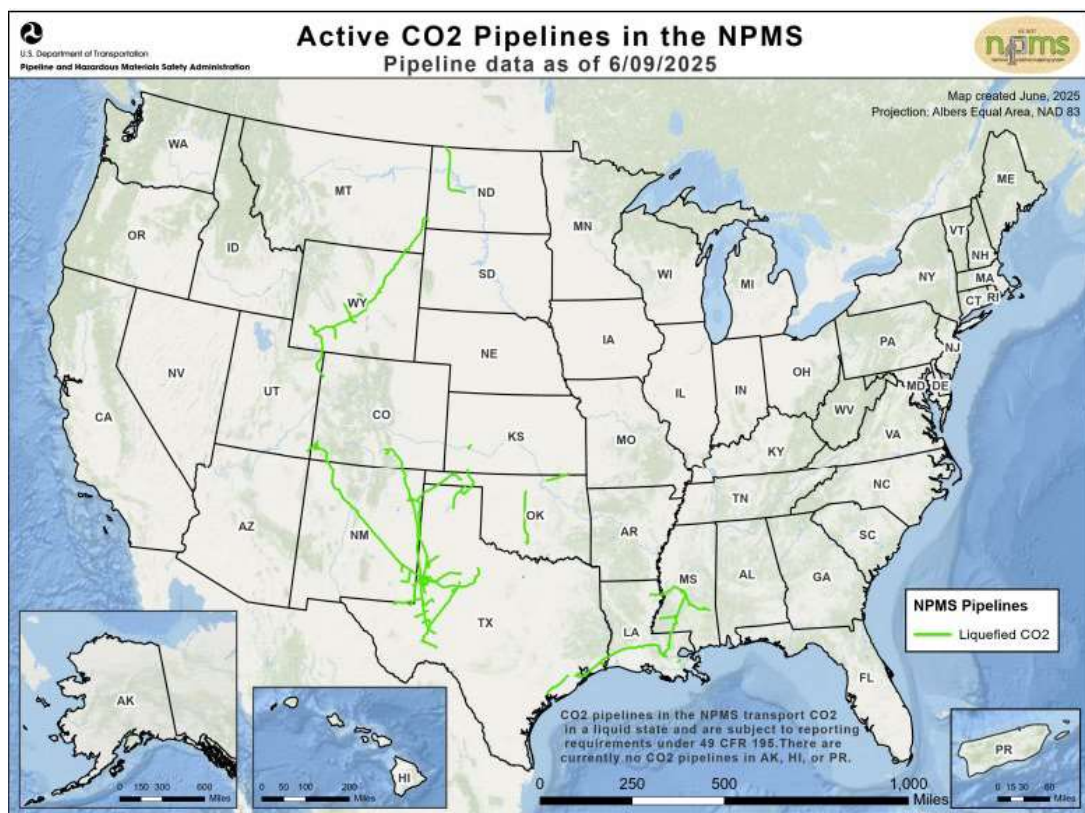


Figure 1: Active CO₂ Pipelines in the United States, U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA), National Pipeline Mapping System (NPMS), June 2025

The Interstate of Carbon

Just as the Interstate Highway System unlocked nationwide commerce by linking cities, a CO₂ pipeline network can unlock industrial growth by linking emitters to storage hubs. Today's network—about 5,300 miles, shown in green on the map—is concentrated in the Gulf Coast and Rockies, leaving much of the country without coverage. Expanding from this patchwork to a truly connected system will be key to making carbon capture practical at scale—connecting industrial corridors to storage basins the way highways connected towns to the national economy.

THE SITING REALITY: STATE AUTHORITY, LOCAL TRUST

Because states control siting, developers face different land-use rules, timelines, and eminent-domain standards in each jurisdiction. That variability has real consequences: one major Midwest project (Navigator Heartland Greenway) was canceled in 2023 amid state-level permitting headwinds; another (Summit Carbon Solutions) faces

a patchwork of approvals and rejections and continues to litigate and re-apply. The result is an uncertain investment environment where timelines and outcomes vary dramatically, discouraging some developers from pursuing multistate corridors. Local opposition—driven by landowner rights, safety concerns, and limited trust in eminent-domain processes—adds further complexity. Expect continued project-by-project adjudication unless Congress federalizes siting, an idea debated but not enacted.

The path to a durable U.S. CO₂ pipeline network is being shaped by three interlinked forces: safety lessons from real-world incidents, actionable design and engagement practices that developers can implement now, and a fast-evolving policy landscape that will determine the pace and scale of build-out. The Satartia rupture underscored why public confidence must come first; the resulting best practices highlight how projects can be engineered and governed responsibly; and the 2025–2030 policy outlook shows where federal and state rules, siting authority, and market demand are heading. Together, these themes provide a roadmap for sponsors and policymakers seeking to move carbon capture from early projects to reliable energy infrastructure.

SAFETY & PUBLIC CONFIDENCE: LESSONS FROM SATARTIA

On February 22, 2020, a landslide triggered by heavy rains ruptured Denbury's Delhi CO₂ pipeline near Satartia, Mississippi. A dense plume displaced oxygen, stalled vehicle engines, and sent dozens to seek medical treatment while approximately 200 residents were evacuated. The event became the reference point for federal scrutiny of CO₂ transport. PHMSA's investigation underscored geohazard risks, plume behavior, and the need for coordinated emergency response-issues that shaped both interim advisories and a comprehensive 2025 rulemaking proposal. As of late 2025, PHMSA's CO₂ pipeline safety rule remains at the proposal stage, with publication in the Federal Register and final adoption still pending.

Key design and operational priorities now embedded in project planning include:

- **Geohazard modeling and plume dispersion analysis** for valleys, floodplains, and other low-lying areas where CO₂ may accumulate.
- **Remote-operated valves and tighter spacing** to limit release volumes and isolate compromised segments quickly.
- **Rigorous dehydration and corrosion control** to prevent carbonic acid damage to steel pipes.
- **Community-facing safety systems** such as real-time air monitoring, emergency alerting, and responder training to ensure preparedness beyond the operator's control room.

ACTIONABLE TAKEAWAYS FOR PROJECT SPONSORS & POLICYMAKERS

ANCHOR WITH REDUNDANCY:

Design hub-and-spoke systems that connect multiple emitters to at least two independent storage sites, reducing single-point failure risk and providing operational flexibility.

BUILD FOR TRUST, NOT JUST COMPLIANCE:

Treat safety deliverables—public alerting systems, first-responder training, local air monitoring—as central project components rather than afterthoughts. Communities now expect tangible protections and benefits up front.

ENGINEER FOR CO₂'S UNIQUE PHYSICS:

Incorporate fracture-control steel specifications, water removal, and geohazard risk assessments into design standards and make them visible in permit filings and community materials.

MAP THE GOVERNANCE TERRAIN EARLY:

In state-sited regimes, prepare county coalition strategies, involve local governments and landowners as partners.

Anticipate eminent-domain restrictions and develop route alternatives to avoid costly legal battles.

LEVERAGE PRIMACY PARTNERSHIPS:

Class VI primacy illustrates how aligned state and federal authority can accelerate reviews and synchronize pipeline and storage development. Where possible, pursue primacy-state models to keep infrastructure timelines on track while maintaining rigor.

POLICY OUTLOOK (2025–2030)

FEDERAL SAFETY

PHMSA's January 2025 Notice of Proposed Rulemaking (NOPR) marks the first comprehensive CO₂-specific update to pipeline safety rules, extending standards beyond supercritical CO₂ to cover gas-phase transport. The proposal requires formal emergency-planning zones, geohazard monitoring, fracture-control specifications, and stronger integrity management. A final rule's timing is pending with phased compliance deadlines running through the late 2020s, giving operators time to retrofit existing lines and design new systems to the updated standard. As of late 2025, the rule remains at the proposal stage and has not yet been finalized for publication in the Federal Register.

SITING

Congress continues to debate federalizing interstate CO₂ pipeline siting authority, with several bills proposing to grant FERC jurisdiction similar to natural gas pipelines. None has cleared both chambers, and states remain in control for now. This preserves the patchwork: some states (e.g., North Dakota, Louisiana) actively accommodate projects, while others impose strict limits on eminent domain or local veto power. Until federal action advances, developers must build county-by-county coalitions and maintain multiple route contingencies. These proposals would place CO₂ pipeline siting and eminent-domain authority under FERC, mirroring its existing role under the Natural Gas Act, but that authority does not yet exist.

MARKET DEMAND

45Q remains a critical driver for early projects. But long-term viability will hinge on commercial contracts: enhanced oil recovery, low-carbon fuels and sustainable aviation fuel (SAF) offtake agreements, procurement by cement and steel buyers, and the ability of storage sites to deliver at scale. The restructuring of Air Products' \$4.5 billion Louisiana Clean Energy Complex in 2025 highlights the risk: even in a favorable policy environment, uncertain demand and cost escalation can stall or reshape projects.

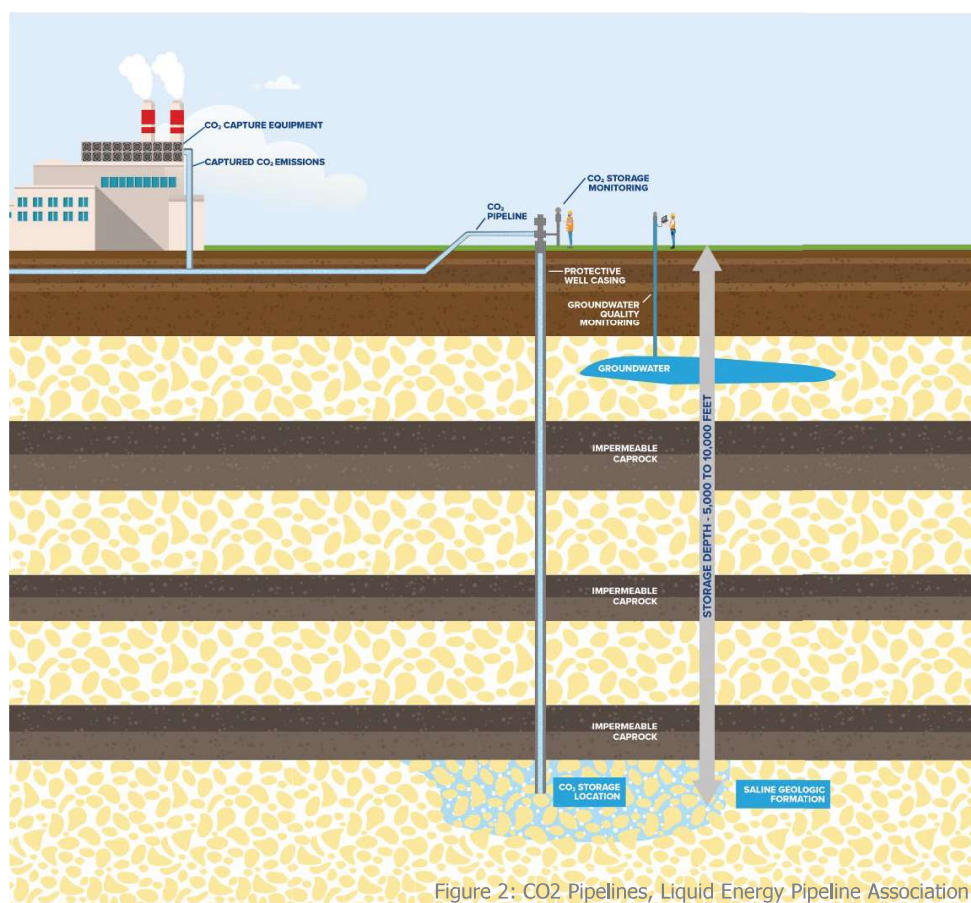


Figure 2: CO₂ Pipelines, Liquid Energy Pipeline Association

STRATEGIC IMPLICATIONS

By 2030, U.S. progress on CO₂ pipelines will be judged not just by miles in the ground but by whether regional infrastructure has emerged with redundancy across multiple storage sites, community confidence secured through real safety deliverables, and financing models proven resilient without perpetual subsidy. States with Class VI primacy offer a model of regulatory alignment, while ongoing Midwest siting battles underscore the urgency of governance reform if national build-out is to reach the tens of thousands of miles analyses show are required by mid-century.

CONCLUSION

CO₂ pipelines will determine whether carbon capture in the United States evolves from scattered demonstrations into a reliable industrial service. The current network—just over 5,300 miles—barely scratches the surface of what is required. Analyses envision a tenfold expansion by midcentury, underscoring the scale of the challenge. But success will depend on more than laying steel in the ground: it requires consistent safety standards, clear and predictable permitting pathways, strong state and community partnerships, and durable market demand from sectors such as fuels, cement, steel, and others.

Active dockets from states with Class VI primacy demonstrate the advantages of aligned policy and regulatory authority, while ongoing Midwest permitting battles highlight the risks of fragmented state oversight. These contrasting experiences show the stakes: coordinated governance can accelerate projects, while patchwork authority can stall them.

If the United States can align safety, siting, and market demand, CO₂ pipelines can become the quiet but essential backbone of a competitive energy economy. Failing to do so would not only leave billions in economic potential untapped but also risk undermining U.S. industrial competitiveness. The question is not whether to build CO₂ pipelines, but whether the nation can build them at the scale required.

SOURCE LIST

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<https://www.epa.gov/uic/federal-requirements-under-underground-injection-control-uic-program-carbon-dioxide-co2>

EPA – Primacy for Underground Injection Control Programs

<https://www.epa.gov/uic/primary-enforcement-authority-underground-injection-control-program-0>

EPA Office of Inspector General – Evaluation of EPA’s Implementation of Class VI Permitting (July 2025)

https://www.epaoig.gov/sites/default/files/reports/2025-07/_epaoig_20250728-25-e-0045_cert.pdf

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"Climate of Fear: Industrial Pollution and Environmental Racism in Louisiana's 'Cancer Alley'" (2023)

<https://www.hrw.org/report/2023/02/18/climate-fear/industrial-pollution-and-environmental-racism-louisianas-cancer-alley>**Industry / Market Developments**

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<https://www.airproducts.com/company/news-center>Navigator CO₂ Ventures – Heartland Greenway Project Cancellation (2023)<https://navigatorco2.com/news/>

Summit Carbon Solutions – Regulatory Updates & Permitting Status (2023–2025)

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<https://www.irs.gov/pub/irs-drop/n-24-29.pdf>**IMAGE SOURCE LIST****Figure 1:** U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA), National Pipeline Mapping System (NPMS) - Figure 1, Active CO₂ Pipelines in the United States (June 2025)https://www.npms.phmsa.dot.gov/Documents/NPMS_CO2_Pipelines_Map.pdf**Figure 2:** Liquid Energy Pipeline Association (LEPA) - "CO₂ Pipelines Are Part of Our Low Carbon Future," including the statistic "Today in America, There Are Already 5,000 Miles Of CO₂ Pipelines."<https://liquidenergypipelines.org/page/co2-pipelines>