CO_2 Cushion Gas Replacement in U.S. Underground Natural Gas Storage: A Facility-Level Analysis of Sequestration, Cushion Gas Recovery, and Working Gas Storage Expansion

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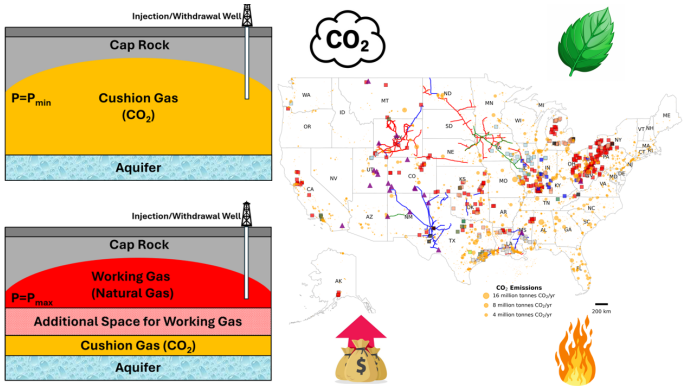

Study Summary

Underground natural gas storage (UNGS) facilities in the U.S. store ~9.2 Tscf of gas in depleted oil and gas reservoirs, saline aquifers, and solution-mined salt caverns, nearly half of which is immobilized as cushion gas. This study presents the first nationwide, site-level assessment of substituting natural gas cushion with the less expensive CO_2, sourced from anthropogenic emissions or geologic reservoirs. This novel CO_2-utilization approach both liberates stranded cushion gas and expands working gas storage space within existing infrastructure, driven by CO_2's greater compressibility under typical storage conditions. When sourced from anthropogenic emissions, the approach also contributes to climate change mitigation through CO_2 sequestration. A database of 384 U.S. UNGS facilities was analyzed to estimate site-level CO_2 utilization, recoverable cushion gas, and additional working gas storage space, and integrated it with data on CO_2 emitters, geologic CO_2 reservoirs, and CO_2 pipelines. Results indicate that full cushion replacement would require ~0.33 gigatonnes CO_2. Individual facility capacities range from nearly 2,200 tonnes to 19 million tonnes. In 96% of facilities (370 sites), CO_2 substitution increases working gas storage space by 0.3–344% (average 28%), totaling 1,113 Bscf nationwide. Depleted reservoirs and siliciclastic aquifers contribute most, with the Midwest, East, and South Central regions showing highest potential. Even a conservative 20% cushion replacement could utilize ~67 million tonnes CO_2, free ~0.9 Tscf of gas, and add ~223 Bscf of storage space for working gas. Spatial correspondence between UNGS facilities, CO_2 emitters, geologic CO_2 reservoirs, and CO_2 transportation infrastructure indicates potential opportunities for CO_2 sourcing and transport, warranting further site-specific evaluation. These results highlight a scalable strategy to enhance energy storage capacity, monetize stranded natural gas, support climate change mitigation, and create new opportunities for CO_2 utilization.

Why is this research important and why do the results matter?

- A novel CO_2-utilization approach that both liberates stranded cushion gas and expands working gas storage space within existing infrastructure
- The first nationwide, site-level assessment of substituting natural gas cushion with the less expensive CO_2, sourced from anthropogenic emissions or geologic reservoirs
- In 96% of facilities, CO_2 substitution increases working gas storage space by 0.3–344% (average 28%), totaling 1,113 Bscf nationwide

Link(s)

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