ISSUE BRIEF:
Pore Space Unitization for Geologic Sequestration of Carbon Dioxide

Prepared for Great Plains Institute by the Center for Energy Regulation and Policy Analysis, School of Energy Resources at the University of Wyoming

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1. Introduction: Pore Space Unitization

Carbon capture and storage (CCS) refers to the process of capturing carbon dioxide (CO_2) from an industrial point source, or directly from the atmosphere, and injecting it deep underground for permanent storage (aka, "geologic sequestration", where it will be securely isolated from the atmosphere). CCS is widely acknowledged as a critical technology needed for the United States and other countries to meet greenhouse gas emission reduction targets in alignment with the Paris Agreement and other climate pledges. Deploying CCS on a meaningful scale for climate change will require not only the capture of CO_2 in significant amounts, but also the availability of large, contiguous storage reservoirs in the substrata that are capable of receiving and containing the millions of metric tons (MMT) of CO_2 expected to be ready for capture over the coming decades.

"Pore space" is the term used to describe the assortment of voids, pores, and cavities within deep subsurface geologic strata which are capable of receiving injected CO_2. Suitable formations may include saline aquifers, shales, basalts, coal seams, or depleted oil or gas fields. Not all pore space is suited for CO_2 storage, however. Pore space must be sufficiently deep to allow for the natural compression of CO_2 into a supercritical state, and must have at least one or more confining zones above it, including regionally continuous caprock or seals, that preclude the possibility of leakage to the surface or into underground sources of drinking water (USDWs). While secure enough to prevent leakage, the formation must also be permeable enough to allow injected CO_2 to pass through the reservoir, and have sufficient porosity to contain large amounts of CO_2—typically up to several million metric tons. To accommodate the high volume of pore space needed to store large amounts of CO_2, commercial-scale CCS projects routinely extend tens of thousands of acres of land. By way of example, two carbon storage hubs currently in development in Wyoming will extend over 50,000 and 200,000 surface acres, respectively.[1] This acreage represents not only the footprint of pore space planned for use in storage, but also a buffer zone where pressure fronts could potentially extend into USDWs (the "area of review").[2]

Obtaining a contiguous block of pore space rights at the scale needed for commercial sequestration projects can be challenging. For any commercial storage project, the area of review likely extends over a number of tracts subject to separate ownership. To facilitate the combination of numerous parcels and interests for development as a single unit, several states have enacted legislation for the unitization of pore space. Unitization—also called "amalgamation" or "integration"—refers to

1 The Sweetwater Carbon Storage Hub (SCS Hub) in Southwest Wyoming extends over 50,000 acres of leased surface lands, which the operator believes will be sufficient to accommodate storage of over 350 million metric tons of CO2. The Eastern Wyoming Sequestration Hub (EWS Hub) in Southeast Wyoming is even larger, with more than 200,000 acres within the area of review. See WYOMING DEPT. OF ENVTL. QUALITY, CLASS VI PERMITS & APPLICATIONS, https://deq.wyoming.gov/water-quality/groundwater/uic/class-vi/.

2 40 C.F.R. § 146.84. (U.S. ENV'T PROT. AGENCY, UNDERGROUND INJECTION CONTROL (UIC) PROGRAM, CLASS VI WELL AREA OF REVIEW EVALUATION AND CORRECTIVE ACTION GUIDANCE 2 (2013) ("Therefore, the AoR encompasses the region overlying the separate-phase (e.g., supercritical, liquid, or gaseous) carbon dioxide plume and the region overlying the pressure front where fluid pressures are sufficient to force fluids into a USDW.").

the process by which separately owned adjoining parcels and interests are either compulsorily or voluntarily consolidated for development as a single coordinated storage unit. Unitization is a process drawn from the oil and gas industry, where it has long been used as a tool to coordinate development among many interest owners, helping to maximize resource recovery, reduce waste from common reservoirs, and prevent minority holdout interest owners from blocking the development. Applying the concept to geologic carbon storage, unitization similarly promotes the coordination of storage development, facilitates the efficient utilization of a common geologic reservoir, and promotes the sharing of benefits and infrastructure among many owners within a geologic storage complex.

Yet, unitization of pore space remains a relatively nascent process—one which many states with geologic storage potential have yet to statutorily authorize. To date, only thirteen states have addressed pore space unitization, including Alabama, Arkansas, California, Indiana, Kentucky, Louisiana, Nebraska, North Dakota, Mississippi, Montana, Utah, West Virginia, and Wyoming. While most state statutes vary in substance and requirements for the unitization process, most address common elements, including:

1. Designation of a regulatory agency responsible for approving unit applications;
2. Establishment of a standard for the portion of landowners affected by a proposed project from whom the project proponent must obtain consent to unit involvement;
3. Establishment of standards for the project proponent's use of good faith in unit negotiations; and
4. Establishment of standards for owner compensation.

Adjacent to statutes authorizing unitization of pore space are statutes enacted by several states that permit eminent domain for geologic storage of CO_2, also discussed below.

2. Regulatory Authority

Obtaining an order of unitization first requires that a relevant state regulatory entity be authorized to order and oversee unitization proceedings. Given that unitization for geologic carbon storage closely parallels the unitization process developed for use in the oil and gas sector, the majority of states with clear geologic storage frameworks have opted to delegate their pore space unitization programs in the agencies with oversight over oil and gas development. This may be the case even when the state's Class VI program for injection operations are overseen by other agencies, such as in Wyoming, where its Department of Environmental Quality is charged with oversight of the state's Class VI Program, while unitization is a matter for the Wyoming Oil and Gas Conservation Commission. States with unitization authority vested in their regulatory bodies for oil and gas development include Kentucky, Mississippi, Montana, Nebraska, North Dakota, Texas, Utah, and Wyoming. West Virginia, conversely, confers jurisdiction on its Department of Environmental Protection to oversee unitization proceedings.

3. Consent from Affected Landowners

Establishment of a Minimum Consent Threshold

Before authorizing pore space unitization for geologic sequestration, most states require the proponent of a given storage project to demonstrate consent from a minimum number of pore space owners. In general, states that have addressed the issue require a high percentage threshold of landowner consent before the relevant regulating agency will order unitization.

Wyoming is at the height of this threshold, requiring the regulating agency overseeing unitization in Wyoming, the Wyoming Oil and Gas Conservation Commission, to approve a unit application only if the unit application is supported by the consent of 80% of the affected pore space owners. Similarly, West Virginia requires the agreement of 75% of affected pore space owners, while Utah and Indiana have imposed a 70% consent threshold.

Importantly, determining ownership of the pore space (and therefore the identities of the parties whose consent must be acquired) is not always a straightforward task. At common law, the "ad coelum" doctrine asserts that a landowner owns everything above and beneath his or her land, inclusive of the airspace to any height, as well as the entire subsurface and all minerals contained therein all the way to the earth's core. Yet, in states with split estate acts that allow separate ownership of the minerals and the surface estates, pore space has generated unique issues. Though pore space underlies the surface, like oil and gas, it is not a mineral. Therefore, some states have sought to modify the common law to definitively characterize the pore space as part of the surface estate—thus conferring ownership to the surface owner.[3] Still, even in states where legislation establishes default rules of pore space ownership, questions are still likely to arise around the interpretation of any prior conveyances that predate comparatively recent pore space ownership laws.[4]

Good Faith Negotiation Requirements

In many states that have imposed minimum unitization consent requirements, merely meeting the minimum percentage threshold for landowner consent is still insufficient to support an order for unitization. Rather, the proponent of the storage project must also demonstrate a "good-faith" attempt to obtain consent from all affected owners—even those whose consent is not needed to meet the minimum threshold.[5] While such requirements may be onerous, potentially delaying the buildout of

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3 Jean Feriancek, Resolving Ownership of Pore Space, 26 NAT. RES. & ENV'T 3, 49 (2012) ("[O]wnership of pore space by the surface owner is considered the majority view in the United States . . . ."). See, e.g., IND. CODE § 14-39-2-3; KY. REV. STAT. ANN. § 353.800(8) (stating if the pore space has been severed from the surface estate, "the pore space owner shall include all persons reasonably known to own an interest in the pore space."); N.D. CENT. CODE § 47-31-03; 60 OKLA. STAT § 60-6; WYO. STAT. ANN. § 34-1-152.

4 Montana's pore space law appears to anticipate the possibility of ambiguity in the chain of title, providing: "[i]f the ownership of the geologic storage reservoir cannot be determined from the deeds or severance documents related to the property by reviewing statutory or common law, it is presumed that the surface owner owns the geologic storage reservoir." MONT. CODE ANN. § 82-11-180(3). See also Tara K. Righetti, Correlative Rights and Limited Common Property in the Pore Space: A Response to the Challenge of Subsurface Trespass in Carbon Capture and Sequestration, 47 ENVTL. L. REP. NEWS & ANALYSIS 10420, 10425 (2017) (discussing City of Kenai v. Cook Inlet Natural Gas Storage Alaska, LLC, 373 P.3d 473 (Alaska 2016)) ("While the precise facts that contributed to the court's determination in City of Kenai are unlikely to apply broadly to interpretation of other deeds, the case indicates the highly nuanced and specific analysis required to ascertain pore space ownership and serves as a reminder that a specific inquiry into the title and ownership of the pore space in split estates is necessary even where the law on the matter appears settled.").

5 See Kentucky Rev. Stat. § 353.806; Nebraska Revised Statute 57-1610; Utah Code Ann. 40-11-6; West Va. §22-11B-4(d)(3). The good faith negotiation requirement is consistent with model legislation proposed by the Interstate Oil and Gas Conservation Commission, which required developers to identify and negotiate in good faith with all property owners "having property interests affected by the storage facility." See INTERSTATE OIL AND GAS COMPACT COMM'N TASK FORCE ON CARBON CAPTURE AND GEOLOGIC STORAGE, STORAGE OF CARBON DIOXIDE IN GEOLOGIC STRUCTURES, A LEGAL AND REGULATORY GUIDE FOR STATES AND PROVINCES, APPENDIX I: MODEL STATUTE FOR GEOLOGIC STORAGE OF CARBON DIOXIDE, § 3(a)(2), at 33 (2007). Other states have phrased their statutes without an explicit good faith requirement, though a good faith requirement could nonetheless be construed under the statute. See Mont. Code Ann. § 82-11-206 ("All terms and conditions of the unit plan must be "just and reasonable."); Miss. Code Ann. § 53-11-13 ("The unit for the geologic sequestration facility and the agreements effectuating the unit are fair and reasonable under all of the circumstances.").

geologic storage facilities on the commercial scale needed for climate change mitigation[6], they may also help foster public trust in the unitization system (or in CCS at large) and ensure storage projects occur with the collaboration and consent of local communities.

In Wyoming, the 80% consent requirement may be lowered to 75% if the proponent of the storage project is able to demonstrate that negotiations with non-consenting landowners were conducted "for a period of at least nine (9) months prior to the filing of the [unitization] application, that the applicant has participated in the negotiations diligently and in good faith, and that the . . . approval [of 80% of affected landowners cannot be obtained]." Wyoming is the only state to allow such a reduction in the minimum consent requirement should the necessary consent be withheld even following diligent, good-faith negotiations.

Compensation for Non-Consenting Landowners

While owners of pore space who consent to unitization have the option to negotiate compensation under the terms of the contract, a different mechanism must be in place to compensate non-consenting owners. Most states with pore space unitization frameworks have adopted language requiring that compensation be paid to any non-consenting landowners at a rate that is "equitable."[7] The meaning of "equitable" may not be clear in every state, however. To this end, in 2024, the Wyoming Legislature amended Wyoming's unitization statute to clarify that the "economic benefits" to which each participating pore space owner is entitled means "the equitable proportionate share of all financial proceeds due to the pore space owners in a unit area based upon each individual pore space owner's contribution of pore space storage capacity to a unit area."[8] Like other states, Wyoming's statute contemplates that non-consenting owners shall not begin to receive compensation until such owners' proportionate share of costs are recovered by any consenting owners who paid a proportionate share of development costs up-front (if any). Utah, for instance, explicitly provides that each nonconsenting owner is entitled to receive his or her proportionate share of profits generated from the storage facility only after the consenting owners have recovered 100% of the nonconsenting owner's share of the costs of storage facility construction and maintenance, estimated costs of facility closure, costs of operation, and costs of preparing the storage facility, rights-of-way, and equipment.[9] However, unlike its counterpart in oil and gas operations—whereby interest owners participating in a unit are responsible for their proportionate costs of reservoir development (at least as a matter of accounting)—it has been observed that "the costs of [a geologic storage] operation are likely to be borne by the party or parties that secure the necessary permits. While there may be profits resulting from disposal fees, carbon credits, and other incentives, the business seems more analogous to waste-disposal operations than it is to unitization for enhanced hydrocarbon recovery."[10]

4. Eminent Domain

Finally, some states have elected to pursue eminent domain as an alternative mechanism for combining pore space interests for geologic sequestration projects. These states include Alabama, Arkansas, and Louisiana.[11] Alabama and Arkansas have taken similar approaches to their eminent domain legislation, with both states recently amending their existing statutes related to eminent domain for natural gas storage to encompass "gas" storage more broadly, now inclusive of "carbon ox-

6 See R. Lee Gresham and Owen L. Anderson, Legal and Commercial Models for Pore-Space Access and Use for Geologic CO2 Sequestration, 72 U. PITTSBURGH L. REV. 1, 32 (2011).
7 Ind. Code § 14-39-2-4.
8 Wyo. H.B. 32 (2024) (amending Wyo. Stat. Ann. § 35 11 314).
9 Utah Code Ann. 40-11-10(d)(i).
10 Gresham & Anderson, supra note 6, at 67.
11 Ala. Code § 9-17-154; Ark. Code Ann. § 15-72-602 –608.

ides."[12] The power of eminent domain extends not only to the subsurface rights useful and necessary for operating a geologic storage facility,[13] but also to surface rights that may be necessary for operations, including easements and rights-of-way.[14]

5. Conclusion

Streamlining the deployment of CCS in the United States will require states across the country to develop effective mechanisms for ensuring access to large swathes of pore space. Unitization, amalgamation, and eminent domain represent possible methods to achieve necessary access. As states without existing CCS frameworks seek to elevate their CCS readiness, they may find guidance in lessons learned from other states which have already addressed the issue—particularly with regard to commonalities of statutes in multiple states. These model state statutes should not only create a mechanism for combining pore space interests sufficient for geologic sequestration projects but should also incorporate effective means for ensuring fair negotiation, compensation, and other measures to promote public trust and acceptance of this nascent but promising technology.

Additional References:

CCUS State Legislative Tracker, Columbia Law School, https://cdrlaw.org/ccus-tracker/ (maintained by Arnold & Porter) (updated Mar. 15, 2024).

Madeleine J. Lewis, *The Space Between Us: Transboundary Challenges of Geologic Carbon Storage in Interstate and Federal Pore Space*, OIL, GAS & ENERGY LAW JOURNAL (OGEL) (2023).

Madeleine J. Lewis, Selena Gerace, *Regulatory Considerations for Carbon Dioxide Storage and Plume Migration on Interstate and Federal Lands*, UNIVERSITY OF WYOMING SCHOOL OF ENERGY RESOURCES CENTER FOR ENERGY REGULATION & POLICY ANALYSIS (September 2023).

Carson Tanner & Tara Righetti, *What Every Wyoming Landowner Should Know About Carbon Capture and Storage: A CCS Resource Guide and Frequently Asked Questions*, UNIVERSITY OF WYOMING SCHOOL OF ENERGY RESOURCES (2023).

Additional Resources:

- Pore Space Unitization Legislation Inventory developed by University of Wyoming School of Energy Resources

12 Ala. S.B. No. 36 (2022); Ark. S.B. 210 (2023).
13 See Ala. Code § 9-17-154; Ark. Code § 15-72-604; La. Stat. § 30:1108.
14 *Id.*