Carbon Capture and Storage: Models for Compensating Holdout Landowners

KEITH B. HALL*

TABLE OF CONTENTS

 Professor Keith B. Hall is the Nesser Family Chair in Energy Law at Louisiana State University's Paul M. Hebert Law Center, where he also holds the Campanile Charities Professorship in Energy Law. He serves as Director of both the John P. Laborde Energy Law Center and LSU's Mineral Law Institute.

The United Nations Intergovernmental Panel on Climate Change and numerous individual governments have concluded that largescale use of carbon capture and storage (CCS) is vital as one tool to address climate change, even as society transitions to renewable sources of energy. CCS is important because transitioning to renewable sources of energy takes time and because some industries (*e.g.*, cement making) release carbon dioxide (CO_2) without regard to the source of energy used.

But in the United States, and perhaps in other countries, CCS raises property rights issues that—if left unresolved—could complicate a ramp-up of CCS. For example, after someone "captures" CO_2 and a CCS developer injects it underground for permanent "storage," using an injection well that the developer owns on the surface of Blackacre, the CO_2 will migrate laterally. Eventually, it will enter the subsurface of neighboring tracts, such as Whiteacre. The *ad coelum* doctrine teaches that the owner of Whiteacre owns the entire subsurface beneath her land, all the way to the center of the earth. A CCS developer could offer to purchase or lease subsurface rights from her, but she might remain a "holdout" who refuses to consent to the use of her subsurface. Could the owner of Whiteacre block a CCS project by obtaining an injunction to bar injections that would cause a subsurface trespass of CO_2?

CCS projects are expensive, and investors generally will not commit money to an expensive project unless there is certainty that the project's proponents have, or at least have the ability to secure, all the property rights that they need to proceed with a project. Thus, if society is going to deploy CCS on a widespread basis, the law must prevent holdout landowners from blocking projects that may be critically important for society as a whole. This article demonstrates that existing law includes multiple models that already are used in other contexts to prevent holdouts from blocking socially useful projects, while compensating those would-be holdouts. This article reviews those various models and discusses the relative merits of each.

I. WHAT IS CARBON CAPTURE AND STORAGE?

Carbon capture and storage (CCS)[1] is the *capture* of CO_2—either directly from the atmosphere or from industrial emissions—followed by the injection of the CO_2 deep into the subsurface of the earth for permanent *storage*.[2] This process is sometimes called "carbon capture and sequestration," particularly in older discussions of CCS.[3] CCS is a subset of a broader

1. The "carbon" of the phrase "carbon capture and storage" refers to carbon dioxide.

2. EPA, *Background information about geologic sequestration*, https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-carbon-dioxide [https://perma.cc/576V-R6V5] (noting that "the process of injecting carbon dioxide" that has been "captured . . . into deep subsurface rock formations for long-term storage" is a step in "a process frequently referred to as 'carbon capture and storage' or CCS"); INT'L ENERGY AGENCY, ABOUT CCUS, (2021), https://www.iea.org/reports/about-ccus [https://perma.cc/LWZ5-MTN6] (referring to "the capture of CO2 from large point sources" or "directly from the atmosphere," and injection of the carbon dioxide "for permanent storage").

3. As recently as several years ago, the process was typically called "CO_2 sequestration," "carbon sequestration" or "carbon capture and sequestration." *See, e.g.*, Christopher J. Miller, *Carbon Capture and Sequestration in Texas: Navigating the Legal Challenges Related to Pore Space Ownership*, 6 TEX. J. OIL GAS & ENERGY L. 399 (2011). Some sources referred to "CO_2 Sequestration" or "Sequestration of Carbon Dioxide." *See, e.g.*, Owen L. Anderson, *Geologic CO_2 Sequestration: Who Owns the Pore Space?*, 9 WYO. L. REV. 97, 101 (2009); *cf.* LA. STAT. ANN. § 31:1101 (2009) (statutory scheme enacted in 2009 that referred to as the "Louisiana Geological Sequestration of Carbon Dioxide Act"). Now, however, it is more common to refer to it as "carbon capture and storage." *See, e.g.*, KY. REV. STAT. ANN. § 353.804 (statute enacted in 2021 referring to "carbon capture and storage technology" and "a carbon capture and storage project").

concept called "carbon capture and utilization."[4]

A. What Does It Mean to "Capture Carbon"?

In the context of CCS, to "capture carbon" is to separate CO_2 molecules from other types of molecules in a gaseous mixture.[5] This is done to facilitate the injection of CO_2 into the subsurface for permanent storage. The separation of CO_2 from other components in a gaseous mixture serves at least two purposes. First, the separation allows a CCS operator to minimize the amount of gas that must be injected into the surface to store a given amount of CO_2.[6] Suppose, for example, that CO_2 constituted twenty percent of a gaseous mixture. If the CCS operator injected the entire mixture into the subsurface, the operator would need to inject five molecules of gas for every molecule of CO_2 that would be stored in the subsurface.[7] This would increase the costs of the operation and, because the storage reservoir will have a finite volume,[8] would cause the storage formation into which the gas is injected to fill up sooner than if a separated stream of nearly pure CO_2 was injected. Second, in some cases, CO_2 might be mixed with other substances that an operator should seek to avoid injecting into the subsurface for permanent storage—either because the substances are valuable or because the substances are potentially harmful.[9]

---

4. DEP'T OF ENERGY, *Carbon Capture, Utilization & Storage*, https://www.energy.gov/carbon-capture-utilization-storage [https://perma.cc/XFR7-24NR] (last visited Mar. 28, 2023) ("Carbon capture, utilization and storage (CCUS), also referred to as carbon capture, utilization and sequestration, is a process that captures carbon dioxide emissions from sources like coal-fired power plants and either reuses or stores it so it will not enter the atmosphere.").

5. Federica Raganati et al., *Adsorption of Carbon Dioxide for Post-combustion Capture: A Review*, ENERGY FUELS 2021, 35, at 12846 (Aug. 5, 2021) (referring to "techniques to separate CO2 from the gas stream").

6. Bert Metz et al., *IPCC, 2005: IPCC Special Report on Carbon Dioxide Capture and Storage*, Intergovernmental Panel on Climate Change, at 25 (2005) [hereinafter *IPCC CCS Report*], https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_wholereport-1.pdf [https://perma.cc/NQ58-8PLK] (noting the purpose of carbon dioxide "capture").

7. Thus, to inject a given amount of carbon dioxide, the CCS facility's equipment and piping would need to be larger.

8. The fact that the volume of storage reservoirs is finite is reflected in regulations. *See, e.g.*, *Carbon Capture and Sequestration Protocol Under the Low Carbon Fuel Standard*, California Air Resources Board, at 40, section 2.1(a)(1) (Aug. 13, 2018), https://ww2.arb.ca.gov/sites/default/files/2020-03/CCS_Protocol_Under_LCFS_8-13-18_ada.pdf [https://perma.cc/LE55-27JP] (requiring that storage reservoir be "of sufficient volume . . . to receive the total anticipated volume of the CO_2 stream"); LA. ADMIN. CODE tit. 43 part XVII § 615(A)(1) (requiring that storage reservoir be of sufficient size "to receive the total anticipated volume of the carbon dioxide stream").

9. The injection of carbon dioxide into the subsurface for permanent storage is regulated under Part C of the Safe Drinking Water Act ("SDWA"). The SDWA is found at 42 U.S.C. §§ 300f thru 300j-27, with Part C of the SDWA (entitled "Protection of

There are various sources of the gaseous mixtures from which a CCS operator might seek to capture CO_2. It could be the post-combustion outlet (or stack) of an industrial facility that burns coal, natural gas, or some other substance to create heat. This could be a power plant that uses heat to vaporize water into steam that will turn a turbine to generate electricity, or it could be some other industrial process that operates at a high temperature.[10] Alternatively, the gaseous mixture might be the gaseous emissions from some other industrial process that, apart from any combustion that might take place, involves chemical reactions that produce CO_2. Examples include the making of ethanol,[11] steel,[12] cement,[13] and fertilizers.[14] Or, it might be

Underground Sources of Drinking Water"), being found at 42 U.S.C. §§ 300h thru 300h-9. Under federal regulations promulgated pursuant to the SDWA, wells used to inject carbon dioxide for permanent underground storage are "Class VI" wells. 40 C.F.R. § 144.6(f). Various sources can be consulted for a basic overview of the SDWA's regulation of underground injections. *See, e.g.*, Keith B. Hall, *Regulation of Hydraulic Fracturing Under the Safe Drinking Water Act*, 19 BUFF. ENV'T L.J. 1, 10–14 (2011); *see also* Bruce M. Kramer, *Federal Legislative and Administrative Regulation of Hydraulic Fracturing Operations*, 44 TEX. TECH L. REV. 837, 840–41 (2012).

10. U.S. GOV'T ACCOUNTING OFFICE, GAO-22-105274, DECARBONIZATION: STATUS, CHALLENGES, AND POLICY OPTIONS FOR CARBON CAPTURE, UTILIZATION, AND STORAGE, at 11 (2022) [hereinafter DECARBONIZATION: STATUS, CHALLENGES, AND POLICY OPTIONS FOR CCS], https://www.gao.gov/assets/gao-22-105274.pdf [https://perma.cc/PPE8-64XQ].

11. *Id*. at 10, 14.

12. *Background information about geologic sequestration*, U.S. ENV'T PROTECTION AGENCY, https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-carbon-dioxide [https://perma.cc/5NPC-FKBH] (last visited Mar. 29, 2023) (referring to steelmaking as a potential source of carbon dioxide).

13. *See, e.g*., U.S. GOV'T ACCOUNTING OFFICE, DECARBONIZATION: STATUS, CHALLENGES, AND POLICY OPTIONS FOR CARBON CAPTURE, UTILIZATION, AND STORAGE, at 4, 12 (2022), https://www.gao.gov/assets/gao-22-105274.pdf [https://perma.cc/PPE8-64XQ] ("approximately two-thirds of CO_2 emissions from cement production are *process emissions*, which are released by limestone as it is heated rather than by fuel as it burns"); *See also IPCC CCS Report*, *supra* note 6, at 3 (noting sources of carbon dioxide emissions including manufacturing cement).

14. In some cases, an industrial process might yield a gaseous waste stream that is almost all carbon dioxide from the start. In such cases, it might be practical to place the entire waste stream into storage, without undergoing the expense of "capturing" and separating the CO_2. *See, e.g*., EPA, *Documentation for Greenhouse Gas Emissions and Energy Factors Used in the Waste Reduction Model (WARM)*, ch. 1, at 20 (paginated as 1–20) (Nov. 2020), https://www.epa.gov/sites/default/files/2020-12/documents/warm_organic_materials_v15_10-29-2020.pdf [https://perma.cc/ZH3Q-G255], (noting that the manufacture of fertilizer releases carbon dioxide).

the emissions from a facility that removes CO_2 from some substance, such as natural gas,[15] in which the CO_2 is sometimes found as a contaminant.[16]

Finally, CO_2 could be captured and removed from the atmosphere.[17] This is called "direct air capture" (DAC).[18] At present, the concentration of CO_2 in the atmosphere is about 412 ppm.[19] Thus, only about 0.04% of the air consists of CO_2. This means that a large amount of air must be handled and processed to separate out a significant amount of CO_2. This can make DAC expensive,[20] but an advantage of DAC is that it can be done almost anywhere. A DAC facility need not be placed next to a source of CO_2 emissions.[21] The only locational requirement is one that can be satisfied at uncounted locations—the need for the existence of a subsurface formation into which carbon dioxide can be injected and reliably stored.[22]

---

15. DECARBONIZATION: STATUS, CHALLENGES, AND POLICY OPTIONS FOR CCS, *supra* note 10, at 18.

16. Natural gas that comes out of the ground is a mixture of valuable components (primarily methane, but also some larger hydrocarbon molecules, such as ethane, propane, and butane, which are sometime called "natural gas liquids") and other components that typically are not valuable, such as nitrogen, water vapor, hydrogen sulfide, or carbon dioxide. NORMAN J. HYNE, NONTECHNICAL GUIDE TO PETROLEUM GEOLOGY, EXPLORATION, DRILLING & PRODUCTION 9–10 (PennWell, 3rd ed. 2012); RICHARD C. SELLEY, ELEMENTS OF PETROLEUM GEOLOGY 14–21 (Academic Press 2nd ed. 1998). The natural gas stream can be made more valuable by removing those less valuable components from the mixture. James Bradbury et al., *Greenhouse Gas Emissions and Fuel Use within the Natural Gas Supply Chain-Sankey Diagram Methodology*, Dep't of Energy 8 (July 2015), https://www.energy.gov/policy/articles/fuel-use-and-greenhouse-gas-emissions-natural-gas-system-sankey-diagram-methodology [https://perma.cc/BCF5-BQZ5] (referring to the amount of carbon dioxide and other non-hydrocarbon gases removed from natural gas during gas processing); *see also* WILLIAM L. LEFFLER, NATURAL GAS LIQUIDS: A NONTECHNICAL GUIDE 2 (Pennwell 2014).

17. INT'L ENERGY AGENCY, DIRECT AIR CAPTURE, https://www.iea.org/reports/direct-air-capture [https://perma.cc/LJW4-5FFZ] (stating, "[d]irect air capture (DAC) technologies extract CO_2 directly from the atmosphere.").

18. *See, e.g.*, DECARBONIZATION: STATUS, CHALLENGES, AND POLICY OPTIONS FOR CCS, *supra* note 10.

19. Alan Buis, *The Atmosphere: Getting a Handle on Carbon Dioxide*, NASA (Oct. 9, 2019), https://climate.nasa.gov/news/2915/the-atmosphere-getting-a-handle-on-carbon-dioxide/ [https://perma.cc/XYB4-T7X9].

20. DECARBONIZATION: STATUS, CHALLENGES, AND POLICY OPTIONS FOR CCS, *supra* note 10, at 6 ("Direct air capture currently incurs higher cost than point source-capture and is more technically difficult because the atmosphere has a much lower CO_2 concentration than industrial waste gas.").

21. *Direct air capture: our technology to capture CO_2*, Climeworks, https://climeworks.com/direct-air-capture [https://perma.cc/K5CQ-YHYK] (last visited Mar. 29, 2023) (noting that "DAC plants can be located anywhere as they do not need to be attached to an emissions source.").

22. *Id*.

B. How Does Someone "Capture" Carbon?

There are various ways that CO_2 can be captured and separated from the other components of a gaseous mixture. In one type of process, the gaseous mixture is passed over a solid substance onto which the CO_2 absorbs, adhering to the surface as a film.[23] The other components of the gaseous mixture do not adsorb onto the surface, or at least they do not do so to any significant extent.[24] This allows the CO_2 molecules to be captured and separated from the compounds in the gaseous mixture. After some period of time, the flow of the gaseous mixture over the solid can be stopped. The operator of the process can then perform some operation, such as heating the solid onto which the CO_2 has adsorbed, that causes CO_2 to desorb from the surface.[25] This CO_2 can then be routed to an injection disposal well.

To allow the "capture" process to operate continuously, the operator can have two separate solid absorption units. While the first unit is going through the heating and desorption process, the operator routes the gaseous mixture through the second unit. When the desorption process is finished on the first unit, meaning that the surface of the first unit is relatively free of CO_2 and is ready to start absorbing CO_2 again, the gaseous mixture can be switched back to flowing through the first adsorption unit and the second unit can be put through the desorption process.

A second way to capture and separate CO_2 from a gaseous mixture is similar to the first, but instead of passing the gaseous mixture over a solid onto which CO_2 adsorb, the gaseous mixture is brought into contact with

23. Raganati et al., *supra* note 5, at 12846 (referring to adsorption of carbon dioxide onto a solid surface as being one means of separating carbon dioxide from other compounds in a gaseous mixture); *see also* 5 Sergio Acevedo et al., *Adsorption of CO_2 on Activated Carbons Prepared by Chemical Activation with Cupric Nitrate*, ACS OMEGA (May 1, 2020).

24. Raganati et al., *supra* note 5, at 12847.

25. Raganati et al., *supra* note 5, at 12846 (referring to regenerate the solid surface onto which the carbon dioxide by a "temperature swing" or a "pressure swing"). The surface can be heated by passing a hot gas, such as nitrogen or stream over the surface. *Id*. at 12858. The carbon dioxide would then need to be separated from the nitrogen or steam. *Id*. This additional separation step could be eliminated by using hot carbon dioxide to heat the surface, but in that case a higher temperature would be needed because of the higher partial pressure of carbon dioxide that exists when the hot gas is 100% carbon dioxide. *Id*. An alternative way to eliminate the additional separation is to use a heat exchanger of some type to heat the surface without passing a gas over it. *Id*. Then, the desorbed carbon dioxide will be the only gas present. *Id*.

a liquid into which CO_2 is absorbed, separating it from the rest of the gaseous mixture.[26] The liquid can then be heated to cause a release of the absorbed CO_2.[27]

The third main way that CO_2 can be captured and separated from a gaseous mixture is to bring the mixture in contact with a membrane through which the CO_2 will pass, but through which relatively little of the remaining portion of the mixture will pass. Thus, the CO_2 ends up on one side of the membrane, while the remainder of the gaseous mixture remains on the other.[28]

C. How is Carbon "Stored"?

The main way of storing CO_2 is to inject it into the subsurface. This is done by drilling a well deep underground to a subsurface rock formation that will serve as the "storage formation."[29] This storage formation must be porous, meaning that it has pore spaces[30] that can hold and thus store CO_2, and the formation must be permeable, meaning that a fluid can flow through the formation.[31] Typically, interconnections between pore spaces allows fluid to flow through a formation by moving from one pore space

---

26. *Id*. at 12846 (referring to "absorption" of carbon dioxide into a liquid solvent, such as an amine-based solvent); *see also* 4 LIONEL DUBOIS & DIANE THOMAS, CARBON DIOXIDE ABSORPTION INTO ACQUEOUS AMINE BASED SOLVENTS: MODELING AND ABSORPTION TESTS, ScienceDirect Energy Procedia (2011).

27. The liquid might be continuously circulated. That is, the liquid does not go through a batch process in which it first absorbs carbon dioxide, then is taken out of service for a desorption step. Instead, the liquid is circulated in a loop. In one portion of the loop, the gaseous mixture is brought in contact with the circulating liquid. In another part of the continuous loop, while the liquid is no longer in contact with the gaseous mixture, the liquid is put through the process (perhaps heating) that liberates the carbon dioxide.

28. Raganati et al., *supra* note 5, at 12846 (referring to membrane technology as one of the methods for separating carbon dioxide from the other compounds in a flue gas).

29. J.J. Dooley et al., *Carbon Dioxide Capture and Geologic Storage*, GLOBAL ENERGY TECH. STRATEGY PROGRAM 19 (2006), https://www.epa.gov/sites/default/files/2015-05/documents/act_2007_02_battelle.pdf [https://perma.cc/G3FX-JTTV] (heading referring to "CO_2 Injection into a Deep Geologic Storage Formation"); *see also id*. at 11, 17 (referring to "storage reservoirs") *and* 13 (referring to injections into "deep geologic formations").

30. "Porosity" refers to the portion of a solid's volume that consists of pore spaces. *See* HYNE, *supra* note 16, at 120.

31. Nat'l Energy Tech. Lab'y, *Carbon Storage FAQs, What are the Characteristics of a Subsurface Carbon Storage Complex*, U.S. DEP'T OF ENERGY, https://netl.doe.gov/carbon-management/carbon-storage/faqs/carbon-storage-faqs [https://perma.cc/UX3H-PGLM] (last visited Mar. 29, 2023) (referring to the need for sufficient "pore volume" in a "permeable" formation and referring to the importance of "high permeability").

to the next,[32] if the formation is sufficiently permeable.[33] The CO_2 typically will not flow back to the surface because of the existence of one or more layers of impermeable caprock above the storage formation.[34]

The storage formation can be a "depleted" oil or natural gas reservoir—meaning a formation that once contained oil or gas, but from which the oil or gas has been recovered already, leaving behind a formation with relatively empty pore spaces that once contained oil and gas.[35] Alternatively, the storage formation can be a saline formation—meaning a subsurface rock formation that is porous and permeable, and which contains salty water.[36] Many subsurface formations contain such salty water[37]—sometimes explained as the remnants of ancient seas[38]—that is not suitable for drinking water (at least not without extensive, expensive treatment).[39]

II. WHY SHOULD SOCIETY ENCOURAGE CCS?

Scientists explain that the climate is changing due to a rise in average global temperatures that is caused in large part by an increase in the

32. HYNE, *supra* note 16, at 122–23.
33. Keith B. Hall, *Hydraulic Fracturing and the Baseline Testing of Groundwater*, 48 U. RICH. L. REV. 857, 860 (2014) (referring to fluids migrating through a formation "by moving from one pore space to the next, through interconnections between the pores"). "Permeability" is a measure of the ease with which fluids can move through a rock or other solid. *See* HYNE, *supra* note 16, at 121; RICHARD C. SELLEY, ELEMENTS OF PETROLEUM GEOLOGY 250 (Academic Press 2nd ed. 1998).
34. Nat'l Energy Tech. Lab'y, *Carbon Storage FAQs, How is CO_2 Trapped in the Subsurface*, U.S. DEP'T OF ENERGY, https://netl.doe.gov/carbon-management/carbon-storage/faqs/carbon-storage-faqs [https://perma.cc/UX3H-PGLM] (last visited Mar. 29, 2023).
35. Nat'l Energy Tech. Lab'y, *Carbon Storage FAQs, What are the Different Storage Types for Geologic CO_2 Storage?*, U.S. DEP'T OF ENERGY, https://netl.doe.gov/carbon-management/carbon-storage/faqs/carbon-storage-faqs [https://perma.cc/UX3H-PGLM] (last visited Mar. 29, 2023).
36. *Id.*
37. HYNE, *supra* note 16, at 124.
38. RICHARD C. SELLEY, ELEMENTS OF PETROLEUM GEOLOGY 149 (Academic Press 2nd ed. 1998).
39. Nat'l Energy Tech. Lab'y, *Carbon Storage FAQs, What are the Different Storage Types for Geologic CO_2 Storage?*, U.S. DEP'T OF ENERGY, https://netl.doe.gov/carbon-management/carbon-storage/faqs/carbon-storage-faqs [https://perma.cc/UX3H-PGLM] (last visited Mar. 29, 2023).

concentration of CO_2 and other greenhouse gases in the atmosphere. [40] Greenhouse gases are gases that help trap heat in the atmosphere.[41] Humans are contributing to climate change by engaging in activities that result in the emission of greenhouse gases. The most common of the greenhouse gases is CO_2,[42] and the main anthropogenic source of CO_2 emissions is the combustion of fossil fuels[43] and petroleum products[44] for energy,[45] though there are some other industrial processes whose chemistry results in the production and emission of CO_2 (such as the manufacture of steel,[46]

---

40. NAT'L ENERGY TECH. LAB'Y, U.S. DEP'T OF ENERGY, CARBON STORAGE ATLAS 7 (5th ed. 2015), https://www.netl.doe.gov/sites/default/files/2018-10/ATLAS-V-2015.pdf [https://perma.cc/T9NT-VG38].

41. *Id*.

42. *See, e.g.*, *Overview of Greenhouse Gases*, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, (May 16, 2022), https://www.epa.gov/ghgemissions/overview-greenhouse-gases [https://perma.cc/23GP-V47H] (noting that carbon dioxide accounted for 79% of U.S. greenhouse gas emissions in 2020). Other greenhouse gases include methane and hydrofluorocarbons. *Id*.

43. "Fossil fuels" or "fossil energy sources" include petroleum, coal, and natural gas, and "are non-renewable resources that formed when prehistoric plants and animals died and were gradually buried by layers of rock. *See* Fossil, DEP'T OF ENERGY, https://www.energy.gov/science-innovation/energy-sources/fossil [https://perma.cc/4RKV-LX6R]. ("Over millions of years, different types of fossil fuels formed—depending on what combination of organic matter was present, how long it was buried and what temperature and pressure conditions existed as time passed.").

44. Most petroleum or "crude oil" is not used in its raw form, but is instead sent to petroleum refineries, where it is made into various petroleum products, including, gasoline, diesel, jet fuel, heating oil, and bunker fuel.

45. NAT'L ENERGY TECH. LAB'Y, CARBON STORAGE ATLAS, U.S. DEP'T OF ENERGY 7 (5th ed. 2015), https://www.netl.doe.gov/sites/default/files/2018-10/ATLAS-V-2015.pdf [https://perma.cc/T9NT-VG38]. This includes burning fossil fuels or petroleum products to generate electricity, as fuel for transportation, for space heating and heating water, and for energy for industrial processes. *See Overview of Greenhouse Gases*, *supra* note 42 ("The largest source of greenhouse gas emissions from human activities in the United States is from burning fossil fuels for electricity, heat, and transportation.").

46. INT'L ENERGY AGENCY, IRON AND STEEL TECHNOLOGY ROADMAP 26 (2020), https://www.iea.org/reports/iron-and-steel-technology-roadmap [https://perma.cc/UP9P-3RN9] (describing how, in addition providing heat, coal provides carbon that is converted to carbon monoxide, which then reacts with iron ore to make carbon dioxide and relatively pure iron); 99 Mark Peplow, *Can industry decarbonize steelmaking*, CHEMICAL & ENGINEERING NEWS (June 13, 2021), https://cen.acs.org/environment/green-chemistry/steel-hydrogen-low-co2-startups/99/i22 [https://perma.cc/5FTV-4LCD].

cement,[47] and fertilizers[48]).

These changes in climate can be disruptive both to human societies and natural environments in various ways. It is too late to avoid these disruptions altogether, but many countries have adopted a goal of preventing the average global temperature from rising more than 2 °C compared to pre-industrial times,[49] with countries at an international meeting in Paris concluding that society should pursue a more ambitious 1.5 °C goal.[50] The United Nation's Intergovernmental Panel on Climate Change has concluded that, in order to accomplish these goals, the world will need to use a multi-strategy approach that includes a substantial reduction in the use of fossil fuels, the increased generation of electricity from sources that emit no net carbon dioxide,[51] energy conservation or energy efficiency,[52] and the use of CCS to limit CO_2 emissions to the atmosphere from the use of fossil fuels and such manufacturing processes as cement making.[53]

---

47. *Overview of Greenhouse Gases*, *supra* note 42 (referring to release of carbon dioxide from chemical reactions in the manufacture of cement). By one estimate, worldwide carbon dioxide emissions from making cement were 2.9 billion tons in 2021, which is more than 7% of total global emissions of carbon dioxide. Seth Borenstein, *Cement carbon dioxide emissions quietly double in 20 years*, AP NEWS (June 22, 2022), https://apnews.com/article/climate-science-china-pollution-3d97642acbb07fca7540edca38448266 [https://perma.cc/XTV5-WJRD]; *see also* Lisa J. Hanle et al., *CO_2 Emissions Profile of the U.S. Cement Industry,* https://www3.epa.gov/ttnchie1/conference/ei13/ghg/hanle.pdf [https://perma.cc/NL32-MBJV] (estimating that carbon dioxide emissions from global cement production were 829 million tons in 2000).

48. NAT'L ENERGY TECH. LAB'Y, U.S. DEP'T OF ENERGY, CARBON STORAGE ATLAS 23 (5th ed. 2015), https://www.netl.doe.gov/sites/default/files/2018-10/ATLAS-V-2015.pdf [https://perma.cc/T9NT-VG38].

49. *Climate Action: Paris*, UNITED NATIONS, https://www.un.org/en/climatechange/paris-agreement [https://perma.cc/N9Q6-SYHL] (last visited Mar. 30, 2023).

50. *Id*.

51. These primarily include such "renewable" sources as solar, wind, traditional hydropower, tidal and wave power, and geothermal, as well as biofuels. It can also include nuclear power.

52. Because society will continue to obtain some of its energy from fossil fuels for years to come, energy conservation can help reduce the consumption of fossil fuels.

53. Jim Skea et al., *IPCC, 2022: Summary for Policymakers, in Climate Change 2022: Mitigation of Climate Change,* Intergovernmental Panel on Climate Change, 28 (2022) [hereinafter *IPCC 2022 SPM*], https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SummaryForPolicymakers.pdf [https://perma.cc/4S79-D786]. An IPCC report calls CCS "a critical mitigation option" for the cement and chemical industries. *Id*. The report also stated, "Until new chemistries are mastered, deep reduction of cement process emissions will rely on already commercialized cementitious material substitution and the availability of CCS." *Id*. at 29. Other authorities agree. For example, the International Energy Agency has stated, "CCUS will be crucial to reduce cement sector

Like the IPCC, various other authorities have also concluded that CCS is an important tool for fighting climate change. The administrations of the last several U.S. Presidents have reached that conclusion,[54] and under multiple administrations the Department of Energy has funded research on CCS.[55] The United States Congress has reached the same conclusion, as shown by its enactment of tax for CCS projects[56]— tax credits that were increased by the recently enacted Inflation Reduction Act.[57] Moreover, several states have enacted legislation to foster CCS.[58] Thus, there is widespread agreement that promoting CCS is an important public policy.[59]

CO_2 emissions." *Cement*, INT'L ENERGY AGENCY (2022), https://www.iea.org/reports/cement [https://perma.cc/QJF6-26AN]. "Accelerating innovation and deployment of innovative low-carbon technologies—particularly CCUS and alternative binding materials —will be key to reduce cement production emissions after 2030." *Id*.

The IPCC report calls CCS "a critical mitigation option" for the cement and chemical industries. *IPCC 2022 SPM*, *supra* note 53, at 28. The report also stated, "Until new chemistries are mastered, deep reduction of cement process emissions will rely on already commercialized cementitious material substitution and the availability of CCS." *Id*. at 29. Other authorities agree. For example, the International Energy Agency has stated, "CCUS will be crucial to reduce cement sector CO_2 emissions." *Cement*, IEA (2022), https://www.iea.org/reports/cement [https://perma.cc/QJF6-26AN]. "Accelerating innovation and deployment of innovative low-carbon technologies—particularly CCUS and alternative binding materials – will be key to reduce cement production emissions after 2030." *Id.* It can also involve seeking to find alternative processes for the non-energy industries, such as the manufacture of steel, which involve the emission of carbon dioxide. *See, e.g*., INT'L ENERGY AGENCY, IRON AND STEEL TECHNOLOGY ROADMAP 68–74 (2020), https://www.iea.org/reports/iron-and-steel-technology-roadmap [https://perma.cc/UP9P-3RN9].

54. PETER FOLGER, CONG. RSCH. SERV., R44902, CARBON DIOXIDE STORAGE AND SEQUESTRATION (CCS) IN THE UNITED STATES 8 (2017); *see also* Leah Douglas, *Factbox: Biden administration sees carbon capture as key tool in climate fight*, REUTERS (Feb. 7, 2022), https://www.reuters.com/business/environment/biden-administration-sees-carbon-capture-key-tool-climate-fight-2022-02-07/ [http://perma.cc/JK8A-8MBC].

55. U.S. DEP'T OF ENERGY, CARBON STORAGE RES., https://www.energy.gov/fecm/carbon-storage-research [https://perma.cc/CL2R-DDA6] (last visited Mar. 29, 2023).

56. 26 U.S.C. § 45Q.

57. Inflation Reduction Act, Pub. L. No. 117-169.

58. *See, e.g.*, ALA. CODE § 9-17-151(a)(2) (2022) ("The underground storage of carbon oxides . . . is in the public interest and welfare of this state and is for a public purpose"); LA. STAT. ANN. § 30:1102(A)(1) (2020) ("The geologic storage of carbon dioxide will benefit the citizens of the state and the state's environment by reducing greenhouse gas emissions"); MISS. CODE ANN. § 53-11-3(a) (West 2022) ("The geological sequestration of carbon dioxide will benefit the citizens of the state and the state's environment").

59. There are some critics of CCS, but a response to those critics is beyond the scope of this Article. Such a response is a subject for a different article. The purpose of this Article, which begins with three premises—promoting CCS is good public policy, holdout landowners should not be able to block CCS projects, and that holdout landowner should be compensated for the use of the subsurface pore spaces beneath their land—is to discuss potential ways to arrange the compensation that would be paid to holdout landowners.

III. WHY IS SOME STATUTORY SCHEME FOR GOVERNING SUBSURFACE PORE SPACE RIGHTS IN THE CONTEXT OF CCS OPERATIONS NECESSARY?

If widespread use of CCS is to be viable, certain basic property law concepts necessitate what this Article calls "Compensation Models"—that is, a statutory scheme[60] to give CCS operators the right to use subsurface pore spaces and to require that those CCS operators compensate persons who own land above those pore spaces.[61] These basic property law concepts include the *ad coelum* doctrine and a landowner's right to exclude others.

A. The Ad Coelum *Doctrine*

A traditional common principle known as the "*ad coelum* doctrine" provides that the person who owns a tract of land owns the entire airspace above it and the entire subsurface below it.[62] This doctrine's name comes from the Latin phrase "*cujus est solum ejus est usque ad coelum et ad inferos*," which has been translated as "for whoever owns the soil, it is theirs up to Heaven and down to Hell."[63] Both courts and commentators have supported this common law doctrine.[64] Further, Louisiana—a civil law jurisdiction—generally follows the same rule. Louisiana Civil Code article 490 states, in part, that "the ownership of a tract of land carries with it the ownership of everything that is directly above or below it."

---

60. One of the potential statutory schemes discussed below—statutory pooling—has a jurisprudential analog—equitable pooling—but that jurisprudential analog has only been adopted in one state, and that adoption was not in the context of CCS. PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS OIL AND GAS LAW § 906. To make CCS viable, more widespread adoption and certainty is needed.

61. Statutory provisions regarding the CCS operator's continuing ownership of the CO_2 injected into the subsurface might also be useful, and some states have enacted such provisions. *Cf.* LA. STAT. ANN. § 30:1104 (2020) (stating that regulator may issue orders providing for continuing ownership), *id.* at § 30:1109(A)(1) (providing for transfer of ownership of CCS facility to the state, in which case the state will become the owner of the injected carbon dioxide). However, a thorough discussion of the ownership of the injected CO_2 is beyond the scope of this Article.

62. Thrasher v. City of Atlanta, 173 S.E. 817, 825 (Ga. 1934).

63. *See* Alyce Gaines Johnson Special Trust v. El Paso E & P Co., L.P., 773 F. Supp. 2d 640, 645 (W.D. La. 2011).

64. *See, e.g.*, 2 WILLIAM BLACKSTONE, COMMENTARIES vol. 2 (1766).

B. The Landowner's Right to Exclude

Ownership is a "collection of rights to use and enjoy property."[65] Commentators and courts often analogize ownership to a bundle of sticks,[66] explaining that ownership includes several benefits, just as a bundle can include several sticks. One of the benefits associated with ownership is the right to exclude others.[67] Thus, the owner of land typically has the right to exclude others from the land.[68] The law of trespass protects this

65. *Ownership*, BLACK'S LAW DICTIONARY (6th ed. 1990); Concord Steam Corp. v. City of Concord, 519 A.2d 266, 269 (N.H. 1986). Louisiana's civil law system uses a similar definition. Louisiana Civil Code article 477 states: "Ownership is the right that confers on a person direct, immediate, and exclusive authority over a thing. The owner of a thing may use, enjoy, and dispose of it within the limits and under the conditions established by law."

66. Kaiser Aetna v. United States, 444 U.S. 164, 176 (1979).

67. Cedar Point Nursey v. Hassid, 141 S. Ct. 2063, 2072 (2021) ("the right to exclude is 'universally held to be a fundamental element of the property right,' and is 'one of the most essential sticks in the bundle of rights that are commonly characterized as property'"); Lightning Oil Co. v. Anadarko E&P Onshore, LLC, 520 S.W.3d 39, 46 (Tex. 2017) ("The owner of realty generally 'has the right to exclude all others from use of the property.'"); Sammons v. American Automobile Ass'n, 921 P.2d 1103, 1105 (Wyo.1996) ("Ownership of property implies the right of possession and control and includes the right to exclude others . . . ."); Guimont v. Clarke, 854 P.2d 1, 6 (Wash. 1993) (referring to the right to exclude others as one of the "fundamental attributes of property ownership"), *abrogated by* Yim v. City of Seattle, 451 P.3d 694 (Wash. 2021). State v. Hall, 47 P.3d 55, 57 (Or. App. 2002) ("As a general rule, one of the incidents of property ownership is the right to invite other persons to use property or, conversely, to exclude them from doing so."). 2 WILLIAM BLACKSTONE, COMMENTARIES vol. 2 (1766).

68. Trespass vindicates the right of possession, Florig v. Estate of O'Hara, 912 A.2d 318, 327 n.13 (Pa. Super. Ct. 2006); *see also* W. PAGE KEETON ET AL., PROSSER AND KEETON ON TORTS § 13, at 77 (5th ed. 1984), as opposed to vindicating ownership, but an owner of land typically has the right to possess the land. Babb v. Lee County Landfill SC, LLC, 747 S.E.2d 468, 473 (S.C. 2013); Johnson v. Paynesville Farmers Union Coop. Oil Co., 817 N.W.2d 693, 701 (Minn. 2012). If the land is under lease, the lessee might be the person who has the right to bring a trespass action. Bascom v. Dempsey, 9 N.E. 744, 744-45 (Mass. 1887) (lessor who was not in possession could not bring trespass action); Ikomoni v. Executive Asset Mgmt., LLC, 709 S.E.2d 282, 286 (Ga. Ct. App. 2011); Sumrall v. City of East St. Louis, 2013 WL 141694 *2 (S.D. Ill. 2013) (lessee can bring trespass action). If someone has established wrongful possession, the landowner may not have a claim in trespass, but if his ownership has not been lost by adverse possession he may have the right to bring an ejectment action or a petitory action to force the possessor to leave. Keeton et al., *supra*, at 77; LA. CODE CIV. PROC. art. 3651. If the owner does not possess the land, but no one else has established possession, the landowner likely has constructive possession and therefore could bring an action in trespass against an intruder. Keeton et al., *supra*, at 77.

For the purposes of this Article, the distinction between trespass being a protection of possession, as opposed to a protection of ownership, will largely be ignored. For an article discussing how the fact that trespass is a protection of possession might come into play during certain allegations of subsurface trespass, see Keith B. Hall, *Hydraulic Fracturing:*

right to exclude others by giving a landowner a cause of action in tort if some other person violates the landowner's right of exclusive possession by intruding onto the land or causing an object to do so.[69] The Restatement (Second) of Torts § 158 states a general rule that a person is liable to another person for trespass if he intentionally "enters land in the possession of the other, or causes a thing . . . to do so," without regard to "whether he thereby causes harm."[70]

When there has been a trespass, a landowner typically can obtain a money judgment to receive compensation for any actual damages that a trespasser has caused to the land during the trespass.[71] If the trespasser has not caused damage, the landowner may be able to obtain an award of nominal damages to vindicate his or her right of exclusive possession.[72] If the trespass does not harm the land, but the trespass is continuing, the landowner may be entitled to a damages award measured by the fair rental value for the trespasser's use of the property (or the diminution in value

If Fractures Cross Property Lines, is There an Actionable Trespass, 54 NAT. L.J. 361 (2014).

69. Liability for trespass is based on entering land "in the possession of the other." Restatement (Second) Torts § 158 (Am. L. Inst. 1934). Similarly, Restatement (First) of Torts § 162 states trespass liability is owed only to persons in possession of land. The Restatement provides that, to be in possession of land, a person must be in "occupancy" of it. Restatement (Second) Torts § 157 (Am. L. Inst. 1934). Restatement (First) of Torts § 157 has a similar definition of "possession." The comments explain that "occupancy" means "such acts done upon the land as manifest a claim of exclusive control of the land," and as an example, the comments note that a person's construction of an enclosure around land generally will qualify as occupancy of the entire area enclosed. Restatement (Second) Torts § 157 cmt. (a) (Am. L. Inst. 1965). Restatement (First) Torts § 157 comment (a) has a similar definition of "occupancy."

70. *See also* Team Enterprises, LLC v. Western Inv. Real Est. Tr., 647 F.3d 901, 912 (9th Cir. 2011) (under California law, a trespass is "an invasion of the interest in the exclusive possession of land."); Minch Family LLLP v. Buffalo-Red River Watershed Dist., 628 F.3d 960, 967 (8th Cir. 2010) (Minnesota law); Keeton et al., *supra* note 68, at 77.

71. Smith v. Carbide and Chemicals Corp., 226 S.W.3d 52, 55 (Ky. 2007) (actual damage for intentional trespass); Whitten v. Cox, 799 So. 3d 1, 18 (Miss. 2000) (actual damages).

72. Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 12 n.36 (Tex. 2008) (noting that, in trespass against a possessory interest, actual damages are not necessary and that nominal damages are available); Whitten v. Cox, 799 So. 3d 1, 18 (Miss. 2000) (reversing lower court's judgment failing to award any damages for trespass, rendering judgment for $10, and stating, "[i]t is a principle of universal application that every trespass gives the landowner a right to at least nominal damages.").

of the property if the trespass is permanent).[73] Further, if a trespass is continuing or repeated, the landowner may be entitled to injunctive relief to require the cessation of an ongoing trespass or to enjoy a repetition of the trespass.[74] However, the award of injunctive relief is discretionary, and a court may decline to award it if such relief would be adverse to the public interest.[75]

IV. Established Law Provides at Least Three Examples of Potential Models for Governing Pore Space Rights in the Context of CCS

Long established, existing statutory schemes authorize persons other than the landowner to use the subsurface beneath land in situations that can be analogized to CCS. Those existing statutes provide schemes that have been tested and proven workable in the situations in which they apply. Those statutory schemes provide potential models for authorizing CCS operators to use subsurface pore spaces and for requiring them to compensate holdout landowners. Three such schemes are eminent domain, oil and gas pooling, and oil and gas unitization.

A. Eminent Domain

This Article argues that the law should give prospective CCS operators the ability to acquire subsurface storage rights from holdout landowners, while requiring those operators to pay compensation to those holdout landowners. One viable scheme to accomplish this is to give prospective CCS operators the authority to use eminent domain to acquire the subsurface rights they need. Eminent domain is the power of a governmental entity to take privately owned property for a public use, subject to the obligation to pay reasonable compensation for the property taken.[76] This authority

73. *See, e.g.*, Devenish v. Phillips, 743 So.2d 492, 494 (Ala. Civ. App. 1999); Krejci v. Capriotti, 305 N.E.2d 667, 669–70 (Ill. App. Ct. 1973); *In re* Minnwest Bank Litigation Concerning Real Property, 873 N.W.2d 139, 147 (Minn. Ct. App. 2015).

74. Gilbert Wheeler, Inc. v. Enbridge Pipelines (East Texas), L.P., 449 S.W.3d 474, 478 n.1 (Tex. 2014); City of Providence v. Doe, 21 A.3d 315, 319 (R.I. 2011); Hobbs v. Mobile County, 72 So. 3d 12, 17 (Ala. 2011); S.L. Garand Co. v. Everlasting Mem'l Works, Inc., 264 A.2d 776, 778 (Vt. 1970); Donahue Schriber Realty Grp., Inc. v. Nu Creation Outreach, 181 Cal. Rptr. 3d 577, 583 (Cal. App. 2015).

75. Madison v. Ducktown Sulphur, Copper & Iron Co., 83 S.W. 658, 664 (Tenn. 1904) (damages could be awarded, but injunctive relief would be denied, in part because of economic interest in allowing continuance of challenged activity).

76. *Eminent domain*, BLACK'S LAW DICTIONARY (11th ed. 2019).

can be delegated to private entities that provide services that are in the public interest.[77]

Under this scheme, if a company acquired the regulatory permits required for constructing and operating a CCS project, the law would authorize the company to use eminent domain to acquire subsurface pore space rights from non-consenting landowners in return for paying the fair market value of the rights acquired.

Society has extensive experience with giving private companies the right to use eminent domain for certain types of projects deemed to be in the public interest. For example, pipeline companies can acquire surface and subsurface easements to construct and operate pipelines,[78] while electric utilities can use eminent domain to acquire easements for electricity transmission and distribution lines.[79]

Moreover, society already has experience with giving private companies the right to use eminent domain to acquire subsurface storage rights. Under the federal Natural Gas Act,[80] companies that obtain a "certificate of public convenience and necessity" from the Federal Energy Regulatory Commission[81] may use eminent domain to obtain subsurface storage rights.[82]

---

77. *See, e.g.*, PennEast Pipeline Co., LLC v. New Jersey, 141 S. Ct. 2244, 2252 (2021) ("the Natural Gas Act delegates the federal eminent domain power to private parties").

78. *See, e.g.*, 15 U.S.C. § 717f(h); CAL. PUB. UTIL. CODE §§ 221 & 613; LA. STAT. ANN. § 19:2 (2020); TEX. NAT. RES. CODE §§ 111.019 (common carriers have power of eminent domain) and 111.002 (stating which companies are common carriers).

79. *See, e.g.*, LA. STAT. ANN. § 19:2(7) (2020); TEX. UTIL. CODE § 181.004 (West 2021).

80. 15 U.S.C. §§ 717–717z.

81. The Natural Gas Act gives the authority to grant such certificates to the "Commission," which is defined in 15 U.S.C. § 717a as the Federal Power Commission. The Federal Energy Regulatory Commission or "FERC" is the successor to the Federal Power Commission. City of Oswego v. Federal Energy Regulatory Comm'n, 97 F.3d 1490, 1494 (D.C. Cir. 1996). This was done in the Department of Energy Organization Act. *See* Department of Energy Organization Act, Pub. L. No. 95–91, 91 Stat. 567 (1977). The codification of the provisions creating FERC is found at 42 U.S.C. § 7171, and the provision transferring the authority of the Federal Power Commission to FERC is found at 42 U.S.C. § 7172.

82. 15 U.S.C. § 717f(h). This statute grants the right to acquire rights necessary for pipelines. Although the statute does not expressly refer to the right to obtain subsurface storage rights, the statute consistently has been interpreted as authorizing the acquisition of subsurface storage rights via eminent domain. *See, e.g.*, Columbia Gas Transmission Corp. v. Exclusive Gas Storage Easement, 776 F.2d 125, 128 (6th Cir. 1985); Miss. River Transmission v. Tabor, 757 F.2d 662, 666 n.5 (5th Cir. 1985); Nat'l Fuel Gas Supply Corp. v. 138 Acres of Land, 84 F. Supp. 2d 405, 410 (W.D. N.Y. 2000); Transcont'l Gas Pipe

In addition, several states have their own statutes that authorize natural gas companies to acquire subsurface storage rights via eminent domain.[83] Further, at least two states already have enacted legislation providing that, if a company obtains regulatory approval for a proposed CCS project, the company may use eminent domain to acquire the subsurface storage rights it needs for its CCS project.[84]

For a company to acquire subsurface rights in this manner, the right to use eminent domain would have to be established by statute. Such a statute could have two salutary purposes. First, it would establish a way for a CCS operator to definitively acquire the right to use the portions of the subsurface that it will use to store CO_2. Second, because the CCS operator would be "taking" a property interest from the landowner, compensation would be required.[85] Except for jurisdictions (if any) where it is very clear that a landowner would not have a subsurface trespass claim for the migration of carbon dioxide, companies likely would willingly use eminent domain statutes to acquire pore space rights from landowners if efforts to reach a voluntary agreement for the acquisition of pore space rights fails.[86] However,

---

Line Corp. v. 118 Acres of Land, 745 F. Supp. 366, 368 (E.D. La. 1990); Columbia Gas Transmission Corp. v. Exclusive Gas Storage Easement, 705 F. Supp. 1242 (N.D. Ohio 1988); Natural Gas Pipeline Co. v. Iowa State Com. Comm'n, 369 F. Supp. 156, 158 (S.D. Iowa 1974). *Cf.* Schneidewinde v. ANR Pipeline Co., 485 U.S. 293, 295 n.1 (1988) (underground natural gas storage is part of "transportation").

In several places, companies store natural gas in the subsurface, near markets for the consumption of natural gas. During times of the year when demand for natural gas is low (and thus excess pipeline capacity is available), a company can move natural gas from the fields where it is produced to subsurface storage locations near areas where large amounts of natural gas are consumed (such as large population centers) for easy delivery during other times of the year when demand is high (such as during the winter).

83. *See*, *e.g*., ALA. CODE § 9-17-154 (2022); ARK. CODE ANN. § 15-72-604 (2022); CAL. PUB. UTIL. CODE §§ 221 & 613 (Deering 2022); COLO. REV. STAT. §§ 34-64-103 & 106 (2022); GA. CODE ANN. § 46-4-57 (2022); 220 ILL. COMP. STAT. §§ 15/1, 15/2, & 15/6 (2022); IND. CODE §§ 32-24-5-2 & 32-24-5-5 (2022); IOWA CODE § 479.24 (2022); KAN. STAT. ANN. § 55-1203 (2022); KY. REV. STAT. ANN. § 278.502 (Deering 2022); LA. STAT. ANN. § 19:2 (2020); MD. CODE ANN., ENV'T § 14-202 (Deering 2022); MICH. COMP. LAWS SERV. §§ 486.251, 486.252 & 486.254 (2022); MISS. CODE. ANN. § 53-3-159 (2022); MO. REV. STAT. § 393.430 (2022); MONT. CODE ANN. § 82-10-303 (2021); NEB. REV. STAT. ANN. § 57-603 (Deering 2022); N.M. STAT. ANN. § 70-6-7 (2022); N.Y. ENV'T CONSERV. LAW § 23-1303 (Consol. 2022); OHIO REV. CODE ANN. §§ 1571.17 & 1571.01 (Deering 2022); OR. REV. STAT. ANN. § 520.350 (West 2022); TENN. CODE ANN. § 65-28-101 (2022); TEX. NAT. RES. CODE ANN. § 91.179 (West 2022); UTAH CODE ANN. § 78B-6-501 (West 2022); WASH. REV. CODE ANN. § 80.40.030 (2022); W. VA. CODE § 54-1-2 (2022).

84. *See* ALA. CODE § 9-17-154 (2022); LA. STAT. ANN. § 30:1108 (2020).

85. U.S. CONST. amend. V.

86. Given the size of the investment needed for a CCS project, it would be foolhardy for a company to inject carbon dioxide without acquiring pore space rights, simply hoping that a court would conclude that the migration of carbon dioxide does not constitute an actionable trespass.

by statute, regulation, or conditions built into regulatory permits, a jurisdiction could require a company to acquire pore space rights.[87]

Notably, at least two states already have enacted statutes that authorize prospective CCS operators to use eminent domain to acquire pore space rights. These states are Louisiana[88] and Alabama.[89]

B. Pooling

A second viable model for allowing a CCS operator to acquire subsurface storage rights from holdout landowners, while requiring the operator to pay those landowners, is a model based on "pooling." Pooling is an oil and gas concept that attempts to address problems associated with the rule of capture, as developed in the common law within the United States. Under pooling, an operator would share revenue with the owners of the pore spaces used in a storage project, rather than purchasing a storage right via eminent domain.

1. Background

Pooling is often used in the oil and gas industry. It can be implemented by agreement, and perhaps by court order in at least one state,[90] but often pooling is implemented by a regulatory order, without the necessity of agreement by all the persons whose interests are affected.[91] A concept similar to pooling could be used to expressly authorize the CCS operator to use the subsurface of neighboring tracts, require that the CCS operator

---

87. Such a requirement would be analogous to the "surface damages statutes" that require an oil and gas company to compensate a landowner for use of the property or reasonably necessary damage to the property in circumstances in which the common law would not require compensation.

88. LA. STAT. ANN. § 31:1108 (2020).

89. ALA. CODE § 9-17-154 (2022).

90. PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS, OIL AND GAS LAW § 906 (3rd ed. 2022).

91. The description of pooling in the text above is a discussion of basic, well-established law. Readers interested in learning more about pooling can turn to any one of several sources. *See, e.g.*, BRUCE M. KRAMER & PATRICK H. MARTIN, THE LAW OF POOLING AND UNITIZATION (3rd ed. 2022) (an entire treatise devoted solely to pooling and unitization); PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS OIL AND GAS LAW § 905 (3rd ed. 2022) (probably the most prominent oil and gas law treatise, chapter 9 of this multi-volume treatise being devoted to pooling and unitization); Keith B. Hall & Hannah J. Wiseman, HYDRAULIC FRACTURING: A GUIDE TO ENVIRONMENTAL AND REAL PROPERTY ISSUES (Am. Bar Ass'n 2017).

share revenue with all landowners in the area where injected carbon dioxide actually migrates (as demonstrated by monitoring wells) or the area where the carbon dioxide is likely to migrate, and provide that the compensation will be a sharing of future revenue from CCS operations (as opposed to an upfront purchase of pore space rights, which might be the case with the use of eminent domain). Thus, instead of paying a one-time fee to acquire subsurface storage rights from a neighbor (as likely would be the case with the use of eminent domain), the CCS operator would compensate neighbors by paying a share of revenue (or profits). Because pooling is designed to address certain problems that arise from the rule of capture,[92] a clear description of pooling must begin with an explanation of the rule of capture and the problems that can arise from it.

a. Rule of Capture

In the United States, the landowner typically has the exclusive right to produce oil and gas by drilling a well on the surface or within the subsurface of his or her land.[93] Under this scheme, the owner of Blackacre becomes the owner of any minerals that he or she produces from operations on and beneath Blackacre. But in the context of oil and gas production, this corollary leads to potential disputes between neighbors.

To illustrate the potential dispute, consider a well that is located on Blackacre that produces oil or gas. The oil or gas that is produced by the well will be drained from some distance around the well (the distance will depend on a number of factors). If the well is located near enough to the boundary between Blackacre and Whiteacre (a neighboring tract), some of the oil or gas that is produced by the well on Blackacre will be drained from beneath Whiteacre. There is no way to prevent this. The owner of Whiteacre may not like it, but the common law rule—known as the "rule of capture"—provides that the owner of the well on Blackacre will own all the oil or gas produced by his well, even if some of the oil or gas was drained from beneath Whiteacre, and he does not owe any compensation

92. Hall & Wiseman, *supra* note 91, at 19–20.

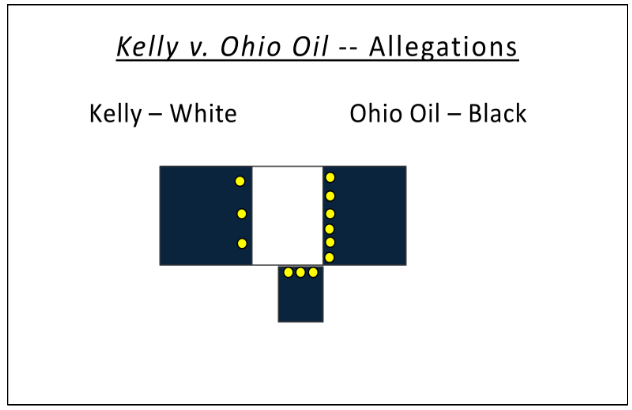
93. *See, e.g.*, LA. STAT. ANN. § 31:6 (2020); Texas Co. v. Daugherty, 176 S.W. 717, 720 (Tex. 1915). This person also could be called the "surface owner." Although the general rule is that the landowner has the exclusive right to conduct mineral operations on and beneath the land, most states allow a landowner to permanently transfer the mineral rights to someone else, while retaining the ownership of the land, thereby creating a "split estate" in which transferor owns the "surface estate" and the transferee owns the "mineral estate." Alternatively, a landowner could create a split estate by transferring the surface estate to someone else, while reserving the mineral estate. An exception to this general is Louisiana, though Louisiana law allows a landowner to grant someone else a mineral servitude or to transfer ownership of the land to someone else, while reserving a mineral servitude.

to the owner of Whiteacre.[94] Under the rule of capture, the owner of Whiteacre's sole remedy is a self-help remedy, to drill her own well in order to recover her share of the oil and gas before it is drained away to the well on Blackacre.

One of the earliest drainage disputes is *Kelly v. Ohio*, a case that was decided by the Ohio Supreme Court in 1897.[95] In this case, Kelly held the exclusive right to explore for and produce oil and gas from a tract of land in Ohio.[96] Ohio Oil Co. held oil and gas rights for tracts on the south, east, and west of the tract where Kelly owned the right to drill.[97]

Kelly alleged that the Trenton formation was a subsurface rock formation that contained oil, and that a well drilled to that formation would drain oil from an area with a radius of 200 to 250 feet around the well.[98] But despite a well being able to drain oil for that distance, Ohio Oil had drilled a series of oil wells just 25 feet from the tract where Kelly held exclusive oil and gas rights.[99] Specifically, Ohio Oil had drilled three wells just 25 feet to the west of Kelly's tract, six wells about 25 feet to the east of Kelly's tract, and three more wells about 25 feet to the south.[100] And, because these wells would drain oil for a distance of 200 to 250 feet in all directions, each of these wells was draining a significant amount of oil from beneath Kelly's tract.

94. *See, e.g.*, LA. STAT. ANN. §§ 31:8, 31:14 (2020); Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 13 (Tex. 2008).
95. Kelly v. Ohio Oil Co., 57 Ohio St. 317 (Ohio 1897).
96. Kelly held these rights under a contract with John Hastings, the owner of the tract. *Id*. at 319.
97. *Id*. at 318.
98. *Id*.
99. *Id*. at 319.
100. *Id*.



Kelly sought injunctive relief to enjoin Ohio Oil from drilling or operating any well within 200 feet of the tract where Kelly had exclusive drilling rights, but the circuit court dismissed the claim, concluding that Kelly had no claim.[101] The Ohio Supreme Court affirmed, giving three reasons for its conclusion that Kelly had no claim.[102] First, the court did not wish to tell a landowner, such as Ohio Oil, what it could do on its own property. The court stated

> The right to acquire, enjoy, and own property carries with it the right to use it as the owner pleases, so long as such use does not interfere with the legal rights of others. To drill an oil well near the line of one's land cannot interfere with the legal rights of the owner of the adjoining lands, so long as all operations are confined to the lands upon which the well is drilled.[103]

Second, it is impossible to know for sure what fraction of the oil that enters a well is oil that was drained from beneath the tract on which the well is located, versus how much of the oil was drained from beneath neighboring tracts. The court explained

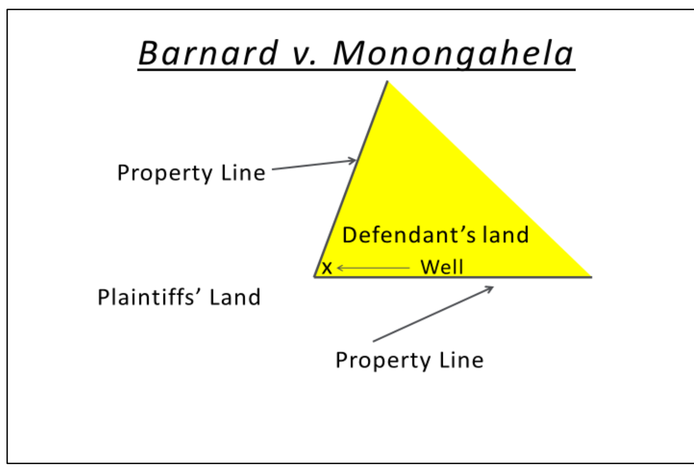
> While it is generally supposed that oil is drained into wells for a distance of several hundred feet, the matter is somewhat uncertain, and no right of sufficient weight can be founded upon such uncertain supposition to overcome the well-known right which every man has to use his property as he pleases.[104]

Finally, the court explained that there was no need for a judicial remedy because a person with oil and gas drilling rights has a self-help remedy—the right to drill their own wells on their side of the property line to "offset"

101. *Id*. at 320.
102. *Id*.at 327–30.
103. *Id*. at 327.
104. *Id*. at 328–29.

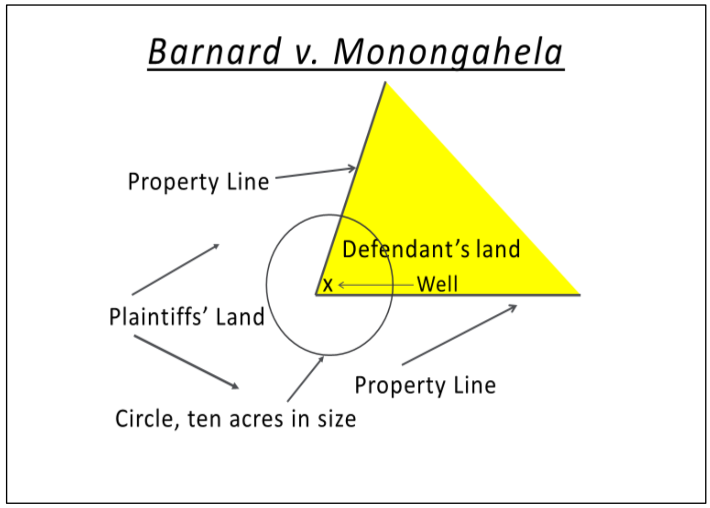
the potential for drainage to the wells drilled just across the proper the neighbor.[105] The court characterized this as "an ample and sufficient remedy for the supposed grievances complained of" by a landowner who complains about drainage.[106] Therefore, the Ohio Supreme Court affirmed the dismissal of Kelly's claim, concluding that he had failed to state a cause of action when he complained about drainage.[107]

Ten years later, in 1907, the Pennsylvania Supreme Court faced a similar issue in Barnard v. Monongahela Natural Gas Co.[108] In this case, Monongahela Natural Gas held an oil and gas lease on a tract that was adjacent to land owned by the plaintiffs, Daniel and Elizabeth Barnard.[109] Monongahela Natural Gas had drilled a well near the corner of the neighboring tract.[110] The two sides that met to form the corner created an acute angle of less than 90°, with this angle protruding into the plaintiffs' land like a wedge.[111]



105. *Id*.
106. *Id*. at 329.
107. *Id*.
108. Barnard v. Monongahela Nat. Gas Co., 65 A. 801, 801 (Pa. 1907).
109. *Id*.
110. *Id*. at 802 (noting that the defendant drilled a well effectively "in the corner").
111. *Id*. at 801 (noting that the angle of the was "about 12 degrees less than a right angle").

The plaintiffs alleged that Monongahela drilled a natural gas well only 55 feet from the corner, and that the well was only about 35 feet from the two sides of the tract.[112] The plaintiffs also asserted that a natural gas well in this area would drain a circle of land surrounding the well that was about ten acres in size.[113] Further, they alleged that, if a circle ten acres in area was drawn around that well, more than 75% of the circle's area would be located beneath the plaintiffs' land.[114]



The lower court dismissed the Barnards' claim and the Pennsylvania Supreme Court affirmed in a per curiam opinion, seeming to adopt the lower court.[115] The lower court's opinion contained three reasons that the court used to justify its holding that the Barnards had no claim. First, the court did not wish to tell a company what operations it could conduct on its own land. The court explained:

> If, then, the landowner drills on his own land at such a spot as best subserves his purposes, what is the standing of the adjoining landowner whose oil or gas may be drained by this well? He certainly ought not to be allowed to stop his neighbor from developing his own farm.[116]

112. *Id*. at 802.
113. *Id*.
114. *Id*. at 801–02.
115. Barnard v. Monongahela Nat. Gas Co., 65 A. 801 (Pa. 1907).
116. *Id*. at 802.

Second, it was uncertain how much of the natural gas produced by the defendant's well was drained from beneath the plaintiff's land. The court declared:

> An oil or gas well may draw its product from an indefinite distance and in time exhaust a large space. Exact knowledge on this subject is not at present attainable. . . . *** There is no certain way of ascertaining how much of the oil and gas that comes out of the well was when in situ under this farm and how much under that.[117]

Finally, the court said that the plaintiffs had a self-help remedy. The court said that, if a landowner did not like the fact that a neighbor was drilling wells near the property line, the plaintiff should, "go and do likewise."[118] The court acknowledged that this rule created certain problems. For example, it encouraged parties to drill an excessive number of wells.[119] The court noted, however, that the legislature had failed to provide a better rule.[120]

The rule produced by *Kelly* and *Barnard* has come to be known as the "rule of capture,"[121] or, sometimes, the "law of capture."[122] This rule is now universally accepted in states that have oil and gas jurisprudence.[123]

117. *Id*. at 802.

118. *Id*. at 802. The phrase "go and do likewise" appears to come from The Parable of the Good Samaritan in the New Testament. Luke 10:27–37. After describing the behavior of the good Samaritan, Jesus is reported to instruct the listener, "Go and do likewise." Luke 10:37.

119. *Barnard*, 65 A. at 802.

120. *Id*. at 802.

121. Hall & Wiseman, *supra* note 91, at 16. *See, e.g.*, Briggs v. Southwestern Energy Prod. Co., 224 A.3d 334, 336-7 (Pa. 2020) (citing Black's Law Dictionary 1358 (8th ed. 2004)); Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 12-13 (Tex. 2008); Nunez v. Wainoco Oil & Gas Co., 488 So. 2d 955, 960 (La. 1986); Jameson v. Ethyl Corp., 609 S.W.2d 346, 351 (Ark. 1980).

122. *See*, *e.g*., Terrence Daintith, FINDERS KEEPERS? HOW THE LAW OF CAPTURE SHAPED THE WORLD OIL INDUSTRY (RFF Press 2010); Atlantic Richfield Co. v. Tomlinson, 859 P.2d 1088, 1095 (Okla. 1993); Cowling v. Board of Oil, Gas and Mining, Dep't of Nat. Res., 830 P.2d 220, 224 (Utah 1991); Budd v. Ethyl Corp., 474 S.W.2d 411, 412 (Ark. 1971); California Co. v. Britt, 154 So. 2d 144, 147 (Miss. 1963); Elliff v. Texon Drilling, 210 S.W.2d 558, 560 (Tex. 1948).

123. *See* 1 PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS, OIL AND GAS LAW § 204 ("The so-called Rule of Capture appears equally applicable in all states . . . ."). *See, e.g.*, NCNB Texas Nat'l Bank, N.A. v. West, 631 So.2d 212, 224 (Ala. 1993) (referring to rules of capture with apparent approval); Osborn v. Arkansas Territorial Oil & Gas Co., 146 S.W. 122, 124 (Ark. 1912); Cont'l Res. of Illinois, Inc. v. Illinois Methane, LLC, 847 N.E.2d 897, 901 (Ill. Ct. App. 2006); Lanyon Zinc Co. v. Freeman, 75 P. 995, 997 (Kan. 1904); LA. STAT. ANN. § 31:14 (1975); Michigan Consol. Gas Co. v.

b. Problems Associated With the Rule of Capture

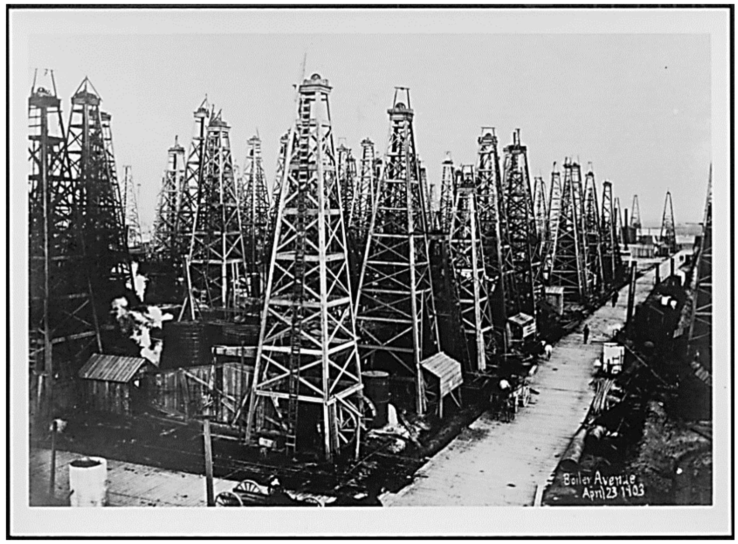
The rule of capture might have been the best rule available at the time it was developed, but the rule can create certain problems. One is that is that the rule encourages economically inefficient behavior.[124] Suppose, for example, that one oil well will efficiently drain 40 acres, and that Blackacre and Whiteacre are each 20 acres in size. Thus, a well drilled by the owner of Blackacre could drain both Blackacre and Whiteacre, but only the owner of Blackacre would benefit (assuming the neighbors do not reach a voluntary agreement to share). If the owner of Whiteacre exercises her self-help remedy by drilling her own well, there will be two wells in an area that could be efficiently drained by one well.[125] Given that drilling wells is expensive, the drilling of two wells in an area that could be efficiently drained by one well is a form of economic waste.[126]

Muzeck, 145 N.W.2d 266, 269 (Mich. Ct. App. 1966) ("This fundamental precept of oil and gas law, commonly known as the 'law of capture', is based upon the fugitive nature of oil and gas, and has been uniformly adopted throughout the United States."); California Co. v. Britt, 154 So. 2d 144, 147 (Miss. 1963); Baumgartner v. Gulf Oil Corp., 168 N.W.2d 510, 515 (Neb. 1969); Kelly v. Ohio Oil, 49 N.E. 399 (Ohio 1897); Atlantic Richfield v. Tomlinson, 859 P.2d 1088, 1094-95 (Okla. 1993); Briggs v. Southwestern Energy Prod. Co., 224 A.3d 334, 336-37 (Pa. 2020); Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 13 (Tex. 2008); Cowling v. Bd. of Oil, Gas & Mining, 830 P.2d 220, 224 (Utah 1991); Energy Dev. Corp. v. Moss, 591 S.E.2d 135, 146 (W. Va. 2003).

124. *See* Hall & Wiseman, *supra* note 91, at 16. This problem was noted as far far back as *Barnard v. Monongahela*. In that case, the court stated: "No doubt many thousands of dollars have been expended in 'protecting the lines' in oil and gas territory that would not have been expended if some rule had existed by which it could have been avoided." 65 A. at 802.

125. Nunez v. Wainoco, 488 So. 2d 955, 960 (La. 1986) (stating that rule of capture encouraged indiscriminate drilling). Indeed, it is possible that more than two wells will be drilled. The owner of Blackacre might drill two wells in a race to produce the oil before the owner of Whiteacre does. Some photographs from early in the history of the oil and gas industry show oil derricks located so close to one another that the bases are almost touching; *see Spindletop Boiler Avenue* (photograph below), *in* Tyrell Historical Library Digital Collections (Apr. 23, 1903), https://cdm16058.contentdm.oclc.org/digital/collection/p16058coll4/id/565 [https://perma.cc/LMJ3-X2WW].

126. 1 PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS, OIL AND GAS LAW § 901 (noting the "economic waste that accompanies the drilling of unnecessary wells"); Hall & Wiseman, *supra* note 91, at 16 (noting that the rule of capture "can prompt persons to drill more wells than are necessary to efficiently drain the oil or gas in an area," and "[b]ecause drilling wells is expensive, excess drilling is a form of economic waste."); *see also* Barnard v. Monongahela Nat. Gas Co., 65 A. 801, 802 (Pa. 1907) (discussing the rule of capture and noting, "No doubt many thousands of dollars have been expended 'in protecting lines' in oil and gas territory that would not have been expended if some rule had existed by which it could have been avoided.").



[127]

Second, in addition to encouraging the owners of Blackacre and Whiteacre to each drill their own well, the rule of capture also encourages the neighbors to produce oil from their respective wells as quickly as possible, in order to produce the oil before the neighbor does. But in some types of formations, producing oil too quickly can reduce total overall recovery.[128] Thus, more wells could mean less total oil production, not just less oil per well.[129]

There is a third potential problem. Although some early court decisions considered the self-help remedy of a landowner drilling her own well to be a perfectly adequate remedy,[130] some people might question the fairness of the rule of capture.[131]

127. *Spindletop Boiler Avenue* (photograph above), *in* Tyrell Historical Library Digital Collections (Apr. 23, 1903), https://cdm16058.contentdm.oclc.org/digital/collection/p16058coll4/id/565 [https://perma.cc/LMJ3-X2WW].

128. HYNE, *supra* note 16, at 437–39 (discussing "bypassing" and "coning" from overly rapid production); MARTIN S. RAYMOND & WILLIAM L. LEFFLER, OIL AND GAS PRODUCTION IN NONTECHNICAL LANGUAGE 213–14 (discussing "coning" that can be caused by rapid production).

129. Hall & Wiseman, *supra* note 91, at 16.

130. The Ohio Supreme Court called the plaintiff's self-help remedy of drilling his own wells "an ample and sufficient remedy for the supposed grievances complained of in the petition." Kelley v. Ohio Oil Co., 49 N.E. 399, 401 (Ohio 1897).

131. Hall & Wiseman, *supra* note 91, at 16.

Finally, a fourth potential problem is that the drilling of more wells than is necessary can cause drilling operations to have a larger environmental footprint. In an area that already is developed—such as on farmland—this may simply be an additional economic cost. That is, in addition to the extra drilling costs, more acreage will be taken out of production. But in an undeveloped area, drilling two wells instead of one may increase the adverse impact on wildlife habitat by increasing the footprint of development.

c. Spacing Rules as a Response to the Rule of Capture, and the Small Tract Problem

In the first half of the 1900s, states with oil and gas activity started to enact conservation statutes, create conservation agencies, and promulgate conservation regulations to prevent inefficient and wasteful development of natural resources, including oil and gas.[132] As part of the conservation movement, states began to adopt regulations that sought to prevent the problems associated with the rule of capture.[133] One type of regulation was spacing regulations, which require that oil or gas wells drilled to the same formation must be spaced some minimum distance apart. Spacing rules can be drafted as "lineal" spacing rules, that specify the distance between wells (e.g., wells must be at least 600 feet apart),[134] or as "areal" spacing rules, that limit the number of wells in a given area (e.g., one well may be drilled for every 40 acres), but both types of spacing rules achieve the same objective.

But spacing rules led to their own problem—the so-called "small tract" problem.[135] To illustrate this problem, assume that a jurisdiction uses areal spacing rules that require at least 40 acres for each oil well. Further, assume that two neighbors—Alice and Bill—each own a 20 acre-tract and that the tracts are contiguous. Collectively, they own 40 acres. If they come to an agreement to voluntarily "pool" their acreage, they will have the 40 acres needed to drill a well. But suppose they cannot reach an agreement. Does that mean that neither of them can drill a well? If so, the spacing regulation has effectively denied them one of the important benefits in the bundle of sticks that constitute land ownership. Further, this would have the effect of reducing production, which is not the goal of the conservation regulations.

---

132. *See, e.g.*, Nunez v. Wainoco Oil & Gas Co., 488 So. 2d 955, 960 (La. 1986).

133. AM. BAR ASS'N MIN. L. COMM., CONSERVATION OF OIL AND GAS: A LEGAL HISTORY, 1938; AM. BAR ASS'N, CONSERVATION OF OIL AND GAS: A LEGAL HISTORY, 1958, 3 (Robert E. Sullivan ed. 1960); *see also* AM. BAR ASS'N MIN. L. COMM., CONSERVATION OF OIL AND GAS: A LEGAL HISTORY, 1948, 348 (Blakely M. Murphy ed. 1949).

134. *See, e.g.*, LA. ADMIN. CODE tit. 43, pt. XIX § 1905.

135. Hall & Wiseman, *supra* note 91, at 19.

To avoid such results, should exceptions to the spacing rules be made so that each of them can drill their own well? If so, the purpose of the spacing rules has been undermined. Or, should the first one of them to start drilling a well be allowed to drill, while the other is denied the right to drill? Such an approach would take away an important property right from the neighbor who was not the first to start drilling. Another possible solution is to let each of them drill, but limit the allowable rate of production for each of them to half the rate at which a well could produce oil. But under this scenario, the neighbors would still collectively drill two wells where one would be sufficient to efficiently produce oil from the two tracts.

d. Pooling as a Response to the Small Tract Problem

To solve the "small tract" problem, virtually all states with oil and gas activity have authorized their oil and gas regulators to enter orders that create drilling units and require "pooling,"[136] which a prominent treatise defined as "the joining together of small or irregularly sized tracts for the purpose of having sufficient acreage to receive a well permit under the relevant state or local spacing laws and regulations"[137] (a few jurisdictions use another term, such as "integration"[138] or "communitization"[139] to refer to the process that is most commonly called "pooling").

136. *See, e.g.*, ALA. CODE § 9-17-13 (2022); ALASKA STAT. § 31.05.100(c) (2022); ARIZ. REV. STAT. § 27-505 (LexisNexis 2022); ARK. CODE ANN. § 15-72-302 (2022); COLO. REV. STAT. § 34-60-116(6) (2022); FLA. STAT. § 377.27 (2022); IDAHO CODE § 47-320 (2022); KY. REV. STAT. § 353.630 (2022); LA. STAT. ANN. §§ 30:9, 30:10 (2011); N.M. STAT. ANN. § 70-2-17(C) (LexisNexis 2023); OKLA. STAT. tit. 52 § 87.1(e) (2022); TEX. NAT. RES. CODE § 102.011 (2021); UTAH CODE ANN. § 40-6-6.5 (2022); WYO. STAT. ANN. § 30-5-109(f) (2022).

137. BRUCE M. KRAMER & PATRICK H. MARTIN, THE LAW OF POOLING AND UNITIZATION § 6.01 (3rd ed. 2014).

138. *See*, *e.g*., ARK. CODE ANN. (2022) § 15-72-304 (integration); IDAHO CODE § 47-320 (2022) (integration); 58 PA. CONS. STAT. § 408 (2022) (integration).

139. Federal code refers to the process as "communitization" when tracts subject to oil and gas leases granted by the federal government are involved. *See, e.g*., 30 U.S.C. § 226; *see also* Kysar v. Amoco Prod. Co., 93 P.3d 1272, 1277 ("Communitization is the federal equivalent of the term pooling, meaning the combination of small tracts so that sufficient acreage is controlled in order to meet the minimum well-spacing requirements.") (quoting BRUCE M. KRAMER & PATRICK H. MARTIN, THE LAW OF POOLING AND UNITIZATION § 16.01); *see also* Bennion v. ANR Prod. Co., 819 P.2d 343, 345 (Utah 1991) (referring to a "communitization agreement").

A different oil and gas treatise provides a similar definition of pooling, describing it as "the bringing together of small tracts sufficient for the granting of a well permit under applicable spacing rules."[140] The effect of pooling generally is to prohibit everyone except a particular person called the "operator" from drilling oil or gas wells within an area called "drilling unit," but to require the operator to share revenue derived from unit operations with the other owners within the drilling unit. Pooling can also have the effect of authorizing the operator to conduct activities in the subsurface (and perhaps on the surface) of any tract in the unit, as reasonably necessary to explore for and produce oil and gas.[141] Pooling can be implemented by private agreement,[142] and perhaps by court order in at least one state,[143] but it is very common for pooling to be implemented by an order of a state's oil and gas regulator.[144] The term "statutory pooling" is sometimes used to refer to pooling that is implemented by a regulator's order.[145]

Pooling works in the following way. First, the regulator will estimate, for a given oil-bearing formation, the maximum area that can be efficiently drained by one well. In this example, given that the regulator has created an areal spacing rule that requires 40 acres per well, we can presume that the regulator determined that one well can efficiently drain about 40 acres. Next, the regulator will establish drilling units, each of which is 40 acres in size, and the regulator will only allow one well to be drilled in that 40 acres. The regulator will state who can drill the well (this party will be called the "operator"), and the regulator may even approve the particular location of the well within the drilling unit. Finally, if there are separately owned tracts within a drilling unit, and the owners have not agreed to voluntarily pool their interests, the regulator will issue an order requiring the "pooling" of the separately-owned tracts in the unit.[146]

---

140. PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS OIL AND GAS LAW § 901 (3rd ed. 2022)

141. *See, e.g.*, Continental Res., Inc. v. Farrar Oil Co., 559 N.W.2d 841, 846 (N.D. 1997); Nunez v. Wainoco Oil & Gas Co., 488 So. 2d 955 (La. 1986).

142. For a general discussion of voluntary pooling, *see* PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS OIL AND GAS LAW § 902 (3rd ed. 2022).

143. Such pooling is sometimes called "equitable pooling." This type of pooling may be limited to Mississippi. For a discussion of so-called "equitable pooling," which is imposed by a court, *see* PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS OIL AND GAS LAW § 906.1 (3rd ed. 2022).

144. This is also sometimes called "forced pooling." *See, e.g.*, Railroad Comm'n v. Broussard, 755 S.W.2d 951, 952 (Tex. App. 1988).

145. *See, e.g.*, *Bennion*, 819 P.2d at 345.

146. In some jurisdictions, such as Louisiana, the same order that establishes a drilling unit will also require the pooling of separately owned interests within the unit. In other jurisdictions, it is common for the regulator to issue orders that establish drilling units, but which do not require pooling. Later, the regulator will issue orders that require the pooling

2. *Sharing of Revenue and Costs Under Pooling*

Pooling orders require the owners of mineral interests in the unit to share the revenue from unit operations, as well as the costs of those operations.[147] The formula sharing of revenue and costs depends on whether all the owners "participate" in the costs of drilling by paying their share of drilling costs.

a. *Sharing of Costs and Revenue When all Owners "Participate" in Drilling*

Under the typical pooling order, a portion of the revenue from a unit well, along with an equivalent portion of the costs of drilling and operating the well, will be allocated to each tract in the unit.[148] A representative pooling statute requires that pooling orders allocate to each owner of a tract in the unit "his just and equitable share of the oil and gas in the pool."[149] Pooling statutes do not specify how a tract owner's "just and equitable share" should be determined, but in practice the allocation is almost always done on a surface acreage basis.[150] Thus, if a particular tract includes ten percent of the area in a drilling unit, ten percent of costs and ten percent of revenue from the unit will be allocated to the tract. If all owners "participate" by timely paying their allocated share of costs, then each owner will be entitled to its allocated share of revenue.

---

of any separately-owned interests in the previously-established units. *See, e.g.*, LA. STAT. ANN. § 30:10 (2014).

Some persons have challenged pooling statutes, asserting that they are unconstitutional, but courts have rejected those challenges. *See, e.g.*, Hunter v. McHugh, 11 So. 2d 495, 498 (La. 1942).

147. *See, e.g*., LA. STAT. ANN. § 30:10 (2014).

148. *See* PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS OIL AND GAS LAW § 902 (3rd ed. 2022); *see also* Hall & Wiseman, *supra* note 91, at 20.

149. *See, e.g.*, LA. STAT. ANN. § 30:10(A)(1)(a) (2020) ("just and equitable share"); ALASKA STAT. ANN. § 31.05.100 ("just and equitable share"). Some jurisdictions use a slightly different phrase, substituting "fair" for "equitable" and stating that a pooling order should allow each tract owner to recover "his just and equitable share." *See* N.M. STAT. ANN. § 70-2-17(C) (pooling orders should allow each owner to recover "his just and fair share"); 52 OKLA. STAT. ANN. § 87.1(e) ("just and fair share").

150. *See* PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS OIL AND GAS LAW § 902 (3rd ed. 2022); *see also* Hall & Wiseman, *supra* note 91, at 20.

b. Sharing of Costs and Revenue When an Owner Does not Participate

No state forces the owner of a mineral interest in a drilling unit to pay a share of drilling costs out-of-pocket. Indeed, it is common that one or more owners will fail to "participate"—that is, they do not timely pay their tract's allocated share of costs. Such a failure affects a tract owner's right to share in the revenue from unit operations, with the effect depending on the jurisdiction. Different jurisdictions take one of three main approaches or a hybrid of the three. The three main approaches are sometimes called the free-ride approach, the risk-charge approach, and the surrender-of-working-interest approach.[151]

1. The "Free-Ride" Approach

The "free-ride" approach is the simplest, but least common approach that states take when the mineral owner[152] of a tract in a drilling unit does not participate in well costs. Under this approach, the non-participating mineral owner has no liability for the portion of costs allocated to his or her tract.[153] On the other hand, this owner will not be entitled to receive his or her tract's allocated share of revenue until the total revenue from the well is sufficient to pay the well's costs. This point in time is sometimes called "payout." Until payout, the participating owners keep the share of revenue that would otherwise be allocated to the tract where the nonparticipating mineral owner has rights.

---

151. Several sources discuss these three main approaches. *See, e.g.*, BRUCE M. KRAMER & PATRICK H. MARTIN, THE LAW OF POOLING AND UNITIZATION §12.02 (3rd ed. 2022); PATRICK MARTIN & BRUCE M. KRAMER, 6 WILLIAMS & MEYERS OIL AND GAS LAW § 944; Keith B. Hall, *Single Well Spacing and Pooling: State Spacing and Jurisdiction Over Conservation*, ROCKY MTN. MIN. L. FDN. SPECIAL INST.—ADVANCED LANDMAN'S INST. 12-7 (2019); Patrick H. Martin, *Unleased and Unjoined Owners—Forced Pooling and Cotenancy Issues*, PROCEEDINGS OF 56TH ROCKY MTN. MIN. L. ANN. INST. (2010); Bruce M. Kramer, *Compulsory Pooling and Unitization with an Emphasis on the Statutory and Common Law of the Eastern United States*, 27TH ANNUAL ENERGY & MIN. L. INST. (2006).

152. When the mineral interest in a tract is subject to an oil and gas lease, the person who is the "mineral owner" and who has the right to participate or not participate is the lessee. When a tract is not subject to an oil and gas lease, the landowner (or mineral estate owner if there is a severed mineral estate)—sometimes called an "unleased owner" in such circumstances—is the person with a right to participate or not participate. With respect to the three options discussed in the text, some states treat non-operator oil and gas lessees differently from unleased owners. For purposes of this Article, the difference in treatment can be ignored without detracting from the basic explanation of how the three options work.

153. Several authorities describe this approach. *See, e.g.*, Patrick H. Martin, *Unleased and Unjoined Owners—Forced Pooling and Cotenancy Issues*, PROCEEDINGS OF 56TH ROCKY MTN. MIN. L. ANN. INST. § 18.03[3] (2010).

In a sense, the effect of this arrangement is that the nonparticipating mineral owner "pays" his or her share of costs out of revenue, without any risk of sharing in losses in the event that the well is a "dry hole" that never produces oil or gas or in the event that the well is not a dry hole, but that it never produces enough oil or gas to pay all the costs of drilling and operating the well. Thus, under the "free-ride" approach, nonparticipating owners do not share in any losses, but they receive their respective tracts' allocated share of profits. The term "free ride" refers to the fact that they share fully in profits, without carrying any share of the risk.

States that follow the free-ride approach include Alaska,[154] Arizona,[155] Indiana,[156] and Missouri.[157]

2. *The Risk-Charge Approach*

Most states reject the free-ride approach, concluding that it is unfair for a mineral owner to share fully in profits without sharing any of the risk of a loss.[158] These states seek to provide extra compensation to the mineral owners who do "participate" by timely paying their share of drilling costs, thus sharing in the risk that the well might be a dry hole or a marginal producer that does not produce enough to fully recover the costs of drilling. They take one of two approaches to providing extra compensation to participating owners who share in the risks of operations. The most common of these is the "risk-charge" approach.[159]

Under the risk-charge approach, the sharing of revenue is the same as under the free-ride approach for the period *before* the well reaches

---

154. ALASKA STAT. ANN. § 31.05.100 (2022) (providing that non-participating lessee is responsible for reimbursing operator for non-participant's share of costs, but that reimbursement is required only out of production).

155. ARIZ. REV. STAT. ANN. § 27-505(A) (2022).

156. IND. CODE § 14-37-9-3 (2022).

157. MO. REV. STAT. § 259.110 (2022).

158. Bruce M. Kramer, *Compulsory Pooling and Unitization: State Options in Dealing with Uncooperative Owners*, 7 J. ENERGY L. & POL'Y, 255, 264 (1986) (stating that, because a free-ride "is so counter-productive to the essence of the compulsory pooling and unitization idea, most of the major oil producing states have followed the private sector and imposed" a risk charge on persons who elect not to participate in drilling costs).

159. *See, e.g.*, PATRICK MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS OIL AND GAS LAW (abridged edition) § 944; Keith B. Hall, *Single Well Spacing and Pooling: State Spacing and Jurisdiction Over Conservation*, ROCKY MTN. MIN. L. FDN. SPECIAL INST.—ADVANCED LANDMAN'S INST. (2019).

payout.[160] That is, the nonparticipating owners do not receive the share of revenue allocated to their tracts. Instead, the participating owners keep that portion to earnings, which helps repay them for the costs of drilling the well.

But the risk charge approach differs from the free-ride approach for the period *after* the well reaches payout. Under the free-ride approach, the nonparticipating owners begin to receive their tracts' share of revenue once the well reaches payout. In contrast, under the risk-charge approach, the participating owners continue to keep all the revenue from unit operations for some additional period *after* the well reaches payout. This extra revenue rewards the participating owners for taking on the risks of operations. This extra revenue is the *risk charge*, which is effectively paid by the nonparticipating owners because they are required to forego their share of revenue for an additional period. The length of this additional period depends on the jurisdiction. It is common for the participating owners to be allowed to keep the nonparticipating owners' tracts' share of revenue until the well has earned two or three times the costs of drilling and operating the well.[161]

States that follow the risk-charge approach include Alabama,[162] Colorado,[163] Idaho,[164] Louisiana,[165] Michigan,[166] Mississippi,[167] Montana,[168] Nebraska,[169] Nevada,[170] New Mexico,[171] New York,[172] North Dakota,[173] Ohio,[174] Texas,[175] Utah,[176] and Wyoming.[177]

---

160. For a general discussion of how the "free ride" and the "risk fee" concepts work, *see* Bruce M. Kramer, *Compulsory Pooling and Unitization: State Options in Dealing with Uncooperative Owners*, 7 J. ENERGY L. & POLICY 255, 261–71 (1986).

161. *See, e.g.*, LA. STAT. ANN. § 30:10 (2014).

162. ALA. CODE § 9-17-13 (2022).

163. COLO. REV. STAT. § 34-60-116(7)(b) (2022).

164. IDAHO CODE § 47-320 (2022).

165. LA. STAT. ANN. § 30:10(A) (2014).

166. MICH. COMP. LAWS SERV. § 324.61513(4) (LexisNexis 2022); MICH. ADMIN. CODE R. 324.1206(4) (2023).

167. MISS. CODE ANN. § 53-3-7(2)(g) (2022).

168. MONT. CODE ANN. § 82-11-202 (2021).

169. NEB. REV. STAT. § 57-909(2) (2022).

170. NEV. REV. STAT. § 522.060(4) (2021).

171. N.M. STAT. ANN. § 70-2-17(C) (2022).

172. N.Y. ENV'T CONSERVATION LAW § 23-0901(3) (2022).

173. N.D. CENT. CODE § 38-08-08(3) (2021).

174. OHIO REV. CODE ANN. § 1509.27 (2022).

175. TEX. NAT. RES. CODE ANN. §§ 102.013, 102.052 (2021).

176. UTAH CODE ANN. § 40—6-6(6) (LexisNexis 2023).

177. WYO. STAT. ANN. § 30-5-109(g) (2023).

3. The "Surrender of Working Interest" Approach

A different approach to compensating participating owners is the surrender-of-working-interest approach (a "working interest" is the right to explore for and produce minerals under an oil and gas lease[178]).[179] Under this approach, a non-participating owner is treated almost like an oil and gas lessor. The owner gives up its working interest to the participating owners, while retaining a royalty interest—that is, a right to specified fraction of the revenue allocated to a tract, without any obligation to share in costs. The royalty fraction may be one-eighth or a little higher fraction of what the owner would have received if it had agreed to pay its share of costs. These fractions—one-eighth or a little higher are similar to the royalties typically paid to a lessor under an oil and gas lease. In some jurisdictions, a nonparticipating owner who is required to surrender its working interest often receives an upfront payment (that resembles the upfront bonus paid to oil and gas lessors), in addition to a royalty on production (that resembles the royalty that an oil and gas lessee pays to an oil and gas lessor)

The leading state (from the standpoint of oil production) that follows the surrender-of-working interest approach is Oklahoma. Oklahoma's statutes do not expressly grant its oil and gas regulator—the Corporation Commission—the authority to utilize the surrender-of-working-interest approach. Instead, Oklahoma's statute requires the Corporation Commission to allocate costs on a "just and reasonable" basis.[180] The Corporation Commission developed the surrender-of-working-interest approach by way of its orders, and the Commission's use of the approach has been upheld by the Oklahoma Supreme Court.[181] Several other states have adopted statutes that authorize use of the surrender-of-working-interest approach,

178. PATRICK H. MARTIN & BRUCE M. KRAMER, MANUAL OF OIL AND GAS TERMS 1147 (Williams & Meyers, 18th ed. 2015).

179. Several secondary sources discuss this approach. *See, e.g.*, Patrick H. Martin, *Unleased and Unjoined Owners—Forced Pooling and Cotenancy Issues*, PROCEEDINGS OF 56TH ROCKY MTN. MIN. L. ANN. INST. § 18.03[3] (2010); *see also* BRUCE M. KRAMER & PATRICK H. MARTIN, THE LAW OF POOLING AND UNITIZATION §12.02 (3rd ed. 2022).

180. OKLA. STAT. ANN. tit. 52 § 52-87.1(e) (2014) (stating that "terms and conditions" of pooling must be "just and reasonable").

181. Anderson v. Corporation Commission, 327 P.2d 699, 700-1 (Okla. 1957).

including Arkansas,[182] Illinois,[183] Kentucky,[184] Pennsylvania,[185] South Dakota,[186] and West Virginia.[187]

4. Hybrid Approaches

Some states follow a hybrid approach. For example, although Louisiana is generally classified as a risk-charge state,[188] Louisiana only applies the risk-charge approach to mineral lessees who choose not to participate.[189] Louisiana follows the free-ride approach for owners who have not granted an oil and gas lease.[190] A few states follow a surrender-of-working interest approach, in which a non-participating owner surrenders his or her working interest, while retaining a royalty. But these states also provide that, after the well has paid for itself two or three times, the non-participating owner recovers his or her working interest.[191] This recovery of the working interest causes this approach to have some similarities to the risk-charge approach.

3. Use of the Land in Drilling Unit—Pooling as Exception to Trespass Rules

Although a company generally has no right to conduct operations on or beneath land unless it owns or leases the land, courts sometimes have found that statutory pooling or unitization of the type described by this article in section II(B)(3) of this article can create an exception to this rule. Thus, in the same way that unitization can provide exceptions to the rule of capture, it can modify rules relating to trespass. In *Nunez v. Wainoco Oil & Gas Co.*,[192] the Louisiana Commissioner of Conservation entered orders creating a compulsory unit and issued a permit authorizing an operator to

---

182. ARK. CODE ANN. § 15-72-304(b)(4) (2023).
183. 225 ILL. COMP. STAT. ANN. § 725/22.2(f) (2023).
184. KY. REV. STAT. ANN. § 353.640 (3) (LexisNexis 2023).
185. 58 PA. CONS. STAT. § 408(c) (2023).
186. S.D. CODIFIED LAWS § 45-9-33 (2023).
187. W. VA. CODE § 22C-9-7(b)(5) (2023).
188. *See, e.g.*, BRUCE M. KRAMER & PATRICK H. MARTIN, THE LAW OF POOLING AND UNITIZATION §12.02 (3rd ed. 2022).
189. LA. STAT. § 30:10(e)(i).
190. This can be gleaned from Louisiana Revised Statute 30:10(e)(i)'s provision that the "risk charge" does not apply to unleased mineral interests and to the jurisprudence prior to the effective date of the risk-charge statute, providing that a non-participating mineral interest owner could not be required to pay out-of-pocket for a share of the expenses associated with an unprofitable well. *See* Davis Oil Co. v. Steamboat Petroleum Corp., 583 So. 2d 1139 (La. 1991).
191. *See, e.g.*, La. Rev. Stat. 30:10.
192. Nunez v. Wainoco Oil & Gas Co., 488 So. 2d 955, 956 (La. 1986).

drill a well that became the unit well. The drilling began on leased property, near an unleased tract that was part of the unit.[193] After the well was completed, a directional survey indicated that the drilling had deviated from vertical and that the well had bottomed about four or five feet inside the subsurface of the unleased tract.[194] The owner of that neighboring tract brought a trespass action against the operator and other defendants who owned mineral interests in the unit, seeking an order that required the operator to remove the wellbore.[195]

The district court dismissed the action, concluding that it was an improper collateral attack on an order of the Commissioner of Conservation.[196] The appellate court reversed, and remanded the case so that the district court could determine whether a trespass occurred.[197] The Louisiana Supreme Court granted review and dismissed the case, but on different grounds than the district court.

The Supreme Court stated that compulsory unitization converts the separate exploration and development rights held by different persons within the drilling unit into a common interest for the drilling and development of the unit.[198] The court described the common interest as "a departure from the traditional notions of private property."[199] The court then explained that this departure is justified as a "reasonable exercise of the police power" because oil and gas "migrate to points of lower pressure caused by . . . drilling," so that one person's production of oil or gas affects "the correlative rights" of others who have exploration and development rights that apply to the "common reservoir."[200] Indeed, unitization "*protect[s]* private property [by] preventing it from being taken by one of the common owners without regard to the enjoyment of the others."[201]

> The court noted that this had "supercede[d] in part" Louisiana's rule that the surface owner also owns the subsurface, and that the trespass alleged by the plaintiff was a subsurface trespass, not a surface trespass. The court then concluded: "Since established private property law concepts, such as trespass, have been superceded in part by Louisiana's Conservation Law when a unit has been created

193. *Id*. at 957.
194. *Id*. at 957.
195. *Id*. at 956.
196. *Id*. at 958.
197. *Id*. at 959.
198. *Id.* at 961–62.
199. *Id.*
200. *Id.* at 962–63.
201. *Id.* at 963 (quoting Ohio Oil Co. v. Indiana, 177 U.S. 190 (1900)).

by order of the Commissioner, we do not find that a legally actionable trespass has occurred in this instance."[202]

In a subsequent dispute between Nunez and Wainoco, the Louisiana Third Circuit applied the same principle in concluding that unitization orders and the grant of a drilling permit for a particular location can also alter the rules relating to surface trespass.[203] In that subsequent dispute, Nunez complained about Wainoco using a portion of his land for activities associated with drilling a well just on the other side of the property line.[204] Using a portion of Nunez's surface during the drilling process had been necessary because, although the well site was not on Nunez's property, the site designated on the drilling permit was near the property line.[205] The appellate court stated that an operator might be required to compensate the non-consenting landowner for any damages to his property, but the mere use of his land is not a basis for trespass liability if use of the land is necessary to drill a unit well at the location specified by the Commissioner of Conservation.[206]

Similarly, the Oklahoma Supreme Court has held that the operator of a pooled unit even has the right to drill a unit well at a surface location owned by a landowner who refuses to give his consent,[207] though the owner might be entitled to compensation for the value of such use under the Takings Clause of the Oklahoma Constitution.[208] Further, the North Dakota Supreme Court has held that, when the state's regulators have created a compulsory unit, an operator does not incur liability for trespass by drilling a horizontal well beneath the property of an unleased owner without that owner's consent.[209]

---

202. *Id*. at 964.

203. Nunez v. Wainoco Oil and Gas Co., 606 So.2d 1320 (La. Ct. App. 1992).

204. *Id.* at 1323 (the plaintiff alleged that "the mud pit, ring levee, water pit, water well, machinery, pipe, board road, derrick and other equipment necessary for drilling were located on his property").

205. *Id.* at 1326.

206. *Id*. at 1327.

207. Texas Oil and Gas Corp. v. Rein, 534 P.2d 1277, 1278-79 (Okla. 1974).

208. Cormack v. WIL-MC Corp., 661 P.2d 525, 526-27 (Okla. 1983) (citing OKLA. CONST. art. II, § 23).

209. Continental Res., Inc. v. Farrar Oil Co., 559 N.W.2d 841, 846 (N.D. 1997). *Cf.* Railroad Comm'n v. Manziel, 361 S.W.2d 560, 568 (Tex. 1962) (normal rules of trespass altered when oil and gas regulator authorized a secondary recovery operation that might result in intrusion of injected water into subsurface of appellees' land). *Cf.* 58 PA. STAT. AND CONS. STAT. § 34.1 (West 2013) (although it otherwise might be a trespass to use the subsurface of one property to transport hydrocarbons produced from another tract, an operator with leases on contiguous tracts can drill a horizontal well for production of hydrocarbons without pooling).

4. Use of a Pooling-Like Model Would be Used for CCS

A pooling-like model could be used for CCS. Just as oil and gas pooling can alter the rules of trespass and allow the operator of a pool unit to use the subsurface of landowners within the pooled area without trespass liability, a pooling-like order for CCS could authorize a CCS operator to inject carbon dioxide that migrates into the subsurface of neighboring tracts, without the CCS operator incurring trespass liability. A pooling-like order could also provide for a sharing of revenues and expenses.

Because CCS operations do not have some of the risks traditionally associated with oil and gas activity, such as the risk of drilling a dry hole, a state that followed a pooling-like approach for CCS might choose to follow an approach for expenses that is similar to a free ride approach (that is, landowners would not pay any costs out of pocket, but their proportionate share of expenses would be deducted from their share of revenue) or a risk-charge approach in which the risk charge is not very high.

Alternatively, they could follow an approach that is somewhat like a surrender-of-working-interest approach. In such an approach, landowners who do not choose to pay their share of expenses would not have to pay any expenses—not even out of production—but in financial terms they would be treated like an oil and gas lessor. The operator might be required to pay such a landowner an upfront fee, analogous to an oil and gas lease bonus, based on the size of the landowner's tract. Such a landowner also would receive an injection fee or share of the revenue from the CCS operation, but the injection fee or share of revenue paid to such a landowner would be less revenue share that would be paid to a landowner who bears his or her share of expenses.

C. Unitization

A third model that could be used to authorize CCS operators to use subsurface pore spaces, while also requiring the CCS operator to compensate the landowners, would be a scheme analogous to the "unitization" or "fieldwide unitization" that is sometimes used in oil and gas development.[210]

210. Hall & Wiseman, *supra* note 91, at 263–66.

1. What is Unitization?

A prominent oil and gas treatise describes unitization as the joint operation of all or some portion of a producing reservoir.[211] Unitization has some similarities to pooling.[212] For example, under unitization, a single company typically will be named operator and there will be a sharing of revenue and costs amongst the various tracts in the fieldwide unit.

However, unitization is different from pooling in several ways. As previously noted, "pooling," traditionally has been used bring together small tracts to form a drilling unit of sufficient size to justify granting a well permit.[213] In contrast, unitization is used to facilitate the coordinated operation of a large area in which there are separately owned tracts. Such fieldwide coordination can increase primary production in some oil and gas fields. Nevertheless, fieldwide unitization is rarely used in the United States for primary production, unless the primary production requires pressure maintenance.[214] However, some types of operations typically cannot be conducted effectively unless operations are conducted in a

---

211. *See* PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS OIL AND GAS LAW § 901.

212. The terms "pooling" and "unitization" are sometimes used interchangeably—probably because the two concepts have some similarity—but oil and gas scholars and commentators generally take care to distinguish the two concepts. Hall & Wiseman, *supra* note 91, at 263–66 ("Although the terms 'pooling' and 'unitization' often are used interchangeably, prominent authorities give different meanings to the two terms").

Further, the law recognizes a difference. The statutes that authorize the regulator to enter pooling orders are different from the statutes that authorize the regulator to enter unitization orders, and the requirements that must be met before a pooling order is authorized are different than the requirements needed to justify a unitization order. Compare, for example: LA. STATS. ANN. § 30:5 (unitization) (2021); on the one hand with 30:9 and 30:10 (pooling); N.M. STAT. ANN. § 70-2-17(B) (2018) (pooling); and N.M. STAT. ANN. § 70-7-6 (2019) (unitization); OKLA. STAT. tit. 52 § 52-87.1(a) (2020) (pooling), and OKLA. STAT. tit. 52, § 52-287.4 (2020) (unitization); WYO. STAT. ANN. § 30-5-109(f) (2020) (pooling) and WYO. STAT. ANN. § 30-5-110 (2020) (unitization).

Texas is an exception to the rule that most states with oil and gas activity grant the oil and gas regulator the authority to order pooling, as well as the authority to order unitization. Texas authorizes its oil and gas regulator—the Texas Railroad Commission—to issue pooling orders, TEX. NAT. RES. CODE § 102.011 (1977), but does not authorize the regulator to order unitization. BRUCE M. KRAMER, PRINCIPLES AND HISTORICAL CONTEXT OF POOLING AND UNITIZATION, at 1–11 (Rocky Mountain Min. Law Special Inst. 1997) ("Today, with the exception of Texas, all major producing states have a compulsory unitization statute.").

Moreover, oil and gas leases often delegate to the lessee the authority to agree to voluntary pooling, voluntary unitization, or both. PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS, OIL AND GAS LAW § 901 (2022) ("A substantial number of contemporary oil and gas leases contain a clause which authorizes the lessee under certain specified conditions to pool or unitize the leased premises with other premises.").

213. PATRICK H. MARTIN & BRUCE M. KRAMER, MANUAL OF OIL AND GAS TERMS 787 (Williams & Meyers, 18th ed. 2015).

214. Hall & Wiseman, *supra* note 91, at 264.

coordinated way over most or all of an oilfield. These types of operations include pressure maintenance,[215] gas injection,[216] secondary recovery,[217] and enhanced oil recovery.[218] In the United States, when fieldwide unitization

215. The term "pressure maintenance" refers to "[t]he injection of gas, water or other fluids into oil or gas reservoirs to maintain pressure or retard pressure decline in the reservoir for the purpose of increasing the recovery of oil or other hydrocarbons therefrom." *See id.* at 806.

216. Gas injection is the "[i]ntroduction of gas under high pressure into a producing reservoir through an input or injection well as part of a [pressure maintenance, secondary recovery, or recycling operation." *See id.* at 424. The "Schlumberger Energy Glossary" defines "gas injection" as being "[a] reservoir maintenance or secondary recovery method that uses injected gas to supplement the pressure in an oil reservoir or field. In most cases, a field will incorporate a planned distribution of gas-injection wells to maintain reservoir pressure and effect an efficient sweep of recoverable liquids." *Energy Glossary: Gas Injection*, SCHLUMBERGER LIMITED, https://glossary.slb.com/en/terms/g/gas_injection [https://perma.cc/NEM8-ZTCR] (last visited Jan. 16, 2023).

217. The "Schlumberger Energy Glossary" entry for "secondary recovery" states in part:

> The second stage of hydrocarbon production during which an external fluid such as water or gas is injected into the reservoir through injection wells located in rock that has fluid communication with production wells. The purpose of secondary recovery is to maintain reservoir pressure and to displace hydrocarbons toward the wellbore. The most common secondary recovery techniques are gas injection and waterflooding. Normally, gas is injected into the gas cap and water is injected into the production zone to sweep oil from the reservoir.

Energy Glossary: Secondary Recovery, SCHLUMBERGER LIMITED, https://glossary.slb.com/en/terms/s/secondary_recovery [https://perma.cc/B7QD-MDNJ] (last visited Jan 16, 2023). Another source states, that the term "secondary recovery" typically is used to refer to methods for the "recovery of hydrocarbons in which part of the energy employed to move the hydrocarbons through the reservoir is applied from extraneous sources by the injection of liquids or gases into the reservoir." PATRICK H. MARTIN & BRUCE M. KRAMER, MANUAL OF OIL AND GAS TERMS 949 (Williams & Meyers, 18th ed. 2015).

218. The "Schlumberger Energy Glossary" entry for "enhanced oil recovery" states in part:

> An oil recovery enhancement method using sophisticated techniques that alter the original properties of oil. Once ranked as a third stage of oil recovery that was carried out after secondary recovery, the techniques employed during enhanced oil recovery can actually be initiated at any time during the productive life of an oil reservoir. Its purpose is not only to restore formation pressure, but also to improve oil displacement or fluid flow in the reservoir. The three major types of enhanced oil recovery operations are chemical flooding (alkaline flooding or micellar-polymer flooding), miscible displacement (carbon dioxide [CO2] injection or hydrocarbon injection), and thermal recovery (steamflood or in-situ combustion).

Energy Glossary: Enhanced Oil Recovery, SCHLUMBERGER LIMITED, https://glossary.slb.com/en/terms/e/enhanced_oil_recovery [https://perma.cc/NEM8-ZTCR] (last visited Jan. 16, 2023). Another sources states that "enhanced recovery" is is used, it typically is used to facilitate one of these types of operations, though sometimes fieldwide unitization might be used for primary production from very deep formation that will involve very expense and complex drilling operations.[219] To understand the use of fieldwide unitization, it is important to understand the distinction between primary production and the more complex operations that are typically used during fieldwide unitization.

In most oilfields, production begins with primary production. In primary production, oil flows to the surface, either without pumping (due to the pressure of the subsurface formation from which the oil is produced) or by being pumped.[220] Over time, however, the rate at which oil can be produced via primary production declines[221] and eventually it no longer will be economical to continue producing oil via primary production because operating costs will exceed operating revenue. At this stage, the subsurface formation will still contain a portion of the crude oil that originally was there.[222] The fraction of the original oil that remains in place when primary production is no longer economical will depend on several factors.[223]

In some types of formations, it may be economical to produce some of the oil that remains in place after primary production by production methods that are more complex and typically more costly than primary production. These include gas injection or pressure maintenance,[224] secondary recovery,[225] and enhanced recovery operations.[226]

Gas injection or pressure maintenance is sometimes used to increase the production of oil or other hydrocarbon liquids from a formation that

---

> [T]he increased recovery from a pool achieved by artificial means or by the application of energy extrinsic to the pool, which artificial means or application includes pressuring, cycling, pressure maintenance or injection to the pool of a substance or form of energy but does not include the injection in a well of a substance or form of energy for the sole purpose of (i) aiding in the lifting of fluids in the well, or (ii) stimulation of the reservoir at or near the well by mechanical, chemical, thermal or explosive means.

PATRICK H. MARTIN & BRUCE M. KRAMER, MANUAL OF OIL AND GAS TERMS 328 (Williams & Meyers, 18th ed. 2015).

219. PATRICK H. MARTIN & BRUCE M. KRAMER, MANUAL OF OIL AND GAS TERMS (Williams & Meyers, 18th ed. 2015). *See, e.g.*, LA. STAT. ANN. 30:5.1 (2021).

220. HYNE, *supra* note 16, at 459.

221. *Id*. at 435.

222. HYNE, *supra* note 16, at 459.

223. *Id*. (noting that it depends on the type of reservoir drive, the viscosity of the oil, and the reservoir's permeability).

224. *Id*. at 539.

225. *Id*. at 459–62 (describing "waterflood" operations, a type of secondary recovery).

226. *Id*. at 462–63.

contains both liquid hydrocarbons and natural gas.[227] During primary production, the pressure of the formation will decrease.[228] This decrease in pressure can cause a decrease in the rate of oil production. If production wells drilled to the formation are producing a combination of hydrocarbon liquids (including oil) and natural gas, as is often the case, the operator of a well might reinject the natural gas back into the formation.[229] Such reinjection of the gas will help maintain the pressure of the formation (that is, decrease the rate at which the pressure of the formation declines over time) and thereby increase the amount of hydrocarbon liquids that are produced. The reinjection of gas may make economic sense because the hydrocarbon liquids sometimes are more valuable than the reinjected natural gas.[230] Further, once it is no longer economical to continue producing hydrocarbon liquids, the operator may still be able to recover natural gas from the formation. Thus, the operator might be simply delaying the recovery of natural gas that is reinjected during the production of hydrocarbon liquids, rather than permanently foregoing such recovery.

During secondary recovery, an operator often employs a combination of injection wells and production wells.[231] The operator will use the injection wells to inject a substance such as water or steam into the formation that contains oil.[232] The water or steam will help push or sweep the oil toward production wells, from which a combination of oil and water are produced.[233] The water is separated from the recovered oil and recycled to join the stream of water being injected. If steam is injected, rather than water, the steam may also heat the oil and reduce its viscosity,[234] making the oil flow more easily.

---

227. For a nice discussion of gas injection for a non-technical reader, *see* JACQUELINE LANG WEAVER, UNITIZATION OF OIL AND GAS FIELDS IN TEXAS: A STUDY OF LEGISLATIVE, ADMINISTRATIVE, AND JUDICIAL POLICIES 14–16 (Resources for the Future Press eds., 1st ed. 1986).

228. *Id*. at 10, 12.

229. *Id*. at 14, 16.

230. *Id*. at 19.

231. HYNE, *supra* note 16, at 460.

232. *Id*.

233. *Id*. at 459–60 (water), 465 (steam).

234. *Id*. at 465. Viscosity is a measure of a fluid's resistance to flowing. Cold molasses is an example of a fluid that has a high viscosity. If the molasses is heated, its viscosity or resistance to flowing will decrease. *See* PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS OIL AND GAS LAW MANUAL OF TERMS (Williams & Meyers, 18th ed. 2015).

During enhanced recovery (sometimes called tertiary recovery because it sometimes begins after secondary recovery can no longer economically recover more oil), a substance such as carbon dioxide is injected into the oil-bearing formation, using injection wells.[235] The carbon dioxide can help push or sweep the oil toward production wells, but the carbon dioxide can also dissolve into the oil.[236] This causes the oil to swell and become less viscous, thereby making the oil flow more easily.[237]

Gas reinjection or pressure maintenance operations typically require fieldwide unitization (or a regulatory order requiring reinjection).[238] This is because, when a large oilfield has several companies operating wells, one company's decision to reinject gas to maintain pressure will not help maintain the pressure of the formation very well if most other operators are not reinjecting gas. Both secondary recovery and enhanced recovery often require fieldwide unitization because they require the conversion of some wells from being production wells to being injection wells that are used to inject a substance that pushes oil to other wells.[239] This requires coordination of operations over a large area.

2. *Implementing Fieldwide Unitization by Regulatory Order*

Fieldwide unitization can be implemented by voluntary agreement,[240] but most oil and gas states also authorize a regulatory agency to enter orders that implement unitization.[241] Typically, the statute or statutes that authorize a regulatory to implement unitization is different than the statute or statutes that authorize the regulator to enter pooling orders. Pooling and unitization are similar in some ways, but unitization typically covers a larger area than a pooling order, unitization is designed to make it easier to coordinate the operation of wells through most or all of an oilfield, whereas pooling simply seeks to avoid the drilling of unnecessary wells.

235. WEAVER, *supra* note 227, at 18; HYNE, *supra* note 16, at 529.

236. HYNE, *supra* note 16, at 462–63.

237. Nat'l Energy Tech. Lab'y, *Carbon Dioxide Enhanced Recovery*, DEP'T OF ENERGY 5 (Mar. 2010), https://www.netl.doe.gov/sites/default/files/netl-file/CO2_EOR_Primer.pdf [https://perma.cc/WV9U-ESPF]; Huazhou Li et al., *Enhanced Swelling Effect and Viscosity Reduction of Solvent(s)/CO_2/Heavy-Oil Systems*, 18 SPE J. 695, 695 (Aug. 2013).

238. PATRICK H. MARTIN & BRUCE M. KRAMER, WILLIAMS & MEYERS OIL AND GAS LAW § 901 (3rd ed. 2022) ("Both economics and property rights require the integration of a field in order for such operations as gas cycling, pressure maintenance, and secondary recovery to be conducted.").

239. WEAVER, *supra* note 227, 16–19.

240. BRUCE M. KRAMER & PATRICK H. MARTIN, THE LAW OF POOLING AND UNITIZATION § 17.01 (3rd ed. 2022).

241. *Id*. § 18.01 ("Every major producing state, other than Texas, has a compulsory unitization statute.").

In addition, there are few other procedural and substantive differences. For example, while most states do not require any particular level of consent amongst landowners and mineral interest owners before a regulator can order pooling, most unitization statutes require consent from a specified fraction of landowners and mineral interest owners before the regulator can order unitization.[242]

Also, in pooling the sharing of revenue is usually in proportion to the acreage in which each person has an interest. Thus, someone who holds all mineral rights in a 20-acre tract would get twice the share of a person who holds all mineral rights in a 10-acre tract. In unitization, however (as is discussed in more detail later), the formula for sharing is often more complex than a simple surface acreage basis. The formula for sharing may consider acreage, as well several other factors. For example, if two persons each held all mineral interests in separate tracts of the same size, but the estimated vertical thickness of the oil formation beneath the first person's tract was fifty feet, while the estimated thickness beneath the second person's tract was one hundred feet, the second person might get twice the share of the first person.

3. Allocation of Costs and Revenues Under Unitization

The allocation of costs and revenue under unitization is typically more complex than under pooling. Under compulsory pooling, costs and revenues are almost always allocated based on a single factor, and it is almost always the same factor from one pooling order to the next—namely, surface acreage. In contrast, the allocation of costs and revenue under fieldwide unitization is often based on several factors, and the factors often differ from one unitization order to the next. The greater complexity of cost and revenue allocations under unitization, compared to pooling, is justifiable for multiple reasons.

One reason relates to the subsurface formation from which hydrocarbons are being produced. A particular formation's porosity, permeability, thickness (from top to bottom of the formation), and depth (beneath the surface) can vary across the formation, as can the quality and amount of hydrocarbons present in the pore spaces can vary from one location to

242. *Id*. § 18.02[4][b] ("with the possible exception of Alaska and Washington, all of the compulsory unitization statutes require that the application for the order have the consent or approval of a minimum percentage of the working- and royalty-interest owners before the order is issued or becomes effective." (footnotes omitted from quote).

another. Given that unitization orders typically cover a larger area than pooling orders,[243] the amount of variation in the subsurface formation being developed will likely be greater under unitization than under pooling.

A second reason for using a more complex formula when allocating costs and revenues under unitization relates to the nature of operations under unitization. In the United States, fieldwide unitization is rarely used during primary production, unless pressure maintenance is required. Instead, it is used for secondary recovery, enhanced oil recovery, and similar operations[244] (such as pressure maintenance)—most of which cannot effectively be carried out unless operations are coordinated over a large area. These types of operations may be more costly than primary production, but they can often be used to produce hydrocarbons profitably after primary production is no longer economical or is so marginally economical that the increased productivity that might be achieved using secondary recovery or enhanced recovery operations will justify the additional expense. But across a large oil field, the point at which primary production becomes uneconomical (or at least less economical than secondary or enhanced recovery) may occur earlier in some areas than others.

It may not make sense to begin fieldwide secondary or enhanced recovery operations as soon as the primary production becomes uneconomical in just one area, if primary production still is profitable elsewhere in the field. On the other hand, it may not make sense to delay the start of fieldwide secondary recovery or enhanced recovery operations until primary production has become uneconomical in every single portion of the oil field. In such cases, an order to start fieldwide secondary or enhanced recovery operations may sacrifice the possibility of continued profitable primary production in some portions of the field in order to gain an overall increase in profitability for the oil field as a whole.[245] In such cases, the persons who held oil and gas operating rights in the area where primary production was still profitable might believe that they are entitled to a greater portion of the revenue from unitized operations to compensate them for the sacrifice of their primary recovery.

The selection of a formula for allocating costs and revenues of unit operations is often complex and contentious. In *Trout v. Wyoming Oil and Gas Conservation Commission*, several persons having oil and gas rights

243. Historically, most pooled orders entered for natural gas production covered areas 640 acres or less, while pooling orders entered for oil production tended to be smaller. *See* Trout v. Wyoming Oil & Gas Conservation Comm'n, 721 P.2d 1047, 1048 (Wyo. 1986) (fieldwide unitization order covered 7,385 acres); *see also* Gilmore v. Oil & Gas Conservation Comm'n, 642 P.2d 773, 774 (Wyo. 1982) (fieldwide unitization order covered 31,065 acres).

244. Hall & Wiseman, *supra* note 91, at 264.

245. Consider, for example, the case of Railroad Comm'n v. Manziel, 361 S.W.2d 560 (Tex. 1962).

in an area became interested in switching from primary production to secondary recovery operations.[246] They notified the regulator of this interest and formed a technical committee to study the potential for secondary recovery and to develop possible formulas for allocating costs and revenues from such operations.[247] The companies with operating rights in different portions of the field favored different formulas.[248]

The various persons with operating rights and other persons who held royalty rights (but no operating rights) met in December 1983 and considered various potential formulas for allocating costs and revenue.[249] During the meeting, they held five votes and eventually reached significant consensus, though not unanimity.[250] Just over 82% (in interest, not heads) of the operators and just over 93% (in interest) of the royalty owners supported a plan to allocate costs and revenues under a formula based 47.5% on a tract's production during the preceding six months, 47.5% on the remaining proved developed and producing reserves, and 5% on the original oil in place.[251] Wyoming's oil and gas regulator entered an order to implement compulsory fieldwide unitization based on the formula approved at the December 1983 meeting.[252] A party that favored a different formula appealed, but the Wyoming Supreme Court upheld the regulator's unitization order.[253]

In *Gilmore v. Oil & Gas Conservation Commission*, operators in an oilfield formed technical committees and subcommittees to consider unitization plans and potential allocation formulas.[254] The committee concluded that overall production from the field would be substantially increased by unit operations, but the operators had trouble agreeing on an allocation formula.[255] They met, considered 71 different formulas, and held votes on nearly 60 of the formulas.[256] They could not come to a consensus because each operator wanted to use a formula that would base allocation

246. *Trout*, 721 P.2d at 1048.
247. *Id*.
248. *Id*. at 1048–49.
249. *Id*. at 1049.
250. *Id*. at 1049.
251. *Id*. at 1049–50. (Production during the preceding six months might be a rough measure of the continuing viability of primary production in an area. The amount of proved developed producing reserves might be a measure of how much recoverable oil remains beneath a tract).
252. *Id*. at 1050
253. *Id*. at 1054.
254. Gilmore v. Oil and Gas Conservation Comm'n, 642 P.2d 773, 774 (Wyo. 1982).
255. *Id*. at 780.
256. *Id*. at 775.

on factors advantageous to that operator's circumstances. To break the deadlock, they used a computer to analyze the patterns of their prior voting and to develop a compromise proposal that gave varying weight to eleven different factors.[257] They obtained a vote of 75.89% in support of the compromise proposal and the Wyoming Oil & Gas Conservation Commission entered a unitization order based on that proposal.[258] An operator that preferred a different formula appealed, but the Wyoming Supreme Court upheld the unitization order.[259]

The discussion above has focused on how costs and revenue are allocated. But what if a particular owner does not wish to participate in the costs of drilling? The general rule is that an owner will not be required to pay a share of costs out of pocket. A nonparticipating owner certainly will have to "pay" their share of costs out of production, but statutes are less likely in the case of unitization than in the case of pooling to impose a risk charge (or surrender of working interest) on nonparticipating owners. For example, Louisiana law authorizes the imposition of a risk charge (at least against non-operator mineral lessees, though not against unleased owners) for those who do not participate in costs under a pooling order,[260] but under a compulsory unitization order a non-participating party is not liable for a risk charge.[261] It only pays its share of costs, not its share of costs and a risk charge, out of production from a compulsory fieldwide unit. A potential justification for this difference is that fieldwide unitization operations probably involve less risk. Although there is no guarantee that the operations will be profitable, such operations do not have the same "dry hole" risk that might be present in pooling.

4. Use of Unitization Model for Compensating Holdout Landowners for CCS Operations

As an alternative to granting CCS operators the power of eminent domain to acquire subsurface pore space rights from holdout landowners, a state could enact legislation that gives a state regulator the power to authorize a CCS operator to inject carbon dioxide into the subsurface even

---

257. *Id*. at 775.
258. *Id*. at 775.
259. *Id*. at 781.
260. LA. STAT. ANN. § 30:10 (2014).
261. LA. STAT. ANN. § 30:5 (2021) ("no such owner who has not consented to the unitization shall be required to contribute to the costs or expenses of the unit operation or to the cost of capital investment in wells and physical equipment and intangible drilling costs except out of the proceeds of production"). *See also* W. VA. CODE § 22C-9-8 (2023) (a unitization statute from a state that follows the surrender-of-working interest approach for pooling, but which, in the unitization context, only makes nonconsenting owners liable for costs out of their share of production).

though the injections will cause the carbon dioxide to migrate into the subsurface of neighboring tracts where the CCS operator has not obtained an agreement from the landowner to allow such migration. Thus, rather than authorizing the CCS operator to obtain and pay a single lump sum to obtain title to some property interest in the pore spaces beneath a neighbor's land (with the ownership interest being either ownership or potentially an easement), the regulator would authorize the CCS operator to use those pore spaces without title, but with an obligation to pay the neighbor a share of revenue from the CCS operation on an ongoing basis.

Notably, several states have already enacted statutes that authorize a state regulator to enter an order for a pooling-like or unitization-like process for CCS operations.[262] These include California,[263] Kentucky,[264] Mississippi,[265] Montana,[266] Nebraska,[267] North Dakota,[268] Utah,[269] West Virginia,[270] and Wyoming.[271]

The process and requirements for obtaining an order under these CCS statutes more closely resemble those required for fieldwide unitization than those required for pooling because the CCS statutes do not allow the regulator to issue a unitization-like order unless a specified percentage of the neighbors reach an agreement with the CCS operator or otherwise

262. As previously noted, although unitization is different than pooling, unitization has some similarities to pooling. Indeed, the terms "pooling" and "unitization" are sometimes used interchangeably—probably because the two concepts have some similarity. Hall & Wiseman, *supra* note 91, at 263 ("Although the terms 'pooling' and 'unitization' often are used interchangeably, prominent authorities give different meanings to the two terms"). Thus, someone could characterize these CCS statutes as creating a pooling-like process, but the author of this Article concludes that these CCS statutes more closely resemble fieldwide unitization statutes than pooling statutes. *Id*.

Further, the law recognizes a difference. The statutes that authorize the regulator to enter pooling orders are different from the statutes that authorize the regulator to enter unitization orders, and the requirements that must be met before a pooling order is authorized are different than the requirements needed to justify a unitization order. Compare, for example: LA. STAT. ANN. §§ 30:5 (unitization) with 30:9 and 30:10 (pooling); N.M. STAT. ANN. § 70-2-17(B) (2018) (pooling) and § 70-7-6 (2019) (unitization); OKLA. STAT. ANN. tit. 52 § 87.1(a) (2014) (pooling) and § 287.4 (2014) (unitization).

263. CAL. PUB. RES. CODE § 71460 (2023).

264. KY. REV. STAT. ANN. § 353.808 (West 2018).

265. MISS. CODE ANN. § 53-11-9 (2017).

266. MONT. CODE ANN. § 82-11-204 (1973).

267. NEB. REV. STAT. § 57-1612 (2021).

268. N.D. CENT. CODE § 38-22-10 (2009).

269. UTAH CODE ANN. § 40-11-10 (West 2022).

270. W. VA. CODE ANN. § 22-11B-19 (LexisNexis 2022).

271. WYO. STAT. ANN. § 35-11-315 (2017).

support the proposed CCS operation. Such a requirement is typical as a prerequisite for compulsory oil and gas unitization, but typically is not a prerequisite for compulsory pooling. Further, the size of the area through which a carbon dioxide plume from CCS operations will spread is probably more like the area typically covered by a fieldwide unitization order than a pooling order. Accordingly, this Article considers these CCS statutes as being designed to implement a unitization-like process, rather than a pooling-like process.

These unitization-like CCS statutes require the operator to share revenue with the neighbors, but like unitization statutes, the CCS statutes do not provide a method for allocating revenue. Some of the factors that should probably be considered in allocating revenue are similar to those that will be considered in allocating cost and revenue in fieldwide unitization. The size of each tract in the area likely probably should be a factor. All other things being equal, the owner of a 100-acre tract should receive a greater share of revenue than the owner of a 20-acre tract. But factors other than acreage *could* be considered, just as with fieldwide unitization, and given that the area through which a carbon dioxide plume spreads may be a large area, perhaps other factors *should* be considered, just as is typical in the allocation of costs and revenue from fieldwide unitization.

The thickness of the formation is one factor should be considered. All other things being equal, if the CCS storage formation is 500-feet thick beneath one 20-acre tract, but the storage formation is only 100-feet thick beneath another 20-acre tract, the tract beneath which the formation is 500-thick probably should be paid more. Porosity and permeability should be considered as well. Perhaps nearness to the injection site should be considered because a greater concentration of carbon dioxide might occupy the pore spaces beneath the tracts near the injection site than those more distant (on the other hand, perhaps being anywhere within the area affected by the carbon dioxide plume will preclude a tract from being part of another CCS project, so that the opportunity cost for a tract is similar without regard to the distance from the injection site).

The fact that a major (and in some cases perhaps the sole) source of revenue for CCS projects will be the 45Q federal tax credit, as opposed to payments for the sale of a product, may complicate the revenue sharing. Presumably, the operator will put a monetary value on the tax break and that a sum of money equivalent to that economic benefit that will from CCS project operator will be obligated to share. Other complications in sharing revenue may arise if the CCS operation is paired with some other operation, such as a coal-fired power plant or a facility that makes a biofuel that qualifies for support under California's Low Carbon Fuel Standard. In such cases, the other facility may receive value by being paired with the CCS operation. Will the CCS operator be required to put a monetary value on any such value and share it with neighbors too?

D. Hybrid Models

A state could choose a hybrid model. For example, rather than selecting an eminent domain model in which the CCS operator makes a one-time payment to acquire some sort of property interest that allows it to use the subsurface of neighboring tracts without further payment, and rather than a unitization-like model in which the CCS operator does not acquire any title (either in the form of subsurface ownership or an easement) and does not pay anything upfront to the neighbors, a state could choose a hybrid model in which the CCS operator can acquire pore space rights via eminent domain, but the neighbors have a right to reserve a limited royalty for each ton injected. In such a case, the CCS operator would pay something upfront, though presumably less than if the CCS operator were to use eminent domain to acquire subsurface rights without the surface owner having reserved the right to a royalty. The CCS operator would also pay an amount based on the amount injected (or perhaps based on the amount of revenue), but presumably this revenue sharing would be less than in a pure unitization-like scheme.

Such a model is also analogous to the surrender-of-working interest approach used by some states to deal with non-participating owners of unleased mineral interests under oil and gas pooling. In such states, the operator of a pooled unit may make both an upfront payment and a royalty to the non-participating owner of an unleased interest.

V. WHICH COMPENSATION MODEL IS BEST?

Because several potential models exist for dealing with holdout landowners, states that wish to prevent holdout landowners from being able to block CCS projects will need to decide which model or models they wish to implement.

A. Considerations in Selecting a Model

Several criteria should be considered in determining which compensation model is best. These include simplicity of administration, fairness, and encouraging CCS.

1. Fairness

One important consideration is the fairness of each potential model. The model should attempt to be fair to both sides, though given that the model will give a CCS operator the right to conduct operations over the objection of holdout landowners, the "fairness" consideration probably should be primarily concerned with the landowner (the "encouraging CCS" factor will help look after the prospective CCS operator's interest). One way this factor might come into play is by favoring a model that most resembles the type of agreements that landowners enter when they voluntarily grant prospective CCS operators the right to use subsurface pore spaces beneath the land.

Relatively few CCS agreements are publicly available, but those that are available generally look somewhat like an oil and gas lease.[272] The prospective CCS operator is required to make an upfront payment in return for the right to use subsurface pore spaces.[273] The agreement can last for decades, but will terminate within a few years if the prospective CCS operator has not actually begun operations (or met someone other benchmark, such as having applied for required permits). The CCS operator also may have to pay annual rental amounts.[274] Finally, the Operator must pay an injection fee that is based on the tons of carbon dioxide injected or the amount of revenue received by the CCS operator.[275] This could weigh in favor of a hybrid model in which a CCS operator might be required pay an upfront amount for acquiring pore space rights by eminent domain, while the landowner is allowed to reserve a royalty interest that entitles the landowner to payments based on the CCS operator's injections or revenue.

2. Ease of Administration

The CCS operator, the neighbors, the regulator, and courts all have an interest in a state using a model that is easy to administer. This interest

272. Four agreements entered by the State of Louisiana are available online. *See Office of Mineral Resources (OMR) Special Notices and Announcements, Final CCS Operating Agreements*, STATE OF LA. DEP'T OF NAT. RES., http://www.dnr.louisiana.gov/index.cfm/page/168 [https://perma.cc/8RVD-VYSB] (last visited Mar. 29, 2023). An agreement entered by Texas is available by public records request from the Texas General Land Office. The author of this article has a copy of the Texas agreement in his files.

273. This payment is much like the upfront "bonus" typically paid to the lessor under an oil and gas lease.

274. These are much like the annual delay rentals that used to be common under oil and gas leases, but which are less common now, because of so many oil and gas leases being "paid up" leases.

275. This is similar to the lessor's royalty that is due on production under most oil and gas leases.

includes ease of administration in the initial grant of rights to the CCS operator and in administering the ongoing relationship between the CCS operator and its neighbors. In some ways, this factor weighs in favor of eminent domain. The prospective CCS operator and landowner might have dueling views about the value of the property right being taken, as in any eminent domain situation. In addition, it is also possible that a landowner could challenge the compensation scheme chosen under a unitization order or under a hybrid order that requires both an upfront payment and an ongoing royalty. Further, a one-time payment for the CCS operator to acquire subsurface pore space rights avoids some of the difficult questions regarding sharing of revenue, which could go on each year throughout the life of a CCS project that might operate for decades.[276]

3. *Encouraging CCS*

This Article has already argued that public policy favors CCS. Consistent with that conclusion, one consideration in choosing between different potential models for dealing with holdout landowners is which model will do the most to encourage CCS. Largely, this turns on which model potential CCS operators and investors will prefer, though it also may turn on which model will generate the most public support or least public resistance.

Some CCS operators and investors may be attracted to the simplicity and certainty of being able to make a one-time, lump sum payment to acquire pore space rights via eminent domain, particularly if the market value of pore space rights is low or modest in a particular area. If the market value of pore space rights becomes elevated, however, some prospective CCS operators and investors may prefer a unitization-like model or a hybrid model instead. These models would have the advantage of avoiding (under a pure unitization scheme) or minimizing (under a hybrid scheme) any upfront payment. Thus, if the prospective CCS project is cancelled altogether without any injections ever having been made or the project terminates after a much lower volume of total injections than planned, the CCS operator will end up having paid less. In essence, some

276. If a pure eminent domain system is used, the rights granted to the CCS operator probably should include a condition that the rights will automatically terminate if the prospective CCS operator does not begin operations within a specified time. Otherwise, the subsurface storage rights might be held forever by an entity created to conduct a CCS operation that never moves forward for some reason.

of the project uncertainties (both upside potential and downside risk) are shared with the neighbors, who are given a royalty or a share of revenue, as opposed to a onetime, upfront payment.

As for gaining public support or minimizing resistance, the different models have their own advantages. An eminent domain system should generate the most upfront money for landowners. On the other hand, some landowners might have visceral objections to a company acquiring ownership of or an easement covering pore spaces beneath the landowner's property that might be more intense than with a unitization model (though the unitization model still would give a CCS operator the right to use pore spaces). Further, once a one-time eminent domain payment is made, the landowners in an area will no longer have any financial stake in the CCS project being a success. In contrast, under a unitization model, the neighbors would continue to receive payments so long as injections continue.

B. The Best Model

Some considerations weigh in favor of one model for dealing with holdout landowners, while other considerations weigh in favor of other options. This makes choosing which model is "best" challenging. The very newness of CCS and lack of experience with it increase the challenge. Given the fact that there are at least some advantages to each of the potential models, and that there also are uncertainties that come with the newness of CCS, the best option would be to give the regulator the power to authorize a prospective CCS operator the right to conduct operations that will cause carbon dioxide to migrate into the subsurface of neighboring tracts. The regulator should have the authority to determine the most advantageous compensation scheme, considering fairness, simplicity of administration, and encouraging CCS.

At one end of the spectrum of possibilities, a compensation scheme could include only a small upfront payment or even no upfront payment whatsoever, with most or all payments being based on the volume of CCS injections or the amount of revenue the CCS operator obtains. On the other end of the spectrum, the compensation scheme could include a higher upfront payment and no payment that is based on the volume of CCS injections or the revenue of the CCS operator. (this would effectively be an eminent domain payment to acquire pore space rights.[277]

Under any model in which landowners are responsible for a share of costs (that is, under any model other than an eminent domain or surrender

277. It its procedural rules, the state should consider providing that, if the regulator chooses a model involving exclusively an upfront payment, the regulator's order should be referred to the court for entry of an eminent domain judgment.

of working interest approach), landowners should not be responsible for paying any costs out of pocket. They should be liable for "payment" of their share of costs, but only out of production. CCS operations are not guaranteed to be profitable, at least there is not the substantial dry hole" risk that was present in traditional oil and gas drilling—that is, the substantial risk that the operator would incur significant drilling costs to drill the well, but that the well might produce no oil or gas whatsoever. Because of this lesser risk, there should not be any risk charge.

VI. CONCLUSION

Public policy favors the widespread use of CCS as one of several tools to address climate change. But to implement CCS on a wide basis, it will be necessary for states to enact legislation that allows CCS operators to inject carbon dioxide that will migrate into the subsurface pore spaces beneath neighboring lands, even if there are holdout landowners with whom the CCS operator is not able to reach an agreement regarding use of the subsurface. Existing federal and state laws provide existing models that have been frequently used in other contexts to allow companies to conduct operations that will affect the subsurface of neighboring landowners (subject to an obligation to pay compensation), even though the companies may not have been able to reach agreements with all those neighboring landowners regarding use of the subsurface.

Such existing models include the use of eminent domain to acquire the right to inject fluids into the subsurface, with compensation typically being a one-time payment. The existing models also include oil and gas pooling and oil and gas unitization, in which companies are given an exclusive right to conduct oil and gas operations in a given area, subject to an obligation to share revenue with the owners of mineral rights in the area, with compensation typically being a share of revenue, without an upfront payment, though these models can include both an upfront payment and payment of a share of revenue. States should adopt one or more of these models to facilitate CCS operations. The best model would give a state regulator the authority to decide whether the compensation to holdout landowners should be exclusively a one-time, upfront payment, or exclusively a share of CCS revenue (or exclusively a fee based on injection volumes), or a mix of both an upfront fee and a fee based on revenue.